Taranaki Regional Council

AGENDA
Policy & Planning

Tuesday 1 September 2020, 10.30am

Policy and Planning Committee

01 September 2020 10:30 AM - 12:00 PM

Agenda Topic | Page

AGENDA

Policy & Planning

Purpose of Policy and Planning Committee meeting

This committee attends to all matters of resource management, biosecurity and related environment policy.

Responsibilities

Prepare and review regional policy statements, plans and strategies and convene as a Hearing Committee as and when required for the hearing of submissions.

Monitor plan and policy implementation.

Develop biosecurity policy.

Advocate, as appropriate, for the Taranaki region.

Other policy initiatives.

Endorse submissions prepared in response to the policy initiatives of organisations.

Membership of Policy and Planning Committee

Councillor C L Littlewood (Chairperson)	Councillor N W Walker (Deputy Chairperson)
Councillor M G Davey	Councillor M J McDonald
Councillor D H McIntyre	Councillor C S Williamson
Councillor E D Van Der Leden	Councillor D N MacLeod (ex officio)
Councillor M P Joyce (ex officio)	
Representative Members	
Councillor C Young (STDC)	Councillor S Hitchcock (NPDC)
Councillor G Boyde (SDC)	Mr P Moeahu (Iwi Representative)
Ms B Bigham (Iwi Representative)	Ms L Tester (Iwi Representative)

Health and Safety Message

Emergency Procedure

In the event of an emergency, please exit through the emergency door in the committee room by the kitchen.

If you require assistance to exit please see a staff member.

Once you reach the bottom of the stairs make your way to the assembly point at the birdcage. Staff will guide you to an alternative route if necessary.

Earthquake

If there is an earthquake - drop, cover and hold where possible.

Please remain where you are until further instruction is given.

MEMORANDUM
Policy & Planning

Date	1 September 2020
Subject:	**Confirmation of Minutes - 21 July 2020**
Approved by:	A D McLay, Director - Resource Management M J Nield, Acting Chief Executive
Document:	2572762

Resolve

That the Policy and Planning Committee of the Taranaki Regional Council:

a) takes as read and confirms the minutes of the Policy and Planning Meeting of the Taranaki Regional Council held in the Taranaki Regional Council chambers, 47 Cloten Road, Stratford, on Tuesday 21 July 2020 at 10.30am

b) notes the recommendations therein were adopted by the Taranaki Regional Council on Tuesday 11 August 2020.

Matters arising

Appendices/Attachments

Document 2546526: Minutes Policy and Planning Committee Meeting - 21 July 2020

MINUTES
Policy & Planning

Taranaki Regional Council

Date	21 July 2020, 10.40am
Venue:	Taranaki Regional Council chambers, 47 Cloten Road, Stratford
Document:	2546526

Members	Councillors	C L Littlewood	Committee Chairperson	
		N W Walker	Committee Deputy Chairperson	
		M G Davey		
		M J McDonald		
		D H McIntyre		
		E D Van Der Leden		
		M P Joyce	ex officio	
		D N MacLeod	ex officio	
Representative Members	Councillors	C Young	South Taranaki District Council	
		S Hitchcock	New Plymouth District Council	
		G Boyde	Stratford District Council	
	Mr	P Moeahu	Iwi Representative	
	Ms	L Tester	Iwi Representative	*Via zoom until 11.30am*
Attending	Councillor	D L Lean		
	Messrs	M J Nield	Acting Chief Executive	
		A D McLay	Director - Resource Management	
		G K Bedford	Director - Environment Quality	
		C Spurdle	Planning Manager	
		R Phipps	Science Manager Hydrology/Biology	
		D Harrison	Rivers Manager	
		S Ellis	Environment Services Manager	
	Ms	G Marcroft	Policy Analyst	
	Messrs	T Parr	Harbourmaster (Port Taranaki)	
		S Tamarapa	Iwi Communications Officer	
		T Davey	Communications Adviser	
	Ms	K Holland	Communications Adviser	
	Miss	L Davidson	Committee Administrator	
	Mr	M Ritai		
	And two members of the public.			

Apologies

Apologies were received from Councillor C Williamson, Mr P Muir and Ms B Bigham.
Littlewood/Walker

Notification of Late Items There were no late items.

1. Confirmation of Minutes – 9 June 2020

Resolved

That the Policy and Planning Committee of the Taranaki Regional Council:

a) takes as read and confirms the minutes of the Policy and Planning Committee meeting of the Taranaki Regional Council held in the Taranaki Regional Council chambers, 47 Cloten road, on Tuesday 9 June 2020 at 10.30am

b) notes the recommendations therein were adopted by the Taranaki Regional Council on Tuesday 30 June 2020.

McDonald/Walker

Matters arising

There were no matters arising.

2. Pest Pathway Management in Taranaki

2.1 Mr S Ellis, Environmental Services Manager, spoke to the memorandum introducing the think-piece *Pest Pathways into Taranaki*. The think-piece was commissioned by the Taranaki Regional Council to review high-risk pest pathways into the Taranaki region, to identify high-risk candidate species, and to contribute to the preparation of a *Risk Assessment Inventory for the Taranaki region*.

Recommends

That the Taranaki Regional Council:

a) receives the memorandum and attached think-piece *Pest Pathways into Taranaki*

b) notes that the attached think-piece identifies 21 high-risk candidate species to be included in a *Risk Assessment Inventory for the Taranaki Region*

c) notes that the *Risk Assessment Inventory for the Taranaki Region* will be regularly amended and updated over time to inform Council responses in the management of pest pathways.

Van Der Leden/Young

Mr S Ellis left the meeting at 10.48am

3. Review of the Navigation Bylaw for Port Taranaki and its Approaches and Harbourmaster Annual Report

3.1 Mr A D McLay, Director - Resource Management, introduced Ms G Marcroft, (Policy Analyst) and Mr T Parr, Harbourmaster.

3.2 Ms G Marcroft, spoke to the memorandum seeking Members agreement to proceed with a review of the *Navigation for Port Taranaki and its Approaches 2009* in accordance with the requirements of the *Local Government Act 2002* (LGA).

3.3 Mr T Parr, Harbourmaster, spoke to the Harbourmasters Annual Report.

3.4 It was clarified that even though the recreational usage of the facilities at Port Taranaki has increased the current facilities are still fit for purpose.

Recommends

That the Taranaki Regional Council:

a) receives this memorandum entitled *Review of the Navigation Bylaw for Taranaki and its Approaches*

b) receives and adopts the draft revised bylaws

c) approves the commencement of the special consultative process for the review of the revised bylaws in accordance with the LGA

d) notes the special consultative process for the review of the *Navigation Safety Bylaw for Port Taranaki and its Approaches 2020* will be run concurrently with another special consultative process for the *River Control and Flood Protection Bylaw for Taranaki 2020.*

Joyce/Boyde

4. Making of River Control and Flood Protection Bylaws for Taranaki

4.1 Mr A D McLay, Director – Resource Management, introduced Mr D Harrison, Rivers Manager and Ms G Marcroft, Policy Analyst.

4.2 Mr D Harrison, Rivers Manager, spoke to the memorandum presenting for Members consideration the proposed *Rivers Control and Flood Protection Bylaws for Taranaki 2020* (Proposed Bylaws) and answered questions arising. Approval to undertake the special consultative process on the Proposed Bylaws in accordance with the *Local Government Act 2002* (LGA) was requested.

4.3 It was clarified that the Proposed Bylaw is for new structures and anything existing would not fall under this Proposed Bylaw.

Recommends

That the Taranaki Regional Council:

a) receives this agenda memorandum *Making River Control and Flood Protection Bylaw for Taranaki*

b) receives and adopts the attached proposed *River Control and Flood Protection Bylaw for Taranaki 2020* and supporting documentation

c) approves the commencement of the special consultative process for the making of new bylaws in accordance with the LGA

d) notes that a hearing may be required to hear submissions made on the proposed bylaws

e) notes that special consultative process for the making of the *River Control and Flood Protection Bylaw for Taranaki 2020* will be run concurrently with another special consultative process for the review of the *Navigation Safety Bylaw for Port Taranaki and its Approaches.*

Van Der Leden/MacLeod

Ms G Marcroft, Mr D Harrison and Mr T Parr left the meeting at 11.15am

5. Update on the Freshwater Reforms

5.1 Mr C Spurdle, Planning Manager, spoke to the memorandum providing an update and summary of the Government's freshwater reforms and answered questions arising.

5.2 Only high level matters had been presented by Government and further detail will be provided later, hence the implications of the proposals were difficult to determine.

Louise Tester left the meeting at 11.30am

Recommends

That the Taranaki Regional Council:

a) receives the memorandum *Update on the freshwater reforms*

b) notes the Council and many others have achieved significant changes through the submission process

c) recognise that until we can review the detail of the regulatory documents, the full implications of the proposals are difficult to assess.

McDonald/Van Der Leden

6. Consideration of Stream Size in Determining Minimum Flows and Water Allocation Limits in Taranaki Rivers

6.1 Mr R Phipps, Science Manager – Hydrology/Biology, gave a presentation for Members introducing the report undertaken by Dr Ian Jowett (Jowett Consulting).

6.2 The report was prepared to inform the review of freshwater plan and, in particular, the consideration of minimum flow and allocation limits for a new proposed *Natural Resources Plan*.

Recommends

That the Taranaki Regional Council:

a) receives the report *Considerations of Stream Size in Determining Minimum Flows and Water Allocation Limits in Taranaki Rivers* and its associated Factsheet

b) notes that the report will underpin technical discussions and the wider consultation of water allocation policy options to be incorporated in the proposed *Natural Resources Plan*.

Walker/Young

7. Report on Advocacy and Response Activities for the 2019/2020 year

Mr A D McLay, Director – Resource Management, spoke to the memorandum reporting on advocacy and response activities for the 2019/2020 year.

Recommends

That the Taranaki Regional Council:

a) receives the memorandum *Report on Advocacy and Response activities for the 2019/2020 year*

b) notes that 22 submissions were made during the year on the policy initiatives of other agencies

c) notes that the senior staff were also involved in various working parties or other for a on central and local government policy development and review projects.

Joyce/Van Der Leden

There being no further business, the Committee Chairperson, Councillor C L Littlewood, declared the meeting of the Policy and Planning Committee closed at 12.05pm.

Confirmed

Policy and Planning
Chairperson: ______________________________

C L Littlewood

Tuesday 1 September 2020

MEMORANDUM
Policy & Planning

Taranaki Regional Council

Date 1 September 2020

Subject: **Update on finalised National Policy Statement on Urban Development 2020**

Approved by: A D McLay, Director - Resource Management

M J Nield, Acting Chief Executive

Document: 2561920

Purpose

1. The purpose of this memorandum is to introduce the finalised *National Policy Statement on Urban Development 2020* (NPS-UD) and to outline Taranaki Regional Council (the Council) requirements relating to its implementation.
2. Further information is available at the Ministry for the Environment's website: https://www.mfe.govt.nz/publications/towns-and-cities/national-policy-statement-urban-development-2020.

Executive summary

3. In August 2019, the Government released a discussion paper for public consultation introducing Government proposals to replace the current *National Policy Statement on Urban Development 2016* (NPS-UDC) with a new national policy statement – the NPS-UD.
4. Under the new NPS-UD, policies would be aimed at ensuring councils remove unnecessary restrictions on urban development and allow for growth 'up' and 'out' in locations that have good access to existing services and infrastructure. Also, under the new NPS-UD, New Plymouth is no longer identified as a major-growth urban area, rather it is now classified as a medium-growth urban area.
5. The Council prepared and submitted a submission in response to a discussion paper on the new NPS-UD, including Council's support for the more directive policies applying only to major metropolitan centres, i.e. Auckland, Hamilton, Tauranga, Wellington, Christchurch and Queenstown.
6. The proposal at that time was that for other urban areas such as New Plymouth councils would be encouraged but not required to undertake quarterly monitoring reports, prepare a three-yearly housing and business development capacity assessment, and prepare a future development strategy.
7. The new NPS-UD was gazetted 23 July 2020, thereby replacing the old NPS-UDC. The NPS-UD 2020 came into effect on 20 August 2020.

8. The newly revised NPS-UD 2020 provides directions to councils (both district councils and regional councils) to ensure planning frameworks are in place to remove overly restrictive barriers to development and to allow growth 'up' and 'out' in locations that have good access to existing services, public transport networks and infrastructure.
9. The NPS-UD identifies three tiers of responsibility for councils, which are informed by population size and growth rates. This represents a major reversal from the Government's earlier proposals whereby urban monitoring and planning requirements largely lied with the metropolitan (Tier 1) areas.
10. Under the requirements of the NPS-UD, both the New Plymouth District Council and this Council are required to (not just 'encouraged to' as was the case under the NPS-UD 2019 discussion paper) complete the following:
    - quarterly monitoring reports, publishing them annually.
    - a three-yearly housing and business development capacity assessment.
    - a future development strategy every six years (updated every three years), as well as an associated implementation plan that is updated annually.
11. The setting of urban development targets and criteria will also be required as part of the Regional Policy Statement review process.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum on the gazetted *National Policy Statement on Urban Development 2020;*

b) notes that the gazettal of the *National Policy Statement on Urban Development 2020* occurred on 23 July 2020 and came into effect on 20 August 2020; and

c) notes that officers will continue to liaise and work with New Plymouth District Council on the delivery of prescribed planning and monitoring requirements.

Background

12. Members will recall that a Productivity Commission inquiry recommended in 2015 that the Government prepare a national policy statement to help address resource constraints on urban housing and business development capacity. Under the *Resource Management Act 1991* (RMA), regional policy statements and plans must give effect to any national policy statement.
13. The first *National Policy Statement on Urban Development Capacity* (NPS-UDC) came into force in December 2016. The NPS-UDC 2016 set out national directions for regional and district councils to provide sufficient urban development and planning capacity for housing and business growth that match projected rises in population. The New Plymouth District Council and this Council have subsequently been collaborating and sharing the work associated with implementing the NPS-UDC since this date.
14. At the time that the NPS-UDC 2016 came into force, New Plymouth was belatedly identified as a '**high-growth**' urban area by Statistics New Zealand. Consequently, in accordance with the requirements of the NPS-UDC, both the New Plymouth District and Taranaki Regional Council were required to:
    - monitor and prepare quarterly monitoring reports;

- monitor, prepare and consult on a three-yearly housing and business development capacity assessment;
- set minimum targets for inclusion in the Regional Policy Statement and district plans to ensure sufficient feasible development capacity for housing; and
- prepare and consult on a future development strategy.

15. Based upon the findings of the three-yearly housing and business development capacity assessments, both councils agreed and set minimum targets in their Proposed District Plan and Regional Policy Statement for sufficient feasible development capacity for housing in New Plymouth.
16. As previously noted, New Plymouth was only confirmed as a **high growth area** in August 2017 therefore had less time than other high growth urban areas to meet statutory deadlines. It has therefore often been a challenge to deliver on the more 'significant monitoring and planning requirements demanded of 'high growth' councils.
17. Despite these tight timeframes the New Plymouth District Council has taken the lead and worked with this Council to:
    - prepare and publish quarterly monitoring reports of house prices, housing affordability and housing development, as well as business land (retail, commercial and industrial) and floor space for the New Plymouth district;
    - prepare a *Housing and Business Development Capacity Assessment* report (HBCA) in June 2019 that forecasts demand and feasible development capacity for the New Plymouth district, as well as the likely take-up of capacity;
    - identify minimum targets for housing to inform the development of a future development strategy[1] and to be included in relevant regional policy statements and the proposed district plan.

The NPS-UD

18. On 21 August 2019, the Ministry for the Environment and Ministry of Housing and Urban Development released the Government's discussion paper *Planning for successful cities: A discussion document on a proposed National Policy Statement*, which included significant new policy proposals of urban planning, including the replacement of the NPS-UDC with the NPS-UD.
19. The Government sees the new NPS-UD as being essential to address, in its view, an unresponsive planning system under the RMA that is characterised by a reliance on restrictive land use regulation and the controlled release of land for urban purposes. Through the new NPS-UD, the Government is seeking to address poor coordination in and between New Zealand's land use and infrastructure planning, plus restrictive zoning where height and density controls are unnecessarily restricting development and pushing up housing prices.
20. Under the new proposals set out in the discussion paper, current urban monitoring and planning requirements would only be <u>required</u> for **major-growth urban areas** (i.e.

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[1] *A draft Future Development Strategy was developed on how population and housing growth will be enabled through district plans, long-term plans and infrastructure strategies over the next 30 years but its publication was deferred when the need for the document was signalled to become superfluous due to impending Government reforms, i.e. a new national policy statement with new requirements*.

Auckland, Hamilton, Tauranga, Wellington, Christchurch and Queenstown). Under the NPS-UDC, both district and regional councils in major-growth urban areas are required to prepare a future development strategy, undertake quarterly monitoring, prepare full three-yearly HBCAs, and include demand and additional margins estimates for urban growth in their plans.

21. New Plymouth under the new proposals is no longer identified as a major-growth urban area, rather a medium-growth urban area.

22. Under the discussion paper, only major urban areas were going to be required to prepare a future development strategy, undertake quarterly monitoring, prepare full three-yearly HBCAs, and include demand and additional margins estimates for urban growth in their plans. For other urban areas (including New Plymouth) councils were only encouraged to undertake the aforementioned monitoring and planning responses.

23. Other provisions of interest in the 2019 discussion paper were policies aimed at ensuring councils remove unnecessary restrictions on urban development and allowing for growth 'up' and 'out' in locations that have good access to existing services and infrastructure.

24. This Council therefore prepared and endorsed a submission largely in support of the discussion paper's proposals by the due date of 10 October 2019. The submission noted Council's support for a more targeted national policy framework addressing urban growth needs across New Zealand than what was previously prescribed by the NPS-UDC. In particular, support was noted for the proposed NPS-UD's most directive policies only applying to major metropolitan centres, i.e. Auckland, Hamilton, Tauranga, Wellington, Christchurch and Queenstown.

25. Support was also provided for proposed NPS-UD requirements directing local authorities to enable high-density residential development in specified areas. Several relatively minor changes were also requested in the submission to some provisions of the proposed NPS-UD to better target local authorities with the jurisdictional responsibilities and capacity to monitor and plan for urban development.

New NPS-UD 2020 requirements

26. The new NPS-UD was subsequently gazetted 23 July 2020, replacing the previous NPS-UDC when it comes into effect on 20 August 2020. A copy of the NPS-UD is available at the Ministry for the Environment's website: https://www.mfe.govt.nz/publications/towns-and-cities/national-policy-statement-urban-development-2020.

27. The new NPS-UD is part of the urban planning pillar of the Government's Urban Growth Agenda.

28. The purpose of the NPS-UD is to support productive and well-functioning cities by directing regional policy statements and regional/district plans to provide adequate opportunity for land development for housing and business, which meets community needs.

29. This new NPS-UD therefore requires local authorities to promote more development capacity, in order for more homes to be built in response to demand. Most of the NPS-UD's provisions therefore contribute to more competitive land markets in some form, but the following three provisions are key:

    - The intensification policies (Policies 3, 4 and 5) seek to improve land-use flexibility in the areas of highest demand – areas with good access to the things people want and need, such as jobs and community services, and good public transport services. These factors are indicators of the best areas for development, and there is strong evidence to demonstrate that reducing constraints on development in these locations would have the biggest impact.

- The responsive planning policy (Policy 8) seeks to improve land-use flexibility generally by ensuring local authorities have particular regard to plan changes that would add significantly to development capacity as they arise.
- The removal of minimum parking rates in district plans (Policy 11) seeks to improve land use flexibility in urban environments. It will allow more housing and commercial developments, particularly in higher density areas where people do not necessarily need a car to access jobs, services or amenities. Developers will still provide car parking in many areas, and must still provide accessible car parking, but the number of car parks will be driven by market demand.

30. The NPS-UD 2020 further intends to:

    - Improve accessibility for all people between housing, jobs, opportunities for social interaction, services, and public open space, including by way of public and active transport (Policy 1).
    - Improve the evidence used by decision-makers in planning decisions (Objective 7, subpart 3 of Part 3).
    - Provide direction on minimum requirements for local authorities in taking into account the principles of the Treaty of Waitangi (te Tiriti o Waitangi) in relation to urban environments (Policy 9).
    - Ensure zones have provisions that individually and cumulatively support the purpose of the zone (Policy 3, subpart 7 of Part 3).
    - Support reductions in greenhouse gas emissions (Objective 8, Policy 1).

31. Rather than focusing on 'high' or 'medium' growth areas, this new NPS-UD categorises all urban environments into three tiers as follows:

Tier 1	Tier 2	Tier 3
• Auckland • Hamilton • Tauranga • Wellington • Christchurch	• Whangārei • Rotorua • New Plymouth • Napier Hastings • Palmerston North • Nelson Tasman • Queenstown • Dunedin	All other urban environments that are not in tier 1 or 2 (see definition of urban environments in footnote 2).

32. The three tiers were informed by population size and growth rates but represents a major reversal from its earlier proposals set out in the discussion paper whereby urban monitoring and planning requirements largely laid with the metropolitan (Tier 1) areas. Under the requirements of the NPS-UD 2020 both the New Plymouth District Council and this Council are now back to being <u>required</u> (no longer just encouraged) to complete the following:

- Quarterly monitoring reports, publishing them annually.
- A three-yearly housing and business development capacity assessment.
- A future development strategy every six years (updated every three years), as well as an associated implementation plan that is updated annually.

33. Appendix 1 provides an outline of responsibilities specified under the new NPS-UD 2020.
34. New Plymouth District Council will continue to take the lead in the preparation of the planning and monitoring documents identified above. This work will inform both regional and district planning processes.
35. In relation to Council planning processes, the immediate task for this Council will be to amend the *Regional Policy Statement for Taranaki* to:
    - Insert housing bottom lines for the short-medium and long term.
    - Include criteria for determining what plan changes will be treated (for the purpose of implementing Policy 8) as adding significantly to development capacity.
36. These inputs will therefore form part of the Regional Policy Statement review process (see separate item).

Decision-making considerations

37. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

38. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

39. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

40. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

41. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendix 1: Summary of responsibilities under the new NPS-UD 2020

This appendix provides a summary of the NPS-UD, identifying policies from the NPS-UDC, with or without significant changes, and objectives and policies that are new. It also indicates which tier(s) each policy applies to.

Strategic planning for growth	Section	Where	Status
Requires councils to prepare a future development strategy (FDS) every six years and update them every three years.	Clause 3.12	Tier 1 and 2	changed
Provides new direction on what an FDS needs to include, and how they should be developed.	Clauses 3.13–3.16	Tier 1 and 2	changed
Requires councils to have an implementation plan for their FDS.	Clause 3.18	Tier 1 and 2	new
Making room for growth	**Section**	**Where**	**Status**
Well-functioning urban environments			
Enables communities and future generations to provide for their wellbeing.	Objective 1	all	existing
Provides a non-exhaustive list of features of well-functioning urban environments for councils to use as an outcomes framework for planning and decision-making.	Policy 1	all	changed
Housing affordability			
Sets an objective for councils to contribute to housing affordability through planning decisions that support competitive land and development markets.	Objective 2	all	new
Climate change			
Sets direction for New Zealand's urban environments to support reductions in greenhouse gas emissions, and be resilient to the effects of climate change.	Objective 8, Policies 1(e), 1(f) and 6(e)	all	new
Clarifying amenity and change in urban environments			
Directs councils to enable New Zealand's urban environments, including their amenity values, to change over time.	Objective 4, Policy 6	all	changed
Enabling opportunities for development			
Councils must provide, at minimum, enough capacity to meet the diverse demands of their communities.	Policy 2, clauses 3.2–3.5 and 3.10	all	changed
Requires bottom lines for development capacity to be set, including competitive margins.	Policy 7, clause 3.6	Tier 1 and 2	changed
Councils must consider whether development capacity is reasonably expected to be realised.	Clause 3.26	all	new
Councils must notify the Minister for the Environment if they have insufficient development capacity in the short, medium or long term.	Clause 3.7	all	new

Ensuring plan content provides for expected levels of development			
Include in their plans a description of each zone's expected development outcomes over the life of the plan and beyond, and ensure that policies and rules in their plans are individually and cumulatively consistent with those outcomes.	Clauses 3.35 and 3.36	all	new
Monitor the uptake of development capacity in higher density zones.	Clause 3.37	Tier 1	new
Providing for intensification			
Sets an objective for councils to enable greater intensity in areas of high access or demand.	Objective 3	All	new
Enable minimum heights and densities in and near city and metropolitan centres and near existing and planned rapid transit stops, unless a qualifying matter applies. In all other areas, enabled building heights and densities should reflect the relative demand for use and the level of accessibility from planned or existing active and public transport.	Policies 3 and 4, clauses 3.31–3.34	Tier 1	new
Enable building heights and densities that reflect the relative demand for use, and the level of accessibility from planned or existing active transport.	Policy 5	Tier 2 and 3	new
Responsive planning			
Local authorities must be responsive to plan changes for unanticipated or out-of-sequence developments.	Policy 8, clause 3.8	all	new
Removing minimum car parking requirements			

MEMORANDUM
Policy & Planning

Taranaki Regional Council

Date	1 September 2020
Subject:	**Resource Management Act Review Panel Recommendations**
Approved by:	A D McLay, Director - Resource Management
	M J Nield, Acting Chief Executive
Document:	2560209

Purpose

1. The purpose of this memorandum is to inform members of the Resource Management Act Review Panel's recommendations from its report *New Directions for Resource Management in New Zealand*.

Executive summary

2. The Resource Management Review Panel (Panel) released their report *New Directions for Resource Management in New Zealand* on Wednesday 29 July 2020.
3. The Report recommends fundamental changes to New Zealand's resource management system including repealing and replacing the *Resource Management Act 1991* (RMA) with the following new legislation:
    - a *Natural and Built Environments Act*;
    - a *Strategic Planning Act*; and
    - a *Managed Retreat and Climate Change Adaptation Act*.
4. The *Natural and Built Environments Act* would be the most direct replacement for the RMA, while the SPA would have the purpose of setting long-term strategic goals, spatial planning and facilitating the integration of functions from across the resource management system (including the *Local Government Act 2002*, *Land Transport Management Act 2003* and *Climate Change Response Act 2002*).
5. Implementation of the new regime will rely heavily on the use of current national policy statements, national environmental standards, national planning standards and regulations, plus the promulgation of new ones.
6. If enacted, the *Managed Retreat and Climate Change Adaptation Act* will establish an adaptation fund to enable central and local government to support necessary steps to address the effects of climate change.

7. The combined effect of the *Strategic Planning Act* and the *Natural and Built Environments Act* would be to significantly overhaul current plan development processes with requirements for combined regional policy statements and regional and district plans.
8. Implementation of the new regime will also require closer links between land and resource planning and associated funding and investment.
9. For further information on the Panel's recommendations refer to the Ministry for the Environment website https://www.mfe.govt.nz/rmreview.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum *Resource Management Act Review Panel Recommendations*

b) notes that the next Government will be considering the Panel's recommendations

c) notes that should the Panel's recommendations be adopted by Government, substantial investment in new systems and planning processes will be needed at both a national and local level.

Background

10. It is the Government's view that the RMA is no longer considered fit for purpose and that New Zealand faces a number of pressing environmental problems including:
    - increasing pressure on New Zealand's natural environment
    - urban areas struggling to keep pace with population growth
    - the urgent need to reduce carbon emissions and adapt to climate change
    - the need to ensure that Māori have an effective role in the system, consistent with the principles of *Te Tiriti o Waitangi*
    - the need to improve system efficiency and effectiveness.
11. Accordingly, in July 2019, Cabinet agreed to undertake a comprehensive review of the resource management system. The Hon David Parker, Minister for the Environment, officially launched the review on 24 July 2019.
12. A panel of experts was appointed to undertake the review. Meeting weekly throughout the review, they worked with officials to thoroughly review the current resource management system. The Panel members were:
    - Hon Tony Randerson QC - Chair
    - Rachel Brooking
    - Dean Kimpton
    - Amelia Linzey
    - Raewyn Peart MNZM
    - Kevin Prime MBE ONZM.
13. The scope of the review included looking at the RMA and how it interfaces with these other pieces of legislation, namely:
    - *Local Government Act 2002*

- *Land Transport Management Act 2003*
- *Climate Change Response Act*, to be amended by the *Zero Carbon Amendment Bill*.

14. The review considered a new role for spatial planning by looking at plans and processes across the RMA, *Local Government Act* and *Land Transport Management Act*. It also considered new ways that planning could respond to the pressures of urban growth, and better manage environmental effects. The Panel believes that spatial planning has the potential to help make better and more strategic decisions about resources and infrastructure over longer timeframes.
15. The review also sought ways to improve intergenerational wellbeing by strengthening environmental protection and better enabling urban development outcomes within environmental limits.
16. The Government will be reviewing the Panel's recommendations in the next term. Both the National Party and the Labour Party have indicated that they are supportive of wide-scale RMA reform. The implications for the Council, in terms of the development and review of its current plans under the current RMA system, is, at this point of time, uncertain.

The report and key recommendations

17. The Panel's Report is extensive, at over 530 pages. The Report highlighted significant challenges with the current approach to planning under the RMA including:
    - Lack of clear environmental protections
    - Lack of recognition of the benefits of urban development
    - A focus on managing the effects of resource use rather than on planning to achieve outcomes
    - A bias towards the status quo
    - Lack of effective integration across the resource management system
    - Excessive complexity, uncertainty and cost across the resource management system
    - Lack of adequate national direction
    - Insufficient recognition of Te Tiriti and lack of support for Māori participation
    - Weak and slow policy and planning
    - Weak compliance, monitoring and enforcement
    - Capability and capacity challenges in central and local government.
    - Weak accountability for outcomes and lack of effective monitoring and oversight.
18. The following discussion provided an overview of key Panel recommendations.

Natural and Built Environments Act

19. The Panel proposes a new statute to replace the RMA – the *Natural and Built Environments Act*. The purpose of the new Act will focus on enhancing the quality of the environment to support the wellbeing of present and future generations. That purpose will be achieved by promoting positive outcomes for both natural and built environments, ensuring that the use, development and protection of resources only occurs within

prescribed environmental limits and that the adverse effects of activities on the environment are avoided, remedied or mitigated.

20. The *Natural and Built Environments Act* would:

- Retain the integrated approach for land use planning and environmental protection as the RMA, but with a revised purpose and focus on achieving positive outcomes.
- Include allocation principles of sustainability, efficiency and equity in the Act, with a more balanced approach to prioritisation of existing users, including shorter permit durations, stronger powers to review consent conditions, and direction towards common expiry dates.
- Set mandatory environmental limits (bottom lines) - specified for biophysical aspects of the environment, including freshwater, coastal water, air, soils and habitats for indigenous species.

21. The Panel recommends that there should be mandatory plans for each region that combine the regional policy statement, regional plans and regional and district plans. These combined plans would be developed through:

- the establishment of a joint planning committee (made up of constituent councils, the Department of Conservation, and mana whenua)
- the drafting of the combined plan by the joint planning committee
- a pre-notification audit by the Ministry for the Environment
- the appointment of an independent hearing panel to hear submissions (chaired by an Environment Court Judge). The hearing panel would then make recommendations for the joint committee to accept or reject
- limited means and rights of appeal are proposed.

22. Of note, the proposed plan submission and adoption process is much more streamlined and no longer includes requirements to engage on a draft policy statement or plan.

Strategic Planning Act

23. The Panel proposes a second new statute to complement resource management planning – the *Strategic Planning Act*. The purpose of the new Act would be to set long-term strategic goals and facilitate the integration of legislative functions across the resource management system.

24. The *Strategic Planning Act* would:

- Include functions exercised under the *Natural and Built Environments Act*, the *Local Government Act*, the *Land Transport Management Act* and the *Managed Retreat and Climate Change Adaptation Act* to enable land and resource planning to be better integrated, with the provision of infrastructure as well as associated funding and investment.
- Require new regional spatial strategies under the *Strategic Planning Act* (encompassing both land and the coastal marine area). The legislation will set out core content that must be included, to ensure consistency in approach across New Zealand, while providing flexibility to tailor the spatial planning process to each region. These strategies would align functions across other legislation.

- Regional spatial strategies would be consistent with national direction and approved by a joint committee with representatives of central government, regional councils and territorial authorities, mana whenua, and an independent chair.

Managed Retreat and Climate Change Adaptation Act

25. The Panel proposes a third new statute – the *Managed Retreat and Climate Change Adaptation Act*. This would establish an adaptation fund to enable central and local government to support necessary steps to address the effects of climate change and would also deal with the many complex legal and technical issues involved in the process of managed retreat.
26. In addition to an increased focus on climate change and natural hazard provisions in the purpose and principles of the *Natural and Built Environments Act*, a dedicated *Managed Retreat and Climate Change Adaptation Ac*t would provide for managed retreat, powers to change established land uses and to address liability and options for potential compensation. The recommendations include:
    - Establishment of a climate change adaptation fund to enable central and local government to support necessary steps to address climate change adaptation and reduction of risks from natural hazards.
    - This would be supplemented by mandatory national direction on climate change mitigation and adaptation, and reduction of risk from natural hazards. These matters would be addressed at a strategic level through regional spatial strategies.
    - Powers to modify established land uses to address climate change adaptation and reduction of risks from natural hazards including powers to extinguish existing use rights.

Other recommendations

27. To underpin and support the new regime, the Panel recommends other changes to the resource management system such as:
    - **An increased focus on national direction:** This involves a greater use of mandatory national direction on a range of core matters including: the identification of features and characteristics that contribute to the quality of both natural and built environments; responding to climate change; how to incorporate Māori perspectives and mātauranga Māori into the system; and prescribed environmental bottom lines and targets to ensure continued improvement, in respect of matters of national significance.
    - **Greater use of economic instruments:** This involves encouraging greater use of economic instruments, ensuring a broad mandate for the use of tradeable rights and permits, incentives and environmental taxes and charges.
    - **Consenting changes:** This involves proposed changes to the powers of regional councils to modify or extinguish resource consents in certain circumstances, removal of the 'non-complying' consent category, plus substantive changes to the consent notification provisions, including removal of the 'no more than minor' effects threshold. It is also proposed to remove the 'subject to Part 2' reference and the permitted baseline test (which have been the subject of considerable case law), plus include an alternative dispute resolution process for controlled and restricted discretionary activities.

- **Designation changes:** This involves changes to the designation powers that they be centred on public-good purposes with a two-stage process (notice of requirement, and construction and implementation plan) and that there be a new default lapse date of 10 years.
- **Changes to compliance, monitoring and enforcement (CME):** This includes new regional hubs to undertake CME functions, strengthening the offences and penalties regime, enabling regulators to recover costs associated with permitted activities and unauthorised activity monitoring, and creating new offences, including a specific offence for contravention of a consent condition, and providing a new power for regulators to apply for a consent revocation order in response to serious or repeated non-compliance.

Transition process to the new NBEA and SPA:

28. The Report of the Resource Management Review Panel sets out the Panel's thoughts on a sensible transition process although they are outside the scope of their terms of reference. The key components of the transition to be addressed are:
    - the timing and sequencing of national direction, regional spatial strategies and combined plans
    - the impact on existing processes, consents and activities under the RMA
    - the financial and resourcing implications to develop and implement the reformed system
    - supporting the change in culture.
29. The *Strategic Planning Act* should come into effect before or at the same time as the *Natural and Built Environments Act*, but the *Managed Retreat and Climate Change Adaptation Act* could come later (although the Panel notes that this should not be delayed).
30. The new legislation for the reforms should be in place by the time the proposed COVID-19 recovery legislation expires. The Panel expects that the overall transition process to be completed within 10 years of the introduction of the *Strategic Planning Act* and the *Natural and Built Environments Act*.
31. The Panel recommends that the Minister select one region to develop the first regional spatial strategy, followed by development of the combined plan, to provide a model for other regions. They suggest that the Ministry for the Environment should initiate this process, which could be advanced alongside development of the new legislation and updates to guidance in the national planning standards.
32. The Panel further recommends mandatory national direction be developed to set targets to achieve outcomes identified in the principles of the *Natural and Built Environments Act* and to set environmental limits for key biophysical resources, among other matters. The Panel notes that it will be important to set these targets and limits as early as possible to achieve the intent of the new Act. However, the Panel recognises it may not be possible to develop the full set of mandatory national direction all at once, and choices will be needed on priority areas. Of interest, is the new regime is underpinned by 'one size fits all' national directions, which do not necessarily translate to more efficient and effective planning and environmental outcomes.
33. The Panel suggests that some work should be commenced immediately, such as data collection and analysis to establish a robust evidence base for setting targets and limits. It is suggested that priority should also be given to addressing significant gaps in the

existing national direction programme such as climate change and natural hazards, and biodiversity.

34. The Panel notes that national direction on how Te Tiriti principles are to be implemented under the *Natural and Built Environments Act* will be an important influence on processes and practice across the system. They therefore recommend that the Government commence development of this national direction before the new legislation is enacted.

35. National planning standards will also play an important role in the reformed system by supporting consistent plan format and structure. Again, the Panel recommends that work on developing these could also begin before the commencement of the new legislation.

36. Finally, Members will recall that the recently enacted *Resource Management Amendment Act 2020* sets out a new freshwater planning process (s80A). The Act also provided for the establishment of a Chief Freshwater Commissioner who will convene freshwater hearings panels to make recommendations to regional councils and unitary authorities on plan provisions relating to freshwater. The process will apply when regional councils or unitary authorities are developing or changing regional policy statements and regional plans that contain provisions to give effect to the *National Policy Statement for Freshwater Management* or otherwise relate to freshwater. Officers suggested that the Ministry for the Environment will need to carefully consider how the proposed freshwater planning process should be integrated into any new process to develop combined plans under the reformed system.

Where to from here?

37. The Panel's report represents the culmination of nine months of intensive work. The Panel concludes its work with the delivery of this report to the Minister for the Environment.

38. The Ministry for the Environment must now provide advice to their Minister on the report's recommendations. Cabinet is ultimately responsible for making all decisions about how to progress the Panel's findings.

39. The report notes that Cabinet has indicated that the Government will undertake a broad, open process of public consultation following Government's consideration of the Panel's proposals. In addition, Cabinet has directed officials to look for opportunities to collaboratively refine and co-design policy options with Māori during the next phase of the review.

40. Wide engagement with New Zealanders and stakeholders is anticipated before the introduction of any new legislation.

41. Should the recommendations be adopted, the implications for the Council and all local government are expected to be significant, particularly in relation to required changes to council's planning and regulatory systems and processes. It is unclear at this point in time how differing planning processes will be aligned noting that this Council has a number of plans at different stages of statutory review, that South Taranaki District is nearing the end of their district plan review, that New Plymouth District is only about half way through their plan review, while Stratford District is about to start their plan review.

42. It has been suggested in political and legal commentary that local government reform could be a logical consequence of the Panel's recommendations.

43. Officers will maintain a watching brief on developments and report back to Council as formal proposals are made by the Government. Ongoing change is a feature of recent Governments and care is needed to demonstrate the change will be beneficial as resource management is a complex area. The recommendations promote the use of national planning instruments and the inherent 'one size fits all' approach has not always delivered benefits to the Council. For any change there will be winners and losers.

Decision-making considerations

44. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

45. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

46. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

47. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

48. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Attachments

49. A full copy of the 531 page report or the 21 page summary can be found at:

- *Report of the Resource Management Review Panel* https://www.mfe.govt.nz/sites/default/files/media/RMA/rm-panel-review-report-web.pdf
- *Report of the Resource Management Review Panel: Summary and Key recommendations* https://www.mfe.govt.nz/sites/default/files/media/RMA/rm-panel-review-report-summary.pdf

MEMORANDUM
Policy & Planning

Date	1 September 2020
Subject:	**Lake Rotorangi SEM Annual Monitoring Report**
Approved by:	G K Bedford, Director - Environment Quality
	M J Nield, Acting Chief Executive
Document:	2568059

Purpose

1. The purpose of this memorandum is to present a report prepared by staff, on the ecological and physico-chemical state of Lake Rotorangi as determined in the 2018-2019 programme monitoring the state of the lake, and trends in that quality since monitoring first began in 1984. The Executive Summary of the report *'State of the Environment Monitoring of Lake Rotorangi water quality and biological programme Annual report 2018-2019, Technical Report 2019-97'* is attached to this memorandum, and the full report is available upon request and on the Council's website.
2. Lake Rotorangi, the region's largest, is monitored for both consent compliance and for state of the environment monitoring purposes, through a programme financed in part by TrustPower, the consent holder for the Pātea Hydroelectric Scheme.

Executive summary

3. The Council's 'Regional Freshwater Plan for Taranaki' (October 2001) states as two of its objectives for the regional community, *'to maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to land and water from point-sources....* and *diffuse sources'* (Objectives 6.2.1 and 6.3.1). In doing so, the Council and community seek to provide for the values associated with surface water, and to ensure the maintenance of aquatic ecosystems (Environmental Results Anticipated ER1).
4. In order to ascertain the successful adoption and application or otherwise of the Council's policies and methods of implementation, the Council conducts 'state of the environment' (SEM) monitoring to obtain up to date robust information for parameters that characterise the region's environment and resources. The results and findings of the SEM programme for the region's freshwater systems can be interrogated to determine trends and changes in trends in the quality of the region's freshwater resources, alongside the information on the current 'state' of the region's physicochemical parameters that SEM generates and how the quality of the region's resources measures up against national requirements.

5. The state of Lake Rotorangi is determined each year, through four water quality monitoring surveys and through phytoplankton, benthic invertebrate, and macrophyte (aquatic plants) surveys conducted at various intervals.
6. Based on these surveys and studies, the lake's condition continues to be classified as mesotrophic, with no change showing in trophic level over the period 1990-2019. If the trend in some individual nutrient metrics continues, then in the very long term future the lake might become mildly nutrient enriched (eutrophic), but this is considered unlikely given the lake displays only moderate levels of chlorophyll. Phytoplankton densities continue to be low, restricted by lack of nutrients and by freshes (which shorten residence times and flush existing communities). The Council continues to meet its LTP target in respect of the lake.
7. The report's recommendation is that the programme continues as currently designed, including the incorporation of elements that are implemented on an occasional basis.
8. The report was prepared prior to the release of the Government's '*National Policy Statement for Freshwater Management 2020*'. The latter imposes a range of obligations upon councils in respect of water quality monitoring and in assessment of monitoring data at regionally representative lakes. The results from 2018-2019 are discussed in the light of the NPS within this memo.

Recommendations

That the Taranaki Regional Council:

a) receives this memorandum noting the preparation of a report into the state of the water quality and biological programme of Lake Rotorangi as determined in monitoring during 2018-2019

b) notes the findings of the SEM programme

c) adopts the specific recommendation therein

d) notes that future SEM-based lake monitoring will be reviewed for conformity with the NPS (2020)

Background

9. This Committee has been regularly informed of the findings that emerge from the Council's various freshwater 'state of the environment' monitoring programmes. These programmes are important as indicators of the effectiveness of the Council's and community's interventions and resource management initiatives addressing freshwater quality in the region. Members will be aware that there is a high level of interest nationally in the state and management of the country's fresh water resources (in both rivers and lakes).
10. The Council's '*Regional Freshwater Plan for Taranaki*' deals with lake and river water quality jointly as 'surface water' quality. The three objectives most relevant are as follows:

    a) Objective 6.1.1: To promote the sustainable management of the surface waters of Taranaki while avoiding, remedying or mitigating any actual or potential adverse effects from the taking, use, damming or diversion of surface water;

b) Objective 6.2.1: To maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to land and water from point sources;

c) Objective 6.3.1: To maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to land and water from diffuse sources.

11. Under 'levels of service' in the Resource Management section within the Council's 2018-2028 Long Term Plan, item 3 ('maintenance and enhancement of overall water quality in our rivers and lakes, groundwater and coastal waters') includes:-

'Measure: physicochemical and biological parameters for quality of Lake Rotorangi

Target (years 1-10): the trophic state (an indication of the ecological condition as affected by nutrient enrichment) of Lake Rotorangi to remain as it was in 1988 (mesotrophic/mildly eutrophic, or the middle category of trophic states).

Baseline: the current life-supporting capacity of the lake is stable and relatively healthy (better than almost 2/3 of lakes monitored nationally). State of lake shown to continue to be mesotrophic/mildly eutrophic.'

12. Lake Rotorangi is an artificial lake (as are four of the region's other significant lakes-Mangamahoe, Ratapiko, Ōpunake, and Rotomanu), and the Council's management of its quality is in part through the conditions imposed within consents held by TrustPower. Because of their use for generation purposes, most of these lakes tend to have a relatively high through-flow and are therefore less susceptible to potential water quality issues than might otherwise be the case.

Discussion

State of Lake Rotorangi

13. One of the Council's 'State of the Environment' monitoring programmes measures the ecological and water quality state of Lake Rotorangi, as the region's largest lake. Monitoring of the lake has been undertaken since its construction in 1984, with reporting to the Council since 1988. Reporting was initially by way of consent compliance reporting, up until 2010-2011, with subsequent lake monitoring being reported as a state of the environment annual report, partially financed by TrustPower.

14. Staff have now reported the data for the 2018-2019 years, including an analysis of trends in the trophic state of the lake over the period 1984-2019.

15. Changes in thermal stratification (layers of distinct water quality within the lake, typified by low oxygen and low temperature at depth during warmer months) during the year were largely similar to that typically recorded in previous surveys of this reservoir-type lake. Thermal stratification was beginning to form at both sites during the spring surveys, and was typically well developed during late summer - autumn at both the mid and lower lake sites, with dissolved oxygen depletion evident in the lower waters of the hypolimnion at both sites (deeper than 5-9 metres). Partial overturn was apparent at both sites by mid-winter (a degree of re-oxygenation was evident).

16. The process of overturn re-oxygenates the deeper parts of the lake (eg down to 25 metres), and also brings minor amounts of phosphorus solubilised from sediment under anaerobic conditions to the surface in late winter, potentially promoting algal growth in spring-summer. Despite mild nutrient enrichment in the lake overall (see later in this memo), during the monitoring year phytoplankton abundances were low to moderate,

coincident with low chlorophyll-a levels. On the other hand, phytoplankton diversity was higher than usual. The main limiting factors for proliferation of communities within the lake probably continue to be plant nutrient availability and frequency of river freshes. Previous studies have concluded that low levels of dissolved reactive phosphorus and ammonia indicated a relative lack of nutrient release under anoxic conditions, consistent with lakebed sediment not yet contaminated with high nutrient levels.

17. As has also been the case in previous years, there were no phytoplankton blooms in the lake during the period under review. Phytoplankton community composition tends to reflect environmental conditions prevailing at the time of each survey, rather than showing any long-term trends. Any proliferation tends to be opportunistic and short-lived. With the exception of the spring 2018 sample, taxa richness at both sites was substantially higher than the median richness of 4 taxa. Despite this higher than usual diversity, chlorophyll-a concentrations were within a relatively low and small range. This indicates that although there was increased diversity, there were not particularly high abundances of the taxa present.

18. An aquatic macrophyte survey was conducted in April 2018, prior to the year under review. Surveys are triennial.

19. The lake biologically continues to exhibit mesotrophic conditions, bordering on eutrophic, rather than having become eutrophic as was originally predicted during the process associated with granting the original water rights (consents), in spite of high turbidity (due to river silt) and associated elevated nutrients (which are primarily present in total, but not in dissolved, forms). Nutrient data surveyed during the period under review were within ranges recorded since 1990 for all sites. TP and TN nutrients have shown non-significant temporal increases over the twenty-seven year period, while a more significant temporal increase in nitrate-N is consistent with a very slow rate of increase in trophic level.

20. Therefore the target set out in the Council's LTP is being maintained: *the trophic state (an indication of the ecological condition as affected by nutrient enrichment) of Lake Rotorangi to remain as it was in 1988 (mesotrophic/mildly eutrophic, or the middle category of trophic states*).

21. The baseline condition of Lake Rotorangi referenced in the LTP notes that from a national study in 2010, it was found that the lake was in better condition than almost 2/3 of lakes monitored nationally. More recently, an updated survey of the conditions of selected lakes nationwide has been undertaken1. The report does not provide a collective overview across all lakes, but does look at classes of lakes based on depth and altitude. Lake Rotorangi fits most closely into two low altitude classes, of lakes either 15-50 metres deep or greater than 50 metres deep. Within these two classes, Lake Rotorangi has typical to better than typical concentrations of phytoplankton (and much better than other lowland lakes); somewhat higher concentrations of ammonia and total nitrate; and typical concentrations of total phosphorus. Levels of turbidity are typical to above typical when compared to equivalent lakes. For total phosphorus, total nitrogen, and turbidity, Lake Rotorangi has much better results than shallower lowland lakes.

22. While these result would indicate that Lake Rotorangi is under slightly greater pressure than comparable lakes elsewhere, the fact that the phytoplankton levels are lower than

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1 *Water quality state and trends in New Zealand lakes- Analyses of national data ending in 2017, NIWA report for Ministry for the Environment*

in other equivalent lakes indicates that such pressures are not driving the lake towards an excessively productive state. Current and proposed Council and community interventions to safeguard catchment water quality will further protect the lake.

The NPS 2020

23. In August 2020, the Government released the *National Policy Statement for Freshwater Management 2020* (NPS). The NPS contains within it water quality attribute (measures) tables, which stipulate criteria against which the water quality in lakes must be measured and reported. These include phytoplankton (assessed by chlorophyll-a concentration); total nitrogen; total phosphorus; ammonia; *E coli*; cyanobacteria; submerged native plants; submerged invasive plants; lake-bottom dissolved oxygen; and mid-hypolimnetic dissolved oxygen.
24. **Phytoplankton**: the NPS requires that the annual median is less than 12 mg chl-a/m^3 and the maximum is less than 60 mg chl-a/m^3. The median at site L2 during the year under review was 2.8 mg chl-a/m^3, with a maximum of 3.7, while at site L3 (near the dam), the median was 2.3 mg chl-a/m^3, with a maximum of 3.0 mg chl-a/m^3. These results classify the lake as at the top of the 'B' category overall, and in the 'A' category based on worst-case results. Nationally, 19% of all lakes exceed the bottom line for the median concentration limit for phytoplankton, and 33% exceed the maximum concentration limit.
25. **Total nitrogen**: the NPS requires that the annual median is less than 750 mg/m^3. In the year under review, the total nitrogen at site L2 had a median value of 530 mg/m^3. At site L3 the median value was 540 mg/m^3. These results would see the lake assigned into the middle of the 'C' category of the NPS.
26. **Total phosphorus:** the NPS requires that the annual median is less than 50 mg/m^3. In the year under review, the total phosphorus at site L2 had a median value of 28 mg/m^3. At site L3 the median value was 15 mg/m^3. These results would see the lake assigned into the middle of the 'C' category of the NPS at site L2, and the middle of the 'B' category at site L3.Nationally, 17% of all lakes exceed the bottom line limit for total phosphorus.
27. **Ammonia:** the NPS requires that the annual median is less than 0.24 g/m^3, and the maximum is less than 0.40 g/m^3. In the year under review, the ammonia at site L2 had a median value of 0.025 g/m^3 and a maximum of 0.067 g/m^3. At site L3 the median value was 0.008 g/m^3 and the maximum was 0.018 g/m^3. These results would see the lake assigned into the 'A' category of the NPS for 3 of these results, or the 'B' category in the case of the maximum value at site L2.
28. **E coli**: the NPS requires that the suitability for recreation be graded into one of 5 categories. There are 4 different criteria to be applied; the water body's final grade is based on the worst result. Both sites fully satisfied the 'A' category thresholds for all four criteria.
29. **Cyanobacteria:** the NPS requires that the 80th%ile result of at least 12 samples is either less than 1.8 mm^3/L of potentially toxic cyanobacteria, or less than 10 mm^3/L total volume of all cyanobacteria. The Council does not currently monitor specifically for cyanobacteria at Lake Rotorangi, but does so at four other lakes within its summer recreational surveys. This latter programme provides representative information for the region. Council officers will evaluate the value of undertaking cyanobacteria monitoring in the near future.

30. **Submerged native plants**: the NPS requires that the lake scores at least 20% of the maximum score in the Native Condition Index. The last survey of the aquatic macrophytes in Lake Rotorangi was performed on 15 April 2018, and is described in the previous annual report. Surveys are now undertaken every three years. This will next be undertaken in autumn 2021, and its design will be reviewed in the light of the NPS monitoring requirements for representative lakes.

31. **Submerged invasive plants:** the NPS requires that the lake scores at less than 90% of the maximum score in the Invasive Impact Index. The last survey of the aquatic macrophytes in Lake Rotorangi was performed on 15 April 2018, and is described in the previous annual report. The oxygen weed *Egeria densa* was identified as the dominant macrophyte in the lower part of the lake, and *Ceratophyllum demersum* (hornwort) in parts of the mid-section. No other species was recorded as dominant, and only one other species, *Glossostigma elatinoides*, was found. *Lagarosiphon major*, which had been recorded in all previous surveys was not found, possibly as a result of the high turbidity. Surveys are now undertaken every three years. This will next be undertaken in autumn 2021, and its design will be reviewed in the light of the NPS monitoring requirements for representative lakes.

32. **Lake-bottom dissolved oxygen:** the NPS requires that the annual minimum is greater than 0.5 g/m^3 within 1 metre of the lake bottom. At both lake monitoring sites, dissolved oxygen concentrations fell below this national bottom line during periods of stratification, when oxygen consumed by either biological or chemical processes cannot be replaced due to thermal separation from the more oxygenated surface waters. This causes oxygen depletion in the hypolimnion unless re-mixing occurs, either as a result of natural overturn processes in winter or as a result of flood events in the river inflow. These results are typical of those recorded in Lake Rotorangi in the past 25 years.

33. It is important to realise that any lake supporting a healthy ecosystem will inevitably go into a state of oxygen depletion during any period of thermal stratification. There is no quick or simple 'fix' to raising the lake-bottom oxygen levels under such conditions, as nutrient levels in the lake are by no means excessive to begin with. The Council's riparian and sustainable hill country programmes, together with recently tightened controls upon the discharge from the Stratford wastewater treatment plant and the Council's policy of diversion of dairy effluent discharges away from waterways, would constitute the elements of the action plan that the NPS requires in the event of non-compliance, by reducing current levels of inputs of nutrients and sediment.

34. Mid-hypolimnetic dissolved oxygen: the NPS requires that the annual minimum is greater than 4.0 g/m^3. At both lake monitoring sites, mid-hypolimnetic concentrations of dissolved oxygen fell below this bottom line on occasion. As with failure to meet lake-bottom dissolved oxygen limits, the NPS response required of the Council is that it prepare an action plan to enhance dissolved oxygen levels in the lake (see previous paragraph).

35. The water quality and ecology of Lake Rotorangi fall into a variety of NPS grading categories, ranging from 'C' to 'A', except for low dissolved oxygen levels that reflect the characteristics of the lake. The enactment of the NPS 2020 means that the Council will have to modify future monitoring programmes and reporting content for Lake Rotorangi, if the lake is deemed representative of other lakes in the region. The programme for 2020-2021 has already been established and is in effect, but changes will be progressively implemented as resources allow.

Decision-making considerations

36. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

37. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

38. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

39. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

40. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices

Executive summary and recommendations extracted from the Technical Report 19-97 *State of the Environment Monitoring Lake Rotorangi Water Quality and Biological Programme Annual Report 2018-2019*

Attachments

Document 2554718: Technical Report 19-97 *State of the Environment Monitoring Lake Rotorangi Water Quality and Biological Programme Annual Report 2018-2019*

Executive summary

Lake Rotorangi was formed in May 1984 by the construction of an earth fill dam on the Patea River for hydro-electric power generation. During the process of obtaining planning consents, it was recognised that, although a regionally significant recreational resource would be formed, considerable environmental impacts might also occur. Consequently, a comprehensive monitoring programme was developed and implemented for the lake. This report presents the results of the 29th year of this monitoring.

Four water quality sampling surveys were performed at two sites each during the 2018-2019 period. The first of the two sites surveyed is located in the mid reaches of the lake, while the second site is located nearer to the dam.

Changes in thermal stratification during the year in both periods were largely similar to that typically recorded in previous surveys of this reservoir-type lake. Thermal stratification was beginning to form at both sites during the spring survey, and was well developed during the late summer-autumn at the mid and lower lake sites, with dissolved oxygen depletion measured in the lower waters of the hypolimnion at both sites. Oxygen depletion remained evident in winter at the lower lake site. Lake overturn had not occurred completely at the lower lake site by the time of the winter survey, although water temperatures were uniform throughout the water column. These conditions have been typical of this reservoir-type lake on most occasions to date.

During the monitoring period, phytoplankton richnesses (diversity) were higher than typical, although coincident with low to moderate chlorophyll-a levels. The main limiting factors for phytoplankton communities within the lake probably continue to be plant nutrient availability and frequency of river freshes. A very sparse macroinvertebrate fauna has been found amongst the fine sediments of the deeper lake sites where only those taxa able to tolerate the lengthy periods of very low dissolved oxygen levels which have been recorded, are able to establish communities.

A macrophyte survey was not carried out during the period under review and is next scheduled for the 2020-2021 period. The autumn 2018 macrophyte survey identified the oxygen weed *Egeria densa* as the dominant macrophyte in the lower part of the lake. The other species recorded as dominant was *Ceratophyllum demersum* (hornwort), in parts of the mid-section of the lake. Hornwort, which was first recorded in the 2012 survey and had increased markedly at the time of the 2015 survey, was not recorded to have extended beyond the mid-section in the 2018 survey. It has been predicted that hornwort will eventually become dominant, out-competing *E. densa* and *L. major*. While this is not expected to cause significant impacts on the ecology of Lake Rotorangi or on the hydro-electric scheme, there is now greater potential for it to spread to nearby lakes, where such impacts could be much more severe, e.g. Lake Rotokare.

Lake condition, in terms of lake productivity, continued to be within the category of mesotrophic to possibly mildly eutrophic (mildly nutrient enriched). However, taking into account the influence of suspended sediment in this reservoir, and the moderately low chlorophyll levels, the classification is more appropriately mesotrophic. Previous trending of these water quality data over time found a very slow rate of increase in trophic level. Updated trend analysis, for the period 1990-2018, reconfirmed the rate of increase in trophic level is very slow and insignificant. Analysis also confirmed that the lake continues to be classified as mesotrophic in terms of biological condition.

The monitoring programme will continue in its present format for State of the Environment reporting purposes with regular (3-yearly) additional biological components (e.g.

macrophyte survey) for consent compliance purposes. This report also includes recommendations for the 2019-2020 monitoring year.

5. Recommendations

The following recommendations are based on the results of the 2018-2019 water quality and biological monitoring programmes and the contractual requirements of the resource consents held by Trustpower for the Patea Hydro Electric Power Scheme on Lake Rotorangi:

1. THAT the Lake Rotorangi physicochemical and biological water quality monitoring programme continue on an annual basis as a component of the Council's State of the Environment monitoring programme, with every third year of the programme also undertaken in conjunction with the Patea Hydro Electric Power Scheme - aquatic monitoring plan (next in 2020-2021), and that the requisite macrophyte and benthic macroinvertebrate surveys be components of the 2020-2021 programme.

2. THAT the calculation of VHOD rates as a component of the Lake Rotorangi physicochemical and biological water quality monitoring programme be discontinued due to the inaccuracies and shortfalls of the calculation method.

State of the Environment Monitoring
Lake Rotorangi water quality and biological programme
Annual Report
2018-2019

Technical Report 2019-97

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Executive summary

Lake Rotorangi was formed in May 1984 by the construction of an earth fill dam on the Patea River for hydro-electric power generation. During the process of obtaining planning consents, it was recognised that, although a regionally significant recreational resource would be formed, considerable environmental impacts might also occur. Consequently, a comprehensive monitoring programme was developed and implemented for the lake. This report presents the results of the 29th year of this monitoring.

Four water quality sampling surveys were performed at two sites each during the 2018-2019 period. The first of the two sites surveyed is located in the mid reaches of the lake, while the second site is located nearer to the dam.

Changes in thermal stratification during the year in both periods were largely similar to that typically recorded in previous surveys of this reservoir-type lake. Thermal stratification was beginning to form at both sites during the spring survey, and was well developed during the late summer-autumn at the mid and lower lake sites, with dissolved oxygen depletion measured in the lower waters of the hypolimnion at both sites. Oxygen depletion remained evident in winter at the lower lake site. Lake overturn had not occurred completely at the lower lake site by the time of the winter survey, although water temperatures were uniform throughout the water column. These conditions have been typical of this reservoir-type lake on most occasions to date.

During the monitoring period, phytoplankton richnesses (diversity) were higher than typical, although coincident with low to moderate chlorophyll-a levels. The main limiting factors for phytoplankton communities within the lake probably continue to be plant nutrient availability and frequency of river freshes. A very sparse macroinvertebrate fauna has been found amongst the fine sediments of the deeper lake sites where only those taxa able to tolerate the lengthy periods of very low dissolved oxygen levels which have been recorded, are able to establish communities.

A macrophyte survey was not carried out during the period under review and is next scheduled for the 2020-2021 period. The autumn 2018 macrophyte survey identified the oxygen weed *Egeria densa* as the dominant macrophyte in the lower part of the lake. The other species recorded as dominant was *Ceratophyllum demersum* (hornwort), in parts of the mid-section of the lake. Hornwort, which was first recorded in the 2012 survey and had increased markedly at the time of the 2015 survey, was not recorded to have extended beyond the mid-section in the 2018 survey. It has been predicted that hornwort will eventually become dominant, out-competing *E. densa* and *L. major*. While this is not expected to cause significant impacts on the ecology of Lake Rotorangi or on the hydro-electric scheme, there is now greater potential for it to spread to nearby lakes, where such impacts could be much more severe, e.g. Lake Rotokare.

Lake condition, in terms of lake productivity, continued to be within the category of mesotrophic to possibly mildly eutrophic (mildly nutrient enriched). However, taking into account the influence of suspended sediment in this reservoir, and the moderately low chlorophyll levels, the classification is more appropriately mesotrophic. Previous trending of these water quality data over time found a very slow rate of increase in trophic level. Updated trend analysis, for the period 1990-2018, reconfirmed the rate of increase in trophic level is very slow and insignificant. Analysis also confirmed that the lake continues to be classified as mesotrophic in terms of biological condition.

The monitoring programme will continue in its present format for State of the Environment reporting purposes with regular (3-yearly) additional biological components (e.g. macrophyte survey) for consent compliance purposes. This report also includes recommendations for the 2019-2020 monitoring year.

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1 Introduction

1.1 General

The *Resource Management Act 1991* ('the RMA') established new requirements for local authorities to undertake environmental monitoring. Section 35 of the RMA requires local authorities to monitor, among other things, the state of the environment of their region or district, to the extent that is appropriate to enable them to effectively carry out their functions under the Act.

To this effect, the Taranaki Regional Council (the Council) established a State of the Environment monitoring (SEM) programme for the region. This programme is outlined in the Council's 'State of the Environment Monitoring Procedures Document', which was prepared in 1997. The monitoring programme is based on the significant resource management issues that were identified in the Council's *Regional Policy Statement for Taranaki (1994a)*.

The SEM programme comprises a number of individual monitoring activities, many of which are undertaken and managed on an annual basis (from 1 July to 30 June). For these annual monitoring activities, summary reports are produced following the end of each monitoring year. Where possible, individual consent monitoring programmes have been integrated with the SEM programme to save duplication of effort and minimise costs (as in the case of the TrustPower Ltd. Patea Dam HEP programme in the past). The purpose of annual SEM reports is to summarise monitoring activity results for the year and provide a brief interpretation of these results.

Annual SEM reports act as 'building blocks' towards the preparation of the regional state of the environment report every five years. The Council's first, or baseline, SEM report was prepared in 1996 (TRC, 1996a), summarising the region's progress in managing environmental quality in Taranaki over the past two decades. The second report (for the period 1995-2000) was published in 2003 (TRC, 2003a). The third SEM report (for the period 1995 to 2007) was published in 2009 (TRC, 2009a) and included trend reporting. The fourth report (for the period 1995 to 2013) was published in 2015 (TRC, 2015a). The provision of appropriate statistical software now allows regular reporting on trends in environmental quality over time where there has been an accumulation of a comprehensive dataset of sufficient duration to permit a meaningful analysis to be undertaken (i.e. minimum of 10 years).

1.2 Lake Rotorangi and catchment

Lake Rotorangi was formed in May 1984 by the construction of an earth fill dam on the Patea River. The dam was integral to a power scheme designed to harness the flow of the Patea River and produce sufficient power for Egmont Electricity to meet approximately 60% of its consumer needs. During the process of obtaining planning consents, it was recognised that, although a regionally significant recreational resource would be formed, considerable environmental impacts might also occur. Consequently, when planning and water right consents were granted, specific conditions were imposed upon water rights, which involved monitoring and otherwise studying the effects of the scheme on the environment, for the protection of the public interest.

The appearance of Lake Rotorangi, its biological value, and its suitability for a range of recreational and commercial uses is directly related to lake water quality. Water quality management is therefore the key to the continued success of the lake and environs as regional and national recreational resources. Consequently, all lake management decisions and lake uses need to be undertaken in consideration of maintaining good lake water quality conditions.

The Patea Catchment above the dam (including the Mangaehu sub catchment) covers an area of 86,944.3 ha, including an urban area of 840.9 ha (1%). Riparian plans have been prepared for an area of

19,466 ha[1] (25% of catchment). As of June 2019, some 235 riparian plans have been prepared by the Council in relation to properties within the Patea River sub-catchment. No additional plans have been produced for properties in the Mangaehu River sub-catchment, upstream of the lake during the period under review. Within these plans, some 1008 km of Patea riverbank [71% of the total banks' length] and 26 km of Mangaehu stream banks [54%] currently have adequate riparian protection provided on the properties covered by the plans. This represents an increase of 143 km in the Patea catchment and 7 km in the Mangaehu catchment over the past three years. Outside of the properties covered by riparian plans, there are a further 51% and 98% of streambanks in the Patea and Mangaehu catchments respectively, with only some (natural) degree of riparian protection or landowner fencing/planting that is not covered by a Council-prepared riparian plan. Within the Lake Rotorangi catchment area, 43233 ha (50%) is covered by Council Hill Country plans, addressing land management and sediment issues. This area is dominated by dry stock properties, as well as 6,588.7 ha (8%) of DOC owned land, and is located to the northeast and south east of the catchment.

1.3 Historic monitoring of Lake Rotorangi

The initial sampling programme was designed to keep a watching brief on lake water quality and productivity trends, in order to assess the way in which the new lake was settling down and its overall environmental consequences. The results of this intensive monitoring programme were published in the 'Lake Rotorangi - Monitoring a New Hydro Lake' (Taranaki Catchment Board, 1988) report.

The initial monitoring of the lake indicated that the lake was not grossly eutrophic as was initially predicted, but mildly eutrophic or mesotrophic. The initial monitoring also determined that the annual thermal stratification cycle, which the lake undergoes, is the single most important factor influencing the overall water quality and biological productivity trends within the lake. The formation of a stable stratified lake during the spring/summer period is dependent upon seasonal ambient temperature changes. Stratification gives rise to a physical barrier, separating the surface water body (epilimnion) from the bottom water body (hypolimnion). The intermediate zone is known as the metalimnion. The characteristics of lakes and the importance of nutrients and eutrophication were fully discussed in the Taranaki Catchment Board (1988) report.

Following the publication of the initial monitoring report, the Taranaki Catchment Board, in conjunction with the Egmont Electric Power Board, considered the frequency and nature of the future monitoring programme for Lake Rotorangi. Given the unexpectedly favourable way in which the lake had settled down, it was decided that the monitoring programme should be scaled down to a residual level involving less frequent sampling, yet be capable of maintaining an on-going measure of lake conditions. These scaled-down programmes have now operated since 1988 and have been the subject of twenty-seven Annual Reports and four subsequent state of the environment reports.

There was concern for the impact that larger flood events could have on the lake during the summer stratification period. The original intensive monitoring period (1984 to 1988) had been conspicuous for the absence of any large flood events entering the lake during such periods. However, the large floods of March 1990 and June 2015 provided some information in this respect (TRC, 1990, TRC 2016). The impacts of minor freshes have been reported from time-to-time (TRC 1992a; TRC 1993; TRC 1995).

In 1995, NIWA reviewed the appropriateness of the Lake Rotorangi monitoring programme and analysed all data collected during the last seven years of monitoring. Only minor changes to the monitoring programme were suggested (Burns, 1995). More details of the suggested changes are provided in Section 1.4. In 1999,

[1] Methodology used to calculate the area covered by plans has changed, resulting in a decrease in the reported area from 22048 ha in June 2018 to 19466 ha in June 2019

water quality data from Lake Rotorangi was assessed by Lakes Consultancy to determine the trophic status of the lake after ten years of monitoring (Burns, 1999). See Section 1.4 for further details. Lakes Consultancy also analysed Lake Rotorangi water quality data collected between 1990 and 2006 for trends to inform the consent renewal process which took place between 2007 and 2010 (Burns, 2006). See Section 1.4 for further details of both analyses undertaken by Lakes Consulting. The Council has analysed water quality trends since 2006, including the period 1990-2018 analysed for this report.

1.4 Trends in lake water quality

In 1995, the Council provided several years' (1988-1995) of Lake Rotorangi monitoring results and water quality reports to NIWA for in-depth lake water quality trend analysis. NIWA concluded that Lake Rotorangi had riverine qualities (such as the potential to be substantially affected by flood events). Consequently, it was deemed unnecessary to de-seasonalise data before conducting trend analysis on water quality over time. Further analysis indicated the lake had remained in a mesotrophic condition (Burns, 1995).

Minor changes to the existing Lake Rotorangi monitoring programme were recommended by NIWA in 1995 (Burns, 1995). Recommendations included the standardisation of sampling events to the current four dates to allow for the additional analysis of data and to provide better statistical power and robustness when determining changes in the lake's trophic condition. These changes were incorporated into subsequent monitoring programmes from 1996 onwards.

In 1999, the trophic status of Lake Rotorangi was reviewed based upon a lengthier period (ten years) of monitoring data (Burns, 1999 and Burns et al., 2000) employing analysis methods detailed in Burns and Rutherford (1998). The review indicated that, while the trophic level in Lake Rotorangi had not changed since monitoring commenced in 1988, the physical and chemical characteristics of the lake changed between upstream and downstream sampling sites. The report stated that the lake at the upstream site (L1) was basically riverine in character, while the lake near the dam had the characteristics of a mesotrophic lake containing surplus nitrate, but with phytoplankton growth limited by phosphorus availability. Hypolimnetic anoxic conditions were frequently encountered at site L2 (half way along the lake) and occasionally at site L3. However, there was little evidence of phosphorus release from the lake-bed sediments into the water column via anoxic regeneration.

The analysis of water quality trends over the period 1990-2006 indicated that the lake remained mesotrophic, although there had been a very slow increase in trophic level (Burns, 2006). The elevated trophic level indices were influenced by high turbidity values (caused by fine suspended sediment characteristic of this lake) and were not a true indication of the lake's actual trophic status. Burns concluded that 'despite the apparently very slow rate of change in trophic level, the lake would benefit from increased riparian management initiatives in the upstream catchment.'

The Council has continued to analyse water quality trends since 2006, including the period 1990-2018 (last 27 years) analysed for this report. The analysis methodology is based on that employed by Burns (2006). The most recent analysis continues to support the conclusions of Burns (2006) and indicates the trophic level continues to increase at a very small, insignificant annual rate of change (0.02 $\pm$ 0.01 TLI units per year). Trend analysis of the key water quality variables (chlorophyll-a, secchi disc, total phosphorus and total nitrogen) showed that chlorophyll-a was increasing over time (albeit at a slow rate of change within the mesotrophic level range). Nitrate was also increasing over time.

1.5 Monitoring programme

The Lake Rotorangi monitoring programme consists of two primary components; physicochemical sampling and biological sampling. These components are detailed in the sub-sections below.

1.5.1 Lake Rotorangi physicochemical sampling

In 2018-2019, the Council undertook sampling of the lake at two sites (L2 and L3) on four occasions designed to coincide with varying stratification stages within the lake. The analytical parameters measured followed the Council's standard lake sampling protocols at intervals and sites determined by the agreed programme. The upper (riverine) site was removed from the programme during the 2010-2011 period as it was not considered to be a representative lake site as required for future lake monitoring and state of the environment trending requirements.

1.5.2 Lake Rotorangi biological monitoring

Phytoplankton monitoring was performed at the same two sites sampled for physicochemical analysis, on all four of the lake sampling visits each year. Macroinvertebrate samples collected from the lake bed at these two sites during the spring physicochemical survey are a triennial component of the programme and were last collected in 2017. The aquatic macrophyte survey of the lake is also a triennial component of the monitoring programme and was last performed during autumn 2018. The macroinvertebrate survey is next due in spring 2020, while the macrophyte survey is next due in autumn 2021.

1.6 Objective

The objective of this Report is to provide an assessment of the physicochemical and biological state and trends in Lake Rotorangi. Findings reported here will be used to inform on consent compliance reporting for Lake Rotorangi and to assist with the management of Lake Rotorangi, general environmental management policy and plans for regional lakes.

2 Water quality monitoring

2.1 Methods

The water quality physicochemical monitoring programme for Lake Rotorangi consisted principally of four sampling surveys each year timed to coincide with:

a. pre-stratification period (spring) conditions (near 20 October);
b. stable summer stratification conditions (near 20 February);
c. pre-overturn (later summer) conditions (within one month of (b), and near 20 March); and
d. post-overturn winter conditions (near 20 June).

The parameters measured at the two lake sites during each sampling survey are listed in Table 1 and the locations of routine lake sampling sites are shown in Figure 1.

Table 1 Water quality parameters measured at the two sampling sites

Parameter	Sampling site	
	Lake Site 2	Lake Site 3
GPS location **General site code**	**1729856E 5626435N** **LRT 000300**	**1734948E 5621974N** **LRT 000450**
Depth profile[1] for		
- dissolved oxygen	X	X
- temperature	X	X
Point source[2] in the:		
(a) Surface, for	[LRT00S300]	[LRT00S450]
- secchi disc transparency	X	X
- black disc transparency	X	X
- pH	X	X
- conductivity	X	X
- turbidity	X	X
- suspended solids	X	X
- chlorophyll-a[3]	X	X
- *E. coli*	X	X
(b) Epilimnion, and	[LRT00E300]	[LRT00E450]
(c) Hypolimnion, for	[LRT00H300]	[LRT00H450]
- suspended solids	X	X
- total phosphorus	X	X
- dissolved reactive phosphorus	X	X
- nitrate-nitrogen	X	X
- nitrite-nitrogen	X	X
- ammoniacal-nitrogen	X	X
- total Kjeldahl nitrogen	X	X
- total nitrogen	X	X
- pH	X	X
- conductivity	X	X
- turbidity	X	X
(d) Sediment/water/interface[4], for	[LRT00B300]	[LRT00B450]
- ammoniacal-nitrogen	X	X
- total phosphorus	X	X
- dissolved reactive phosphorus	X	X
- nitrite and nitrate nitrogen	X	X
- pH	X	X
- turbidity	X	X

Note:
1 *Depth profile sampling refers to taking discrete depth measurements*
2 *Point source sampling refers to taking samples which reflect the water quality of a specific zone*
3 *Chlorophyll-a collected through a column (= 2.5 x secchi disc transparency) ie depth integrated (at sites LRT00P300 & LRTOOP450)*
4 *February and March only*

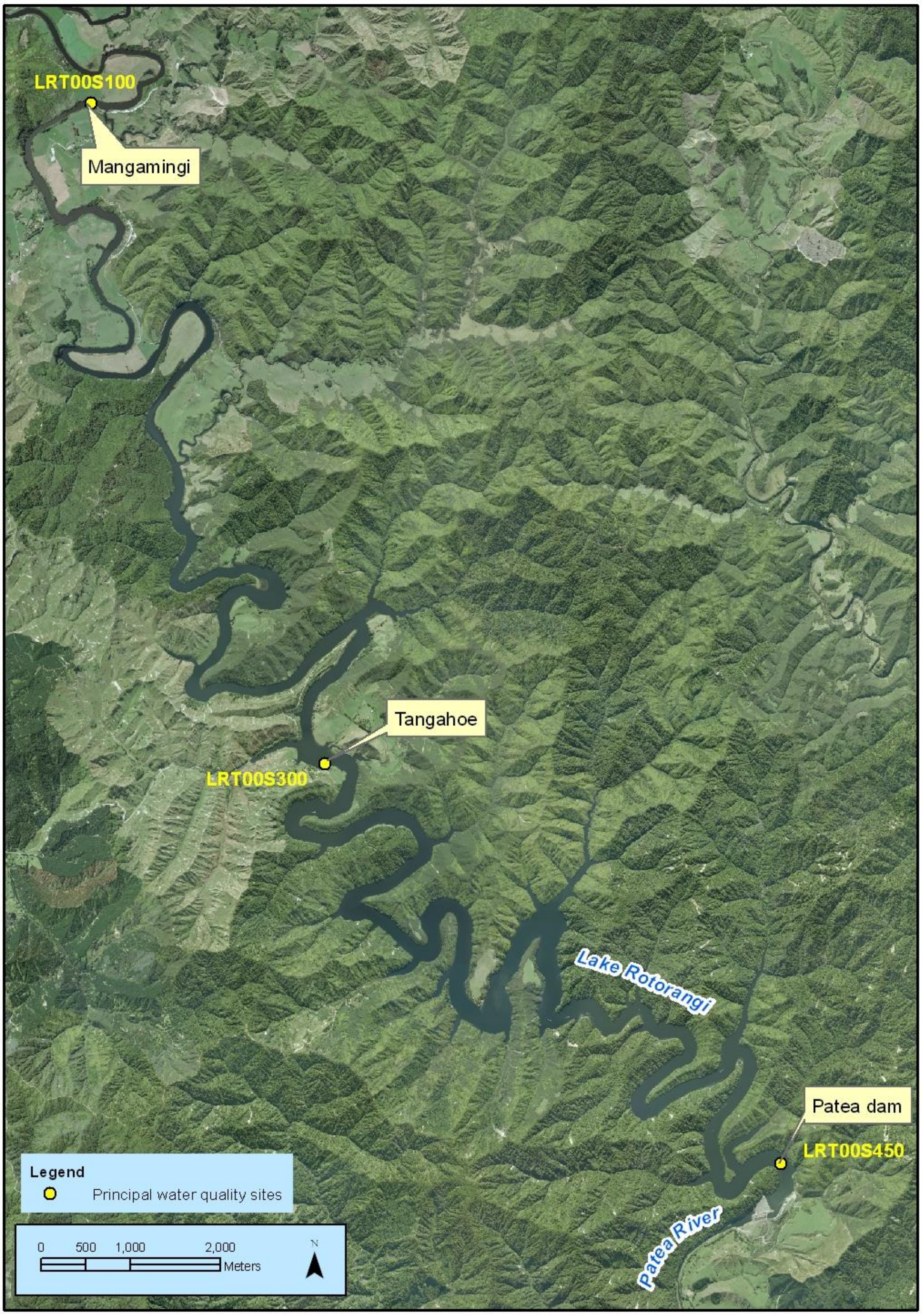

Figure 1 Aerial location map of Lake Rotorangi water quality sampling sites for 2018-2019 (LRT000300 and LRT000450)

In the year under review, the sampling runs were performed at the established monitoring sites on the dates shown in Table 2.

Table 2 Sampling dates for the Lake Rotorangi water quality monitoring programme

Sampling Run	Time	Date
1	Spring	24 October 2018
2	Late summer, stratification	20 February 2019
3	Autumn, stratification	19 March 2019
4	Winter	19 June 2019

The spring sampling survey was performed under steady fresh recession river flow conditions following a period of two small freshes in the Patea catchment and three small freshes in the Mangaehu catchment over the preceding month (Appendix I). The late summer survey occurred under steady low flow conditions during a dry period of over a month prior in both catchments. The autumn survey was performed under steady fresh recession flow conditions five days since a small fresh in the Mangaehu catchment and eleven days after a small fresh in the Patea catchment, preceded by a dry period of three weeks. The final (winter) survey was performed during river recession flow conditions, thirteen days after a small fresh and twenty days after a moderate fresh. There were a further two moderate freshes in each of the two catchments during the preceding six weeks. Lake level was moderate at the time of the spring (75.9 m asl), summer (76.1 m asl), autumn (76.7 m asl) and winter (76.0 m asl) surveys.

Flow data for the Patea River and Mangaehu River are presented in Appendix I, while the synthesised inflow to Lake Rotorangi is shown in Figure 2. This synthetic flow is the flow entering the head of the lake (at Mangamingi) and equates to flows from the Patea River and Mangaehu River catchments above Mangamingi.

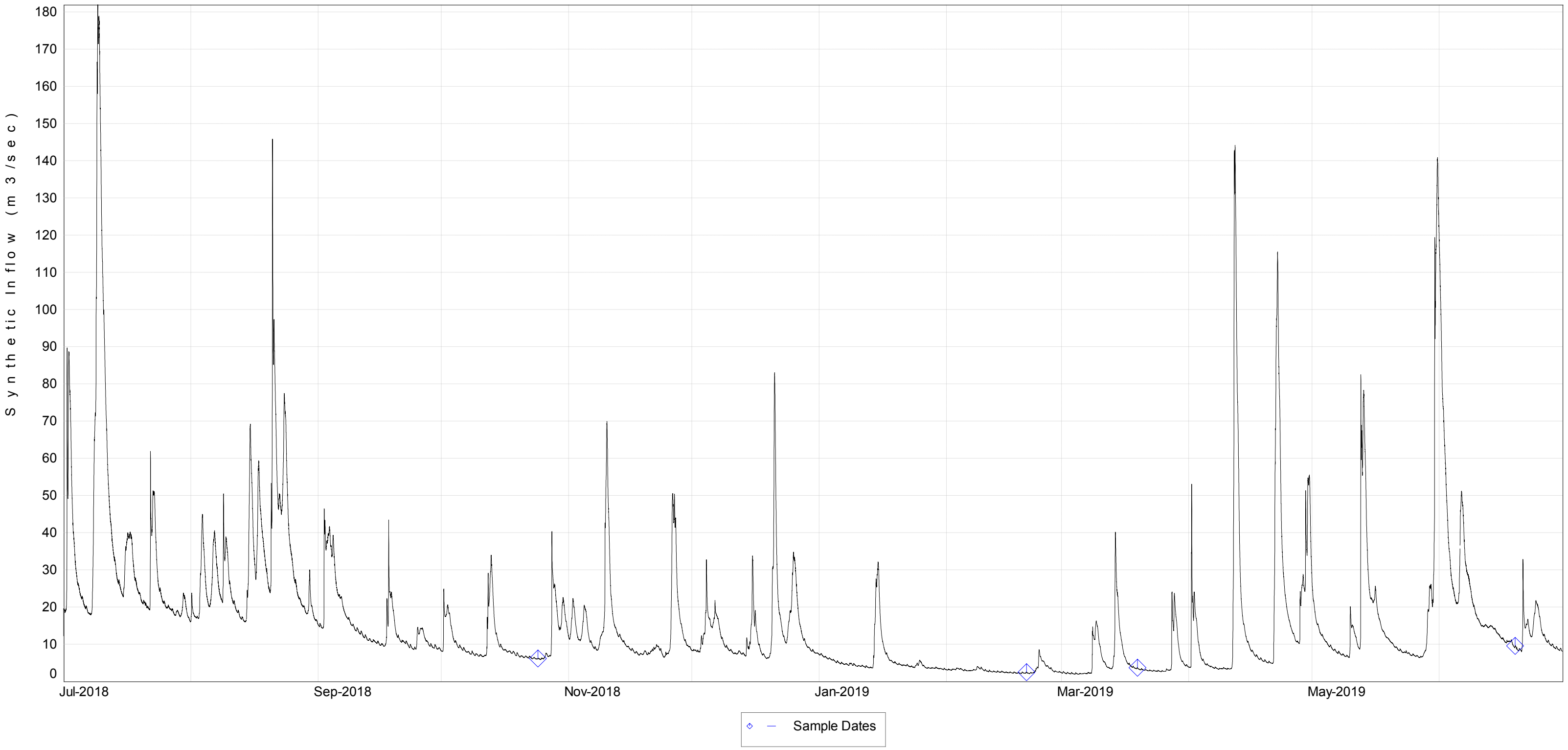

Figure 2 Synthetic inflow at Lake Rotorangi for the period 1 July 2018 to 30 June 2019

3 Results

3.1 General observations

Information recorded at each site on the four sampling occasions in 2018-2019 is summarised in Table 3. This information is collected in conjunction with physicochemical sampling data as a component of the monitoring programme. Lake conditions reflected the preceding river flow conditions referenced in Section 2.1.

Table 3 Observations at Lake Rotorangi monitoring sites on each sampling date during 2018-2019

Site	Date	Time	Weather	Wind	Air Temp	Surface Water Temp	Lake Appearance	Secchi Disc transparency	Black Disc transparency	Lake depth at sampling site
Unit		(NZST)			(ºC)	(ºC)		(m)	(m)	(m)
L2	24 Oct 2018	0913	Overcast, fine	Calm	14.4	17.7	Slightly turbid, brown; surface flat; no debris noted	3.02	1.66	38.4
	20 Feb 2019	0930	Scattered cloud, fine	Calm	22.4	23.1	Slightly turbid, dark brown; surface flat; no debris noted	4.32	2.99	38.4
	19 Mar 2019	0906	Scattered cloud, fine	Light breeze	18.2	22.2	Clear, brown; surface rippled; no debris noted	3.58	2.71	39.6
	19 Jun 2019	1012	Overcast, fine	Calm	4.4	11.3	Slightly turbid, brown, surface flat; no debris noted	2.19	1.68	38
L3	24 Oct 2018	1103	Overcast, fine	Calm	16.3	17.4	Slightly turbid, brown; no debris noted	4.21	2.4	51.5
	20 Feb 2019	1215	Scattered cloud, fine	Light breeze	29.4	24.3	Slightly turbid, dark brown; surface rippled; no debris noted	4.63	4.32	52.8
	19 Mar 2019	1103	Scattered cloud, fine	Calm	24.3	22.5	Clear, brown; surface rippled; no debris noted	5.08	3.7	52
	19 Jun 2019	1201	Fine	Calm	11.8	11.9	Slightly turbid, brown, surface flat; no debris noted	3.88	2.9	50.1

3.1.1 Thermal stratification

A summary of historical water temperature data is provided in Table 4.

Table 4 Statistical summary of surface water temperature data from June 1990 to June 2018

Location	Parameter	Unit	Minimum	Maximum	Median	N
L2 surface	Temperature	ºC	9.6	23.9	17.2	110
L3 surface	Temperature	ºC	9.5	24.6	17.9	110

The two lake sites (L2 and L3) continued to exhibit varying degrees of thermal stratification during the monitoring period (Figure 3), typical of the majority of past years' stratification patterns. Temperatures measured in the surface and bottom waters at each lake site during the period under review are compared with historical monthly averages in Table 5.

Table 5 Surface and bottom waters temperatures at each Lake Rotorangi site during the period under review

Sites	L2		L3	
Date	Surface	Bottom	Surface	Bottom
October 2018	17.7 (14.8)	9.4 (9.0)	17.4 (15.0)	9.1 (8.7)
February 2019	23.1 (21.9)	9.6 (9.6)	24.3 (22.1)	9.2 (9.4)
March 2019	22.2 (19.5)	9.6 (9.8)	22.5 (19.8)	9.3 (9.6)
June 2019	11.3 (11.2)	9.7 (9.5)	11.9 (11.3)	9.4 (9.5)

Note: ( ) = average monthly temperature for period 1984 to mid-2018

Results from the 2018-2019 survey indicated surface water temperatures at both sites were within range of historical measurements (Table 4). The temperatures recorded in February 2019 were within 0.3˚C to 0.8˚C of the maximum temperatures, recorded in February 1994 at a similar time of day.

At site L2, temperatures recorded over 2018-2019 were within 0.1˚C to 2.9˚C of averages calculated for individual sampling months. At site L3, temperatures were within 0.6˚C to 2.7˚C of individual monthly averages.

Temperatures at the bottom of the water column recorded over 2018-2019 at both sites were 1.6°C to 2.5°C lower than surface water temperatures in winter. In late summer, differences between bottom and surface water temperatures increased to 13.5°C to 15.1˚C. However, these temperatures were within 0.4˚C of average temperatures calculated for corresponding sampling months throughout most of the year. Bottom water temperatures at both sites showed a narrow range of just 0.3˚C due to minimal mixing throughout the year. Surface water temperature ranges were much wider (11.8°C [L2] to 12.4°C [L3]).

Water temperature and dissolved oxygen profiles recorded on each sampling occasion during 2018-2019 at each site are illustrated in Figure 3. Partial thermal stratification was recorded at sites L2 and L3 at the time of the October 2018 survey, while both the February 2019 and March 2019 surveys illustrated more well-established thermal stratification. The location of the thermocline during summer-autumn was between 5 m and 9 m below the lake surface at site L2, and 5 to 8 m at site L3. By the June 2019 survey, the thermal stratification had overturned, due to the cooling of epilimnetic waters and the occurrence of several significant river freshes to Lake Rotorangi during the autumn and winter of 2019. However, strong dissolved oxygen stratification remained at site L3 (see Section 3.1.2), a similar situation to that monitored in many previous years.

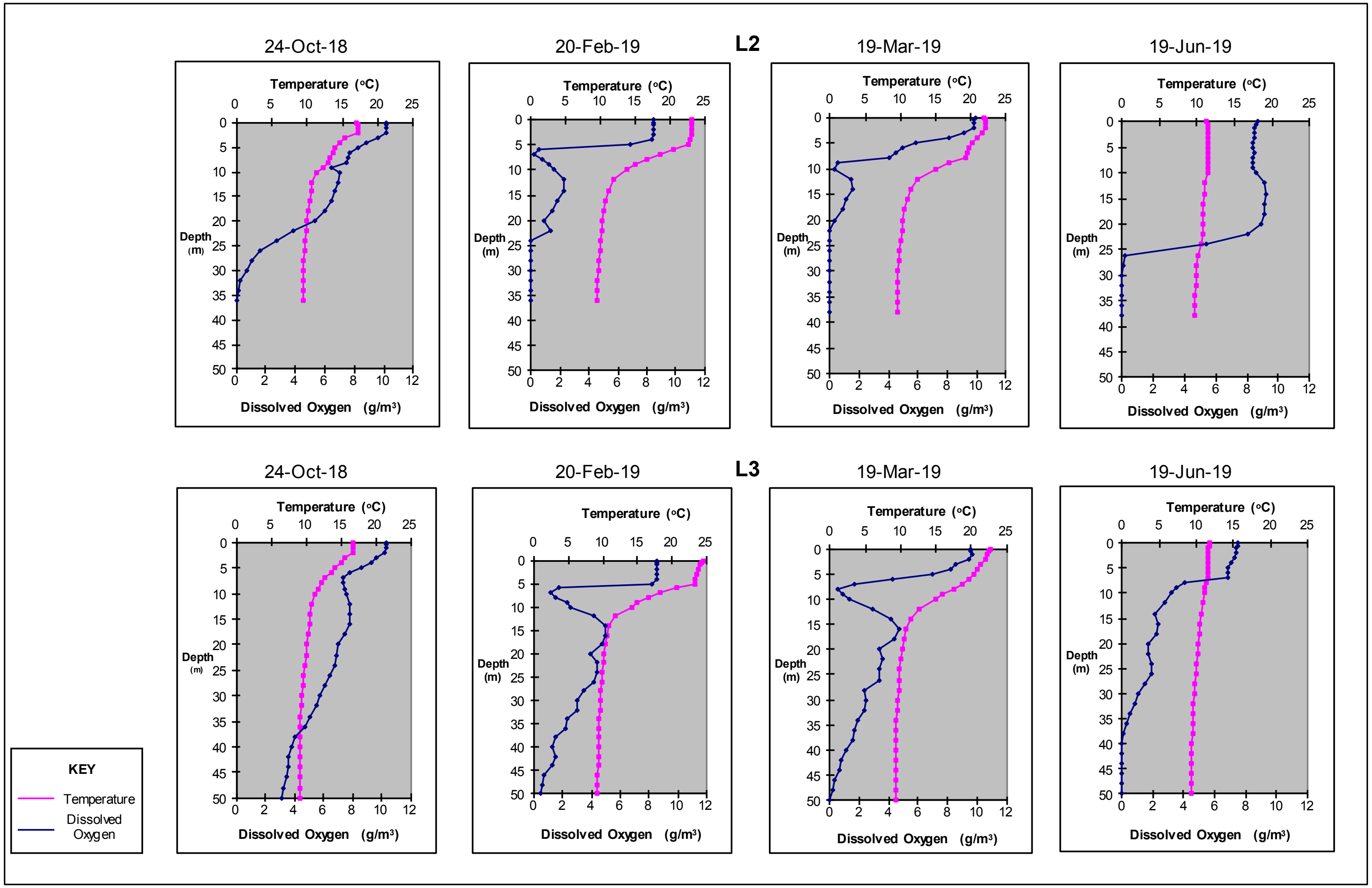

Figure 3 Temperature (°C) and dissolved oxygen (g/m³) profiles for sites L2 and L3, 2018-2019

3.1.2 Dissolved oxygen stratification

A summary of historical dissolved oxygen data is provided in Table 6.

Table 6 Statistical summary of dissolved oxygen data from June 1990 to June 2018

Location	Parameter	Unit	Minimum	Maximum	Median	N
L2 surface	Dissolved oxygen	g/m^3	6.8	11.1	8.9	110
	Dissolved oxygen saturation	%	68	116	92	110
L3 surface	Dissolved oxygen	g/m^3	3.6	11.0	8.8	110
	Dissolved oxygen saturation	%	34	116	95	110

Table 7 Temporal changes in percentage dissolved oxygen saturation in surface and bottom waters at each Lake Rotorangi site during the period under review

Sites	L2		L3	
Date	Surface	Bottom	Surface	Bottom
October 2018	105 (95)	7 (27)	97 (98)	15 (33)
February 2019	99 (99)	0 (2)	103 (101)	1 (7)
March 2019	112 (93)	0 (4)	111 (94)	0 (7)
June 2019	79 (81)	0 (55)	70 (66)	0 (13)

Note: ( ) = average monthly saturation for period 1984 to mid-2018

Surface water percentage dissolved oxygen saturation levels were within past ranges at both sites during the 2018-2019 monitoring year (Table 7). Levels varied in relation to average saturation levels recorded from previous monitoring surveys for the four relevant months. Surface saturation levels were either within 3% of total saturation, or were supersaturated, with the exception of the winter. Partial mixing of the more saturated surface waters with the less saturated hypolimnetic water was recorded by June 2019, as indicated by the decrease in percentage saturation to well below 100% saturation.

The oxygen saturation level in hypolimnetic water of Lake Rotorangi varied according to the degree of stratification established at the time of sampling. Oxygen consumed by either biological or chemical processes cannot be replaced due to thermal separation from the more oxygenated surface waters. This causes oxygen depletion in the hypolimnion unless re-mixing occurs, either as a result of natural overturn processes or as a result of flood events in the river inflow.

In the period under review, there were lengthy periods of dissolved oxygen reduction in the hypolimnion at both sites L2 and L3 (Figure 3), although a lesser degree of oxygen stratification was recorded at site L3 in October 2018. Strong dissolved oxygen stratification remained at both sites in the June 2019 survey, despite both sites being isothermal at this time. These results are typical of those recorded in Lake Rotorangi in the past 25 years.

During the late summer-autumn period, anoxic conditions (i.e. dissolved oxygen concentrations less than 0.5 g/m^3) were recorded at depths below 25 m at site L2, and below 45 m at site L3. Some depletion was found at site L2 in spring, below a depth of 30 m.

Data from both the temperature and dissolved oxygen profiles at sites L2 and L3 for each of the February/March periods to date have been used to calculate the gross volumetric hypolimnetic oxygen depletion rate (VHOD) and the area hypolimnetic oxygen depletion rate (AHOD) (Rutherford, 1982; Vant

1987). Due to destruction of stratification by extensive February 2004 flooding, these rates could not be determined for the 2003-2004 period, and partial destruction by frequent freshes in March 2012 affected calculations for the 2011-2012 period, particularly at site L2. Calculated VHOD results are presented in Appendix II. However, due to a number of shortcomings in the calculation method, along with calculations introduced due to the unique setting and nature of Lake Rotorangi, we do not provide an overall analysis of the data or any trends.

The main shortcoming of the calculation method is that annual VHOD rates are calculated by regression. Currently, the February and March sampling provide only two data points to form the basis of this regression. Ideally a regression analysis should be carried out on a minimum of three data points. Furthermore, the calculation of VHOD requires that data points be no further than a month apart. Therefore, increased sampling effort during the stratified period would be required during the stratified period to increase the reliability of the annual VHOD regression.

In addition to the drawbacks in the sampling and calculation methodologies, reservations about the appropriateness of the VHOD method, given the nature of Lake Rotorangi, have been noted in previous reports (eg. Taranaki Catchment Board, 1988 and 1989). In particular, Burns (1995) noted that the average hypolimnion temperature in the lake often decreased over the duration of the stratified period, whereas in most lakes the hypolimnion temperature increases over this period. The decreasing temperature means that it is not possible to calculate the rate of re-oxygenation which occurs when the hypolimnion is warmed by downward mixing of thermocline water. The observed drop in hypolimnion temperature may be due to the inflow of cooler water into the top levels of the hypolimnion or be the result of the hypolimnetic withdrawal of water for power generation, although the latter is relatively unlikely. Whatever the driving mechanism, the observation of decreasing hypolimnion temperatures indicates that the water mass being monitored has changed, and thus largely invalidates any reliable calculation of dissolved oxygen depletion rates.

Furthermore, it has been noted that dissolved oxygen values close to the lake bottom are often near zero in February and March, invalidating the calculated oxygen depletion rates. Depletion rates should not be calculated when oxygen concentrations drop below 2 g/m^3, as rates become concentration-dependent below this concentration (Burns 1995). While analysis of VHOD has continued in the past despite these limitations, Burns (2006) noted that the calculated VHOD rates show high variability over the 1990-2006 period. This could be due to vertical turbulence (provided by wide ranges of inflows) given the reservoir-type lake system. As a result, the calculated rates are unlikely to provide useful trend information (see Figures in Appendix II).

3.1.3 Secchi disc transparency/suspended solids

Summary statistics for Lake Rotorangi physical water quality data from 1990 to June 2018 is provided in Table 8.

Table 8 Statistical summary of physical water quality data from 1990 to June 2018

Location	Parameter	Unit	Minimum	Maximum	Median	N
L2 Surface	Secchi disc transparency	m	0.09	5.23	2.72	110
	Black disc transparency	m	0.09	4.50	1.82	103
	Turbidity	NTU	0.4	240	1.7	96
	Suspended solids	g/m^3	<2	170	2	103
	Conductivity @ 25ºC	µS/cm	59	165	119	90
L2 Epilimnion	Turbidity	NTU	0.6	250	2.3	101
	Suspended solids	g/m^3	<2	180	2	107
	Conductivity @ 25ºC	µS/cm	58	160	120	105
L2 Hypolimnion	Turbidity	NTU	1.6	510	5.4	103
	Suspended solids	g/m^3	<2	340	3	109
	Conductivity @ 25ºC	µS/cm	64	149	118	107
L3 Surface	Secchi disc transparency	m	0.12	7.0	3.12	110
	Black disc transparency	m	0.12	5.25	2.6	95
	Turbidity	NTU	0.4	250	1.3	99
	Suspended solids	g/m^3	<2	170	<2	104
	Conductivity @ 25ºC	µS/cm	68	167	116	94
L3 Epilimnion	Turbidity	NTU	0.4	250	1.6	101
	Suspended solids	g/m^3	<2	170	2	109
	Conductivity @ 25ºC	µS/cm	68	165	117	105
L3 Hypolimnion	Turbidity	NTU	0.7	780	3.2	103
	Suspended solids	g/m^3	<2	500	<2	111
	Conductivity @ 25ºC	µS/cm	68	136	112	107

Notes: 1) Turbidimeter changed from Hach 2100A to Cyberscan WTW in June 2005, then to Hach 2100N in June 2018.
2) Conductivity units have changed from mS/m @ 20°C to µS/cm @ 25°C. Previously reported values have been converted to the new standard unit, resulting in an approximately 11-fold increase.

Data recorded from both sites during the 2018-2019 year (Table 9) were within previously recorded ranges. Suspended solids remained below the detection limit for the entire period under review. It should be noted that a change in laboratory provider in June 2018 increased the suspended solids detection limit from <2 g/m^3 to <3 g/m^3, and that median historical suspended solids for all sites are lower than the new detection limit.

Table 9 Physical water quality monitoring data for the two Lake Rotorangi sites in the 2018-2019 period

	Sites		L2			L3		
Date	Parameter	Unit	S	E	H	S	E	H
24 Oct 2018	Secchi disc	m	3.02	-	-	4.21	-	-
	Black disc	m	1.66	-	-	2.40	-	-
	Turbidity	NTU	1.05	1.23	2.7	1.00	1.09	3.3
	Suspended solids	g/m^3	<3	<3	<3	<3	<3	<3
	Conductivity @ 25°C	µS/cm	138	138	113	134	134	105
20 Feb 2019	Secchi disc	m	4.32	-	-	4.63	-	-
	Black disc	m	2.99	-	-	4.32	-	-
	Turbidity	NTU	1.52	1.04	2.4	0.54	0.69	1.83
	Suspended solids	g/m^3	<3	<3	<3	<3	<3	<3
	Conductivity @ 25°C	µS/cm	155	154	121	132	132	108
19 Mar 2019	Secchi disc	m	3.58	-	-	5.08	-	-
	Black disc	m	2.71	-	-	3.70	-	-
	Turbidity	NTU	0.69	1.88	2.2	0.66	0.93	1.32
	Suspended solids	g/m^3	<3	<3	<3	<3	<3	<3
	Conductivity @ 25°C	µS/cm	164	180	123	140	142	109
19 Jun 2019	Secchi disc	m	2.19	-	-	3.88	-	-
	Black disc	m	1.68	-	-	2.90	-	-
	Turbidity	NTU	2.8	2.3	8.9	1.43	1.28	1.24
	Suspended solids	g/m^3	<3	<3	<3	<3	<3	<3
	Conductivity @ 25°C	µS/cm	111	111	126	130	129	110

Note: [Sites: S = surface; E = epilimnion; H = hypolimnion]

Secchi disc measurements (an estimate of vertical water clarity) in 2018-2019 were greater than median values, with the exception of those recorded in June 2019. Surface turbidities showed the same pattern, reflecting the proximity to a fresh as baseflow was not reached prior to the June 2019 survey (Figure 2). Turbidity was also below median in the epilimnion and hypolimnion thoughout the year, except at site L2 in the June 2019 survey. Secchi disc and conductivity recorded a narrower range at site L3 than at L2 during the period under review.

Black disc measurements (Table 3) provide an estimate of horizontal water clarity. Black disc observations in conjunction with vertical (Secchi disc) readings provide information on the penetration of diffuse light into water. A correlation between Secchi disc and black disc transparencies has been prepared for both of the sampling sites (Figure 4). This indicates that a direct relationship exists between the two transparency readings, as might be expected, and that while in general Secchi disc (vertical) clarity has been slightly greater than black disc (horizontal) clarity at both sites (by a ratio of about 1.2:1), the two transparencies' values are more similar further down the lake, i.e. where the river influence is less pronounced.

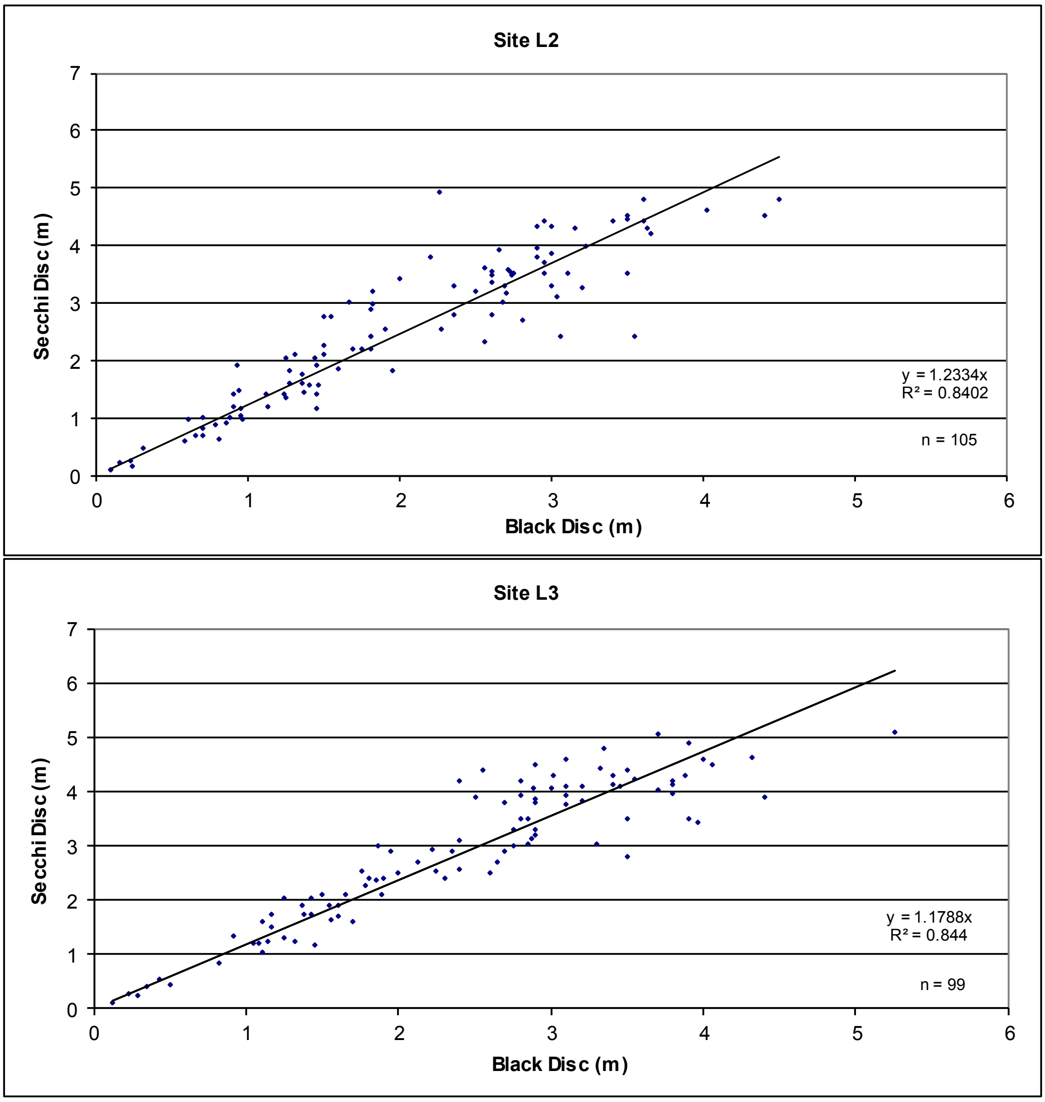

Figure 4 Relationship between Secchi and black disc transparency at each sampling site

These trends have continued to be recorded during the most recent monitoring period under a moderate range of clarities.

3.1.4 Biological productivity

Primary productivity is indicated by chlorophyll-a concentrations (Pridmore, 1987). The summary statistics for chlorophyll-a data collected between 1990 and June 2018 are provided in Table 10, while results from the 2018-19 monitoring programme are presented in Table 11.

Table 10 Statistical summary of chlorophyll-a data from 1990 to June 2018

Location	Parameter	Unit	Minimum	Maximum	Median	Mean	N
L2 photic zone	Chlorophyll-a	mg/m^3	<1.0	13.9	2.8	3.3	109
L3 photic zone	Chlorophyll-a	mg/m^3	<1.0	13.4	2.3	3.4	109

A change in laboratory provider in June 2018 has resulted in increased variability in the detection limit for the (same) chlorophyll-a analysis. Since this time, the detection limit has increased from <1 mg/m^3, to <3 mg/m^3 and <5 mg/m^3 for two samples, and has also decreased from <1 mg/m^3 for one sample.

Table 11 Chlorophyll-a concentrations (mg/m^3) (including historical monthly means) for the Lake Rotorangi sites

Month	Sites			
	L2		L3	
	Mean (1984-2018)	Result 2018-19	Mean (1984-2018)	Result 2018-19
October	3.5	3.5	4.2	2.8
February	3.7	3.7	3.1	2.6
March	4.1	2.8	4.4	3.0
June	1.8	1.1	1.5	0.9
Annual Range: 2018-2019	-	1.1-3.7	-	0.9-3.0
Historical Range: 1984-2018	-	<1-13.9	-	<1-15

All chlorophyll-a concentrations measured at the two sites during the 2018-2019 period were within past ranges (Table 10) found by surveys since 1990. The concentrations during the period under review were lower than or equal to historical seasonal means (Table 11). Recorded concentrations were higher than historical medians except in the winter survey.

Maximum lake chlorophyll-a concentrations have tended to be measured during late summer or autumn at sites L2 and L3. Over the 2018-2019 period, the highest concentrations were found in the photic zone of the mid lake (L2) in summer and in the lower lake (L3) in autumn. All measured concentrations were within previous ranges recorded since 1984 (Table 11). The maximum chlorophyll-a concentration of 3.7 mg/m^3 was measured at site L2 during the late summer period and was only 0.7 mg/m^3 higher than the concentration found at site L3 in autumn.

In terms of broad guidelines listed in Pridmore (1987) for maximum and annual mean chlorophyll-a concentrations, the lake would continue to be most likely categorised as mesotrophic. This categorisation is consistent with the conclusions of Burns (1995, 1999, and 2006). However, these guidelines should be used with caution due to the variability of the sample monitoring particularly in earlier years and the riverine nature of this lake. It should also be emphasised that chlorophyll-a measurements are only partial indications of trophic state. Determination of trophic condition requires examinations of a number of diverse criteria, particularly nutrients, clarity, and chlorophyll-a (see Burns, 1999, Burns, 2006 and Appendix II).

3.1.4.1 Nutrients

A summary of historical nutrients data is provided in Table 12, with water quality data relating to nutrient species, measured during the monitoring period, summarised for each site in Table 13 to Table 16. The results are discussed in relation to the epilimnion and hypolimnion of the lake.

Table 12 Statistical summary of nutrients data from 1990 to June 2018

Site	Parameter	Unit	Minimum	Maximum	Median	No. of samples
L2 Epilimnion	Dissolved reactive phosphorus	g/m^3P	<0.003	0.018	0.005	109
	Total phosphorus	g/m^3P	0.006	0.27	0.024	109
	Ammonia nitrogen	g/m^3N	<0.003	0.37	0.020	109
	Nitrite	g/m^3N	<0.001	0.021	0.007	99
	Nitrate	g/m^3N	0.006	0.99	0.34	101
	Total Kjeldahl nitrogen	g/m^3N	<0.01	1.20	0.26	106
	Total nitrogen	g/m^3N	0.15	1.65	0.62	105
	pH		6.8	8.6	7.5	101
L2 Hypolimnion	Dissolved reactive phosphorus	g/m^3P	<0.003	0.029	0.008	108
	Total phosphorus	g/m^3P	0.008	0.46	0.022	109
	Ammonia nitrogen	g/m^3N	<0.003	0.44	0.071	109
	Nitrite	g/m^3N	<0.001	0.022	0.008	99
	Nitrate	g/m^3N	0.02	0.92	0.51	103
	Total Kjeldahl nitrogen	g/m^3N	<0.01	0.99	0.27	108
	Total nitrogen	g/m^3N	0.45	1.72	0.78	108
	pH		6.5	7.4	6.9	102
L3 Epilimnion	Dissolved reactive phosphorus	g/m^3P	<0.003	0.023	0.004	104
	Total phosphorus	g/m^3P	0.004	0.33	0.019	109
	Ammonia nitrogen	g/m^3N	<0.003	0.183	0.011	109
	Nitrite	g/m^3N	<0.001	0.020	0.005	99
	Nitrate	g/m^3N	<0.01	0.83	0.35	101
	Total Kjeldahl nitrogen	g/m^3N	<0.01	1.15	0.25	105
	Total nitrogen	g/m^3N	0.18	1.51	0.61	105
	pH		6.6	8.7	7.6	101
L3 Hypolimnion	Dissolved reactive phosphorus	g/m^3P	<0.003	0.026	0.006	109
	Total phosphorus	g/m^3P	0.005	0.67	0.017	109
	Ammonia nitrogen	g/m^3N	<0.003	0.34	0.005	109
	Nitrite	g/m^3N	<0.001	0.020	0.001	99
	Nitrate	g/m^3N	0.05	1.00	0.58	103
	Total Kjeldahl nitrogen	g/m^3N	<0.01	1.63	0.16	108
	Total nitrogen	g/m^3N	0.30	2.2	0.73	108
	pH		6.5	7.2	6.8	103

Table 13 Nutrient water quality monitoring data for Lake Rotorangi site L2: Epilimnion (2018-2019)

Parameter		Date			
	Unit	24 Oct 2019	20 Feb 2019	19 Mar 2019	19 Jun 2019
Sample depth	m	1.8	4.5	7.5	5.5
Dissolved reactive phosphorus	g/m³P	0.002	0.001	0.002	0.006
Total phosphorus	g/m³P	0.040	0.029	0.020	0.024
Ammonia-N	g/m³N	0.007	<0.005	0.067	0.022
Nitrite	g/m³N	0.005	0.003	0.006	0.009
Nitrate	g/m³N	0.37	0.025	0.112	0.62
TKN	g/m³N	0.26	0.26	0.29	0.17
Total nitrogen	g/m³N	0.63	0.29	0.41	0.80
pH	pH	7.8	8.0	7.3	7.2

Table 14 Nutrient water quality monitoring data for Lake Rotorangi site L2: Hypolimnion (2018-2019)

Parameter		Date			
	Unit	24 Oct 2019	20 Feb 2019	19 Mar 2019	19 Jun 2019
Sample depth	m	17	25	25	32
Dissolved reactive phosphorus	g/m³P	0.006	0.004	0.004	0.003
Total phosphorus	g/m³P	0.022	0.016	0.015	0.014
Ammonia-N	g/m³N	<0.005	0.073	0.0067	0.20
Nitrite	g/m³N	0.002	0.003	0.001	0.002
Nitrate	g/m³N	0.66	0.49	0.48	0.22
TKN	g/m³N	0.19	0.26	0.20	0.31
Total nitrogen	g/m³N	0.86	0.75	0.68	0.53
pH	pH	7.1	6.9	7.0	7.0

Table 15 Nutrient water quality monitoring data for Lake Rotorangi site L3: Epilimnion (2018-2019)

Parameter		Date			
	Unit	24 Oct 2019	20 Feb 2019	19 Mar 2019	19 Jun 2019
Sample depth	m	1.8	4.5	5.4	7.2
Dissolved reactive phosphorus	g/m³P	<0.001	0.002	0.001	0.005
Total phosphorus	g/m³P	0.022	0.009	0.011	0.018
Ammonia-N	g/m³N	0.006	0.007	0.018	<0.005

Parameter		Date			
	Unit	24 Oct 2019	20 Feb 2019	19 Mar 2019	19 Jun 2019
Nitrite	g/m³N	0.005	0.003	0.002	0.009
Nitrate	g/m³N	0.48	0.069	0.104	0.60
TKN	g/m³N	0.27	0.27	0.22	0.14
Total nitrogen	g/m³N	0.75	0.34	0.33	0.74
pH	pH	7.9	7.8	7.4	7.3

Table 16 Nutrient water quality monitoring data for Lake Rotorangi site L3: Hypolimnion (2018-2019)

Parameter		Date			
	Unit	24 Oct 2019	20 Feb 2019	19 Mar 2019	19 Jun 2019
Sample depth	m	30	32	33	32
Dissolved reactive phosphorus	g/m³P	0.005	0.003	0.002	0.002
Total phosphorus	g/m³P	0.018	0.010	0.009	0.008
Ammonia-N	g/m³N	<0.005	<0.005	<0.005	<0.005
Nitrite	g/m³N	<0.001	<0.001	<0.001	<0.001
Nitrate	g/m³N	0.66	0.60	0.62	0.55
TKN	g/m³N	0.15	0.13	0.13	0.14
Total nitrogen	g/m³N	0.80	0.73	0.75	0.70
pH	pH	7.0	6.9	6.9	7.0

3.1.4.2 Epilimnion

The nutrient concentrations of the epilimnetic waters of the main lake were again characterised by relatively low levels of available plant nutrients (Table 13 and Table 15) on the majority of the monitoring occasions. In general, the lowest concentrations of nutrients, such as TN and TP, were coincident with times when the lake waters were strongly stratified (e.g. summer and autumn). Concentrations of all nutrients were within previously recorded ranges. Total phosphorus concentrations have varied in the past in association with temporal and spatial fluctuations in suspended solids concentrations. These variations were not apparent in the period under review, where suspended solids remained low throughout that lake.

In most previous monitoring years, there was a significant reduction in the readily available nutrient species (particularly nitrate-N) with lake stratification in late summer and autumn at sites L2 and L3, attributable to a possible increase in biological activity e.g. uptake by phytoplankton. During the period under review, ammonia-N and nitrate-N did not follow this pattern, with concentrations being the highest in autumn. Consistent with this, pH levels were slightly elevated in spring and late summer (7.8 to 8.0), but decreased in autumn. Elevated pH levels would often occur in conjunction with a small increase in dissolved oxygen, due to increased phytoplankton photosynthetic activity.

One possible explanation for this atypical result is a river fresh which occurred just prior to the March 2019 sampling. This may have caused the pH to be lowered while simultaneously increasing the concentrations of certain nutrients. Chlorophyll-a concentrations indicated that this fresh did not cause a significant change in phytoplankton productivity. This is consistent with dissolved oxygen concentrations (Table 7), which were highest in autumn (111 to 112% at both sites). This supersaturation indicates that phytoplankton photosynthetic activity was not significantly affected by this fresh.

3.1.4.3 Hypolimnion

The onset of anoxic conditions in the hypolimnetic waters at site L2 during stratification resulted in increased ammonia-N levels between February and June 2019 (Table 14). At site L3, complete anoxia in the hypolimnion was not recorded and ammonia-N levels remained low during the period under review (Table 16). The pH level in the hypolimion was consistently close to neutral (6.9 to 7.1 pH units) and was often significantly lower (by up to 1.1 pH units) than the pH of the epilimnion. These differences in pH are typical particularly during periods of stratification. As is typical, pH levels in the epilmnion and hypolimnion were more similar in winter when the lake was mixed.

The lengthy period of partial to complete stratification at sites L2 and L3 contributed to the variability in nutrient concentrations. The total phosphorus levels at sites L2 and L3 showed some variability in relation to changes in turbidity, particularly at site L2 in spring 2018, caused by suspended sediment settling through the hypolimnetic waters.

3.1.4.4 Bottom of hypolimnion

In an addendum to the Burns (1995) report it was noted that dissolved oxygen concentrations close to the lake bottom were often near zero in February and March each year. Burns recommended that on these occasions additional samples should be collected from near the lake bottom (at sites L2 and L3) in order to determine whether this anoxia had caused the redox potential at the sediment-water interface to drop to a point whereby dissolved reactive phosphorus and/or ammonia had been released from the sediment.

Samples for this purpose have been collected at sites L2 and L3 in February and March of each monitoring year since 1996 during anoxic conditions at site L2 and usually approaching anoxia at site L3. A summary of historical data is provided in Table 17.

Table 17 Statistical summary of nutrients and related data during late summer-autumn in the lower hypolimnion in relation to comparative hypolimnetic data at sites L2 and L3 from 1996 to June 2018

Site	Location			Lower hypolimnion (near bed)			Hypolimnion			
	Parameter	Unit	N	Minimum	Maximum	Median	N	Minimum	Maximum	Median
L2	Dissolved reactive phosphorus	g/m^3P	44	<0.003	0.040	0.007	44	<0.003	0.017	0.008
	Total phosphorus	g/m^3P	44	0.012	0.28	0.023	44	0.008	0.220	0.020
	Ammonia nitrogen	g/m^3N	44	0.015	0.62	0.143	44	<0.003	0.297	0.106
	Nitrate + nitrite	g/m^3N	39	<0.01	0.75	0.43	41	0.02	0.72	0.47
	Temperature	°C	44	8.1	14.3	9.5	44	8.1	14.4	9.7
	Turbidity	NTU	44	2.4	310	9.0	44	1.6	230	3.7
	Dissolved oxygen	g/m^3	44	0.0	6.4	0.1	44	0.0	7.6	0.1
	pH		35	6.5	7.0	6.7	44	6.5	7.3	6.8
L3	Dissolved reactive phosphorus	g/m^3P	43	<0.003	0.032	0.007	43	<0.003	0.024	0.006
	Total phosphorus	g/m^3P	43	0.008	0.298	0.020	43	0.006	0.082	0.017
	Ammonia nitrogen	g/m^3N	43	<0.003	0.111	0.006	43	<0.003	0.064	0.005
	Nitrate + nitrite	g/m^3N	39	0.12	0.77	0.58	43	0.17	0.78	0.61
	Temperature	°C	43	7.4	14.7	9.2	43	7.7	15.6	9.3
	Turbidity	NTU	42	0.7	140	6.2	43	0.7	65	1.8
	Dissolved oxygen	g/m^3	43	0.0	3.5	0.7	43	0.0	4.8	1.7
	pH		33	6.6	7.0	6.7	43	6.6	7.1	6.8

Historical median data (1996-2018) indicate that the general trend at both sites (L2 and L3) has been a small increase in ammoniacal nitrogen and very small decrease in nitrate N in the hypolimnetic anoxic zone near the sediment interface compared to the hypolimnetic water column. There has been no significant change in phosphorus species at site L2 but some increase at site L3, for total phosphorus, noting that a more marked increase in turbidity has been typical at this site nearer the sediment interface.

The nutrient analytical results from sampling in February and March 2019, are summarised in Table 18 and may be compared with results of samples collected from higher up the water column within the hypolimnion on the same occasion (Table 14 and Table 16).

Table 18 Nutrient water quality monitoring data for Lake Rotorangi sites L2 and L3: lower hypolimnion (above the lake bed) in the 2018-2019 period

Site		L2		L3	
Parameter	Unit	20 Feb 2019	19 Mar 2019	20 Feb 2019	19 Mar 2019
Sample depth	m	36	39	50	50
Dissolved reactive phosphorus	g/m^3P	0.004	0.004	0.004	0.004
Total phosphorus	g/m^3P	0.024	0.029	0.013	0.010
Ammonia-N	g/m^3N	0.22	0.25	<0.005	<0.005
Nitrate + nitrite-N	g/m^3N	0.36	0.26	0.57	0.53
[Dissolved oxygen]	g/m^3	[0]	[0]	[0.5]	[0]
[Turbidity]	NTU	[15.3]	[16.8]	[2.6]	[2.6]
[pH]		[7.0]	[6.9]	[6.9]	[7.0]
[Total BOD_5]	g/m^3	-	-	-	-

[ ] = additional parameters N/S = not able to sample

During the summer stratification period anoxic conditions were present in the lower hypolimnion at site L2 but not at site L3 (see Figure 3). Both sites showed no significant increases in dissolved reactive phosphorus in the lower hypolimnetic waters near the sediment interface (Table 18) compared with higher in the water column of the hypolimnion (Table 14 and Table 16), but an increase in total phosphorus was observed at site L2 in February and March 2019 when there was an increase in turbidity. Increases in ammonia nitrogen (0.22 and 0.25 g/m^3N) at site L2 were coincident with reducing conditions deep in the anoxic zone on both survey occasions but there were no increases in ammonia nitrogen at site L3.

Differences in nutrient species between the deeper hypolimnetic waters and waters higher in the hypolimnion were slightly more marked at site L2 during late summer and autumn when more widespread anoxia was recorded. However all nutrient concentrations measured near the lake bed at sites L2 and L3 (Table 18) were within the ranges of historical data (Table 17) measured during summer-autumn anoxic and near anoxic conditions. Ammonia-N was present above median values under anoxic conditions at site L2.

Burns (2006) concluded that DRP and ammonia-N levels indicated a relative lack of nutrient release under anoxic conditions, consistent with lakebed sediment not yet contaminated with high nutrient levels.

Monitoring of the waters of the lower hypolimnion at sites L2 and L3 will be continued during February and March surveys as a component of the long-term monitoring programme.

3.1.4.5 General

Nutrient data surveyed during the period under review were within ranges recorded since 1990 for all sites.

Nutrient data gathered over the 1990 to 2006 period have been analysed by a consultant (Burns, 2006) and by TRC for the 1990-2018 period (Appendix II), and indicate for the lacustrine (lake-like) sites L2 and L3, that total nitrogen (TKN plus nitrate) availability is surplus to phytoplankton requirements and that phosphorus is the growth-limiting nutrient. Phosphorus is reduced more than nitrogen by phytoplankton uptake and sedimentation while nitrates in the lake remain high. While TP and TN nutrients have shown non-significant temporal increases over the twenty-seven year period, a more significant temporal increase in nitrate-N is consistent with a very slow rate of increase in trophic level (Burns, 2006 and Appendix II).

3.1.4.6 Bacteriological surface water quality

The Council undertakes an extensive freshwater contact recreational bacteriological state of the environment monitoring programme at various bathing sites over summer months (see TRC, 2019). In recognition of the recreational uses of Lake Rotorangi (mainly boating and water-skiing at site L2, but also at site L3), bacteriological surface water quality sampling are undertaken at both sites on each survey occasion. These results are presented in Table 19 and Table 20.

Table 19 Bacteriological quality monitoring data for Lake Rotorangi site L2: surface water (2018-2019)

Site		Date			
Parameter	**Unit**	**24 Oct 2019**	**20 Feb 2019**	**19 Mar 2019**	**19 Jun 2019**
Time	NZST	0913	0930	0906	1012
Temperature	˚C	17.7	23.1	22.2	11.3
Turbidity	NTU	1.05	1.52	0.69	2.8
E.coli	/100 mL	2	3	10	23

Table 20 Bacteriological water quality monitoring data for Lake Rotorangi site L3: Surface (2018-2019)

Site		Date			
Parameter	**Unit**	**24 Oct 2019**	**20 Feb 2019**	**19 Mar 2019**	**19 Jun 2019**
Time	NZST	1103	1215	1103	1201
Temperature	˚C	17.4	24.3	22.5	11.9
Turbidity	NTU	1.00	0.54	0.66	1.43
E.coli	/100 mL	3	<1	2	3

Bacteriological water quality was well within the guidelines for contact recreation (MfE, 2003) at both sites on all sampling occasions. Sparse birdlife has been noted on the water in the vicinity of sites L2 and L3 in previous surveys and, although minimal recreational usage was recorded on sampling occasions, boating and water-skiing are popular activities at site L2 in particular and swimming also occurs at site L3.

3.2 Biological monitoring

3.2.1 Methods

During the 2018-2019 monitoring periods the biological monitoring of Lake Rotorangi involving the Regional Council included monitoring of the lake phytoplankton communities

Phytoplankton (open-water algae) sub-samples were taken from the chlorophyll-a samples collected from the photic zone at each of the two lake sites in October 2018, and February, March and June 2019. The phytoplankton samples were preserved with Lugol's iodine solution and all samples were later identified under a compound microscope using up to 400 x magnification.

The macrophyte survey is next due in April 2021, and was performed last in April 2018, when both banks were visually surveyed from a boat. The dominant species was recorded, with the presence of other species noted and mapped.

Benthic macroinvertebrate samples were collected by Ekman dredge from the lakebed at sites L2 and L3 in conjunction with the survey of October 2017, as a long-term component of the monitoring programme. These samples were run through a 0.5 mm sieve, before being sorted and identified under a stereoscopic microscope. This is next due in October 2020.

3.2.2 Results

3.2.2.1 Lake phytoplankton communities

Phytoplankton samples were collected from Lake Rotorangi on 24 October 2018, and 20 February, 19 March and 19 June 2019. These samples were taken from within the photic zone (surface waters) of sites L2 and L3. Table 21 and Table 22 list the phytoplankton taxa found at each site. Taxa data from previous years are listed in previous Annual Reports, but particularly in TRC, 2009.

3.2.2.1.1 Site L2

Site L2 in the central reaches of the lake has generally supported more lake-like algal communities than previously found at site L1 (see TRC, 2009).

Table 21 Phytoplankton found at site L2 in Lake Rotorangi during the 2018-2019 period

Date	24 Oct 2018	20 Feb 2019	19 Mar 2019	19 Jun 2019
GREEN ALGAE				
Unidentified (unicellular)		P		P
Unidentified colonies		P	P	P
Closterium				P
Cosmarium			P	P
Chlorella		P		
Oocystis		P		
Staurastrum		P	P	P
Kirchneriella				P
Dictyosphaerium		P		
Micractinium				P
Golenkinia		P		
Scenedesmus				P
Mougeotia		P		
CYANOBACTERIA				
Dolichospermum[1]			P	P
DIATOMS				
Synedra		A		
Navicula		P		
Fragilaria		P		P
GOLDEN BROWNS				
Mallomonas		P	P	P
Dinobryon		A		P
DINOFLAGELLATES				
Peridinium			P	
EUGLENOIDS				
Trachelomonas	P	P	P	P
CRYPTOPHYTES				
Cryptomonas		A	P	P
TOTAL	1	15	8	14

P – Present

A – Abundant

1 – formerly *Anabaena*

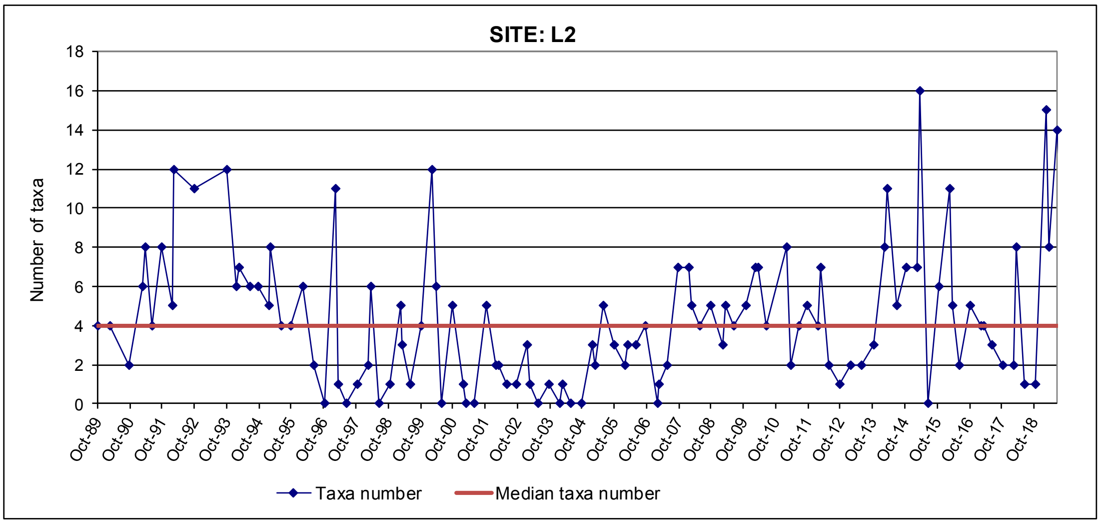

Figure 5 Number of phytoplankton taxa recorded at site L2 in Lake Rotorangi since monitoring began in 1989

Moderate to high numbers of taxa (1 to 15) were recorded at site L2 during the period under review. With the exception of the spring 2018 sample, taxa richness was substantially higher than the median richness of 4 taxa. Chlorophyll-a concentrations ranged from 1.1-3.7 mg/m^3 (Table 11), congruent with taxa being recorded as abundant on only one sampling occasion. The three taxa recorded as abundant were the diatom *Synedra,* the cryophyte *Cryptomonas* and the golden brown alga *Dinobryon.*

A total of 22 taxa were recorded at this site throughout the year, and one taxon (the euglinoid *Trachelomonas*) was present on all four sampling occasions, while four taxa were present on three of the four sampling occasions (*Cryptomonas*, the golden brown alga *Mallomonas*, the green alga *Staurastrum* and unidentified colonial green algae).

3.2.2.1.2 Site L3

Moderate to high taxa richness was found at L3 during the period under review. As was the case at site L2, taxa richness was substantially higher than the median richness of 4 taxa except in spring 2018. Chlorophyll-a concentrations ranged from 0.9- 3.0 mg/m^3 (Table 11).

Table 22 Phytoplankton found at site L3 in Lake Rotorangi during the 2018-2019 period

Date	24 Oct 2018	20 Feb 2019	19 Mar 2019	19 Jun 2019
GREEN ALGAE				
Unidentified (unicellular)	P			P
Unidentified colonies		P	P	P
Cosmarium		P	P	P
Chlorella		P	P	
Oocystis		P	P	
Staurastrum		P	P	P
Coelastrum		P	P	
Micractinium			A	P
Eudorina				P
Elakatothrix		P	P	
CYANOBACTERIA				
Dolichospermum[1]				P
DIATOMS				
Asterionella		A		
Synedra		P	P	
Aulacoseria		P		
Fragilaria		P	A	P
GOLDEN BROWNS				
Mallomonas		P	P	P
Dinobryon		P	P	
DINOFLAGELLATES				
Peridinium			P	
EUGLENOIDS				
Trachelomonas	P	P	P	
CRYPTOPHYTES				
Cryptomonas		A	A	P
TOTAL	2	15	15	10

P – Present

A – Abundant

1 – Formerly *Anabaena*

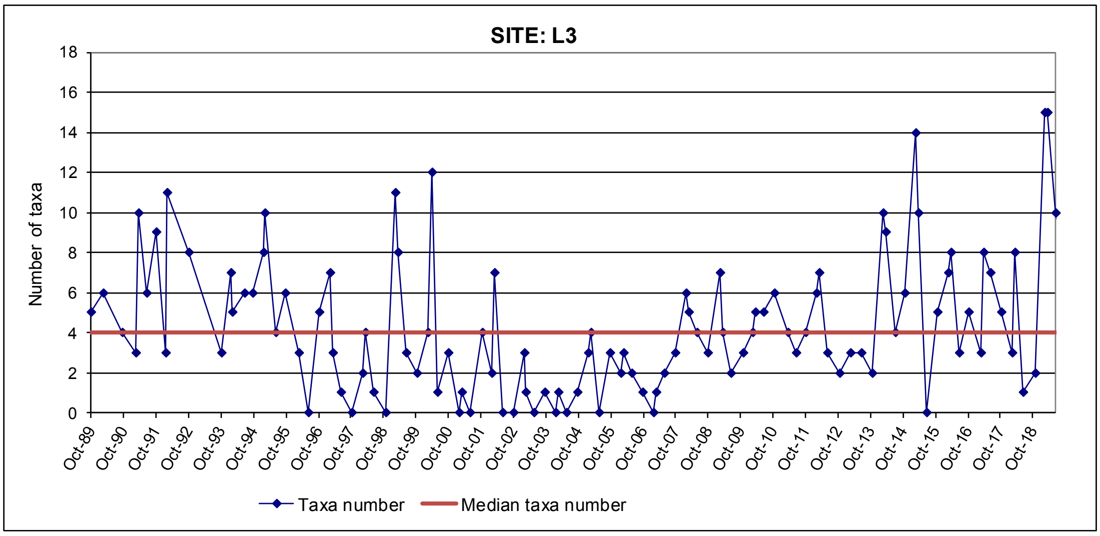

Figure 6 Number of phytoplankton taxa recorded at site L3 in Lake Rotorangi since monitoring began in 1989

A total of 20 taxa were recorded during the period under review, with up to 15 taxa present on any one sampling occasion. Abundant taxa were recorded on two occasions, with the cryophyte *Cryptomonas* being abundant in both late summer and autumn. The diatom *Asterionella* was also abundant in late summer, while the diatom *Fragilaria* and the green alga *Microactinium* were abundant in autumn. Seven taxa were present on three of the four sampling occasions during the year.

3.2.2.1.3 General comments

Phytoplankton density limiting factors include:

- limited nutrient levels in the lake;
- the settling of algal cells within the dark hypolimnetic waters;
- flood events reducing the clarity of surface waters and flushing surface waters along the length of the lake;
- the limited and variable retention time of water in the lake;
- grazing of phytoplankton by zooplankton (primarily microscopic crustacea); and
- cooler winter temperatures.

The absence of significant blooms of algae to date has indicated that one or more of these limiting factors have prevented algal population increases from continuing for long periods of time. Phytoplankton survey results to date indicate that the open-water algal community composition of Lake Rotorangi is determined by the ability of opportunist taxa to proliferate during the very limited periods of favourable conditions (e.g. late summer/autumn). Phytoplankton provides the food source for the microscopic crustacea in the open water (the major component of zooplankton). Such zooplankton taxa as cladocerans *Daphnia* and *Ceriodaphnia* have been recorded in highly variable densities in Lake Rotorangi in past years. Large numbers of these cladocerans have been recorded in the stomachs of perch (*Perca fluviatilis*) taken from Lake Rotorangi. Some of the algal taxa recorded in the lake phytoplankton are likely to have drifted downstream from the discharge from the Stratford oxidation pond system (where extensive algal populations are a feature of the biological treatment system), and from the mid-reaches of the Patea River. [Note: A major upgrade to the Stratford wastewater treatment plant in 2009 has been designed to reduce the algal population component of the effluent discharge to the river downstream of Stratford (TRC, 2018a)].

In summary, taxa richness was much higher than usual in Lake Rotorangi from late summer to winter 2019, with both sites recording up to 11 taxa more than the running median for the respective sites. Despite this higher than usual diversity, chlorophyll-a concentrations were within a relatively low range. This indicates that although there was increased diversity, there were not particularly high abundances of the taxa present. There were also some differences in the phytoplankton communities between sites L2 and L3, with 12 of a total 27 taxa recorded in the lake during the year present at only one site.

3.2.2.2 Benthic macroinvertebrate fauna

A review of the monitoring undertaken by Council staff in late 1991 in conjunction with Dr V M Stout (Department of Zoology, University of Canterbury), indicated that an important additional parameter (benthic macroinvertebrate presence/absence information) should be included as a long term lake status indicator. Sampling from the lake bed (at the deeper sites L2 and L3) was recommended once annually in late winter/spring prior to lake stratification (and the chironomid hatching period).

Generally, the limited information gathered on the macro-benthos of New Zealand lakes indicates that lakes are rather poor in terms of numbers of species, with the main groups found including annelid worms, chironomid midges, ceratopogonid flies and molluscans (Forsyth, 1975 and 1977).

The initial sampling of the lake bed at the deeper sites (L2 and L3) was undertaken in October 1992 with samples collected at similar times over subsequent years until the October 2013 survey using an Ekman dredge. Following the October 2013 survey, the frequency of monitoring was reduced to triennial sampling. The October 2017 survey was the first survey at the reduced frequency. Macroinvertebrate sampling was not undertaken during the period under review and will next be undertaken in October 2020.

The results of the October 2017 survey are reported in the 2016-2018 Lake Rotorangi water quality and biological monitoring report (TRC 2018).

In general, the paucity and lack of diversity of the fauna continues to be indicative of low dissolved oxygen levels, consistent with the often lengthy periods of anoxic conditions during lake stratification common to these deeper sites.

3.2.2.3 Aquatic macrophyte survey

The latest survey of the aquatic macrophytes in Lake Rotorangi was performed on 15 April 2018. Surveys are now undertaken as a requirement of consent 0489-2, which requires that surveys be undertaken every three years (commencing in 2012). This survey was not undertaken during the period under review and will next be undertaken in autumn 2021.

The results of the April 2018 macrophyte survey are reported in the 2016-2018 Lake Rotorangi water quality and biological monitoring report (TRC 2018).

4 Conclusions

4.1 Discussion of 2018-2019 programme

4.1.1 Water quality

Pre-stratification, two summer stratification, and post-stratification (winter) sampling surveys were performed during each monitoring period at times dictated by requirements for trend detection purposes.

The annual cycle of stratification was recorded in the mid and lower lake during the summer-autumn period in 2018-2019 with anoxic hypolimnetic water recorded at site L2 and oxygen depleted hypolimnetic water recorded at site L3. Normal lake overturn was complete at site L2 but only partially complete at site L3 in mid-winter. These conditions generally were similar to those recorded during the majority of the previous monitoring years and are a particular feature of the lower lake site. Complete re-oxygenation of the water column due to further mixing at site L3 might have been anticipated later in winter (as had been the situation recorded in August 2008 and found in July 2012 and July 2013 from readings taken through the water column at the log boom as a part of the Patea Hydro Electric Power Scheme - aquatic monitoring plan), although spring 2013 records at site L3 suggest that mixing may never be complete nearer the lake bed.

Primary productivity measurements (chlorophyll-a) continued to indicate that predicted eutrophic lake conditions have not eventuated. The lake biologically continues to exhibit mesotrophic bordering on eutrophic conditions as confirmed by a NIWA consultant's report (Burns, 1995) commissioned during the 1995-1996 period and subsequent follow-up reports (Burns, 1999; Burns et al, 2000 and Burns, 2006) and the most recent trend evaluation for the period 1990 to 2018 (Appendix II) which was carried out by the Council. However, relatively high turbidity levels (caused by riverine derived fine silt) from time to time have increased total phosphorus and nitrogen levels and lowered secchi disc values, indicative of a trend toward slightly eutrophic conditions (Burns, 2006). Nutrient supply has been limited principally to those quantities present in the river inflow waters. Despite low dissolved oxygen concentrations and periods of anoxic conditions in the lower waters of the hypolimnion, minimal increases in nutrient concentrations in these waters (usually due to the increased solubility of nutrients from sediments and decomposing vegetation under reducing conditions), have been recorded, with the main variations relating to relatively small increases in ammonia levels measured during this period with minor changes in total phosphorus levels (usually coincident with increased turbidity due to fine sediment).

Variability in levels of turbidity and suspended solids concentrations at the times of the four survey in 2018-2019 were related to the temporal proximity to river freshes. Secchi disc transparencies and turbidity were generally similar or respectively higher and lower than historical median values, indicating that the freshes prior to sampling were of relatively small magnitude. As has been noted in the past, lake surface water suspended solids concentrations generally were not excessive at mid and lower lake sites and were due to the finer colloidal material which remained suspended and would be expected to be carried through the lake.

The calculation of VHOD has a number of shortfalls and inaccuracies in the calculation method. Further, the nature of Lake Rotorangi and the variability in the VHOD rates means that the value of this parameter is of questionable value for trend detection purposes. The limitations of this parameter are discussed more fully in Section 3.1.2. Increased sampling effort would be required to improve the annual VHOD calculation, but would not address many of the shortcomings of this parameter. It is therefore recommended that the calculation of VHOD is removed as a component of the Lake Rotorangi physicochemical and biological water quality monitoring programme. It should be noted that the temperature and dissolved oxygen profiles of the lake will continue to be collected. This will allow VHOD rates to be calculated in future should inadequacies with the calculation methodology be addressed.

The most recent lake water quality trend analysis, performed by the Council for the 28 year period 1990-2018 (see Appendix II) has continued to support the findings and conclusions of Burns, 2006. i.e. that the trophic level continues to increase at a very small, insignificant annual rate of change (currently 0.02 $\underline{+}$ 0.01 TLI units per year). However, given the tendency for the reservoir water to contain elevated (fine) silt levels, which artificially elevate the trophic index, the trophic category is more appropriately mesotrophic. This is further confirmed by mesotrophic chlorophyll-a level. The analysis also notes significant increase in the average concentration of chlorophyll-a and total phosphorus, but not the other key variables (secchi disc visibility and total nitrogen). The other variable showing a significant temporal trend was nitrate, which is increasing.

4.1.2 Biology

No phytoplankton blooms were recorded in Lake Rotorangi. The lake has been unable to sustain significant abundances of planktonic algae for long due to the frequency of river freshes. Low to moderate numbers of algal taxa were recorded, partly as a result of the frequency of river freshes through the system. Several of the taxa that have been found to date probably originated from the Stratford oxidation pond wastewater treatment system discharge (where extensive algal populations have been a feature of the biological treatment system) and from the mid reaches of the Patea River. Phytoplankton results to date indicate that lake phytoplankton community composition is determined by opportunistic taxa which have the ability to proliferate during favourable conditions which may be confined to very limited periods often due to the frequency of river freshes moving down the lake. Chlorophyll-a concentrations in the lake were low to moderate at survey times although phytoplankton communities were more diverse than is typical in Lake Rotorangi. This indicates that although diversity was higher than usual, abundances were relatively low.

The macrophyte survey was conducted in 2017-2018 at a time of high turbidity throughout the length of the lake, caused by a recent fresh in the upper catchments, which may have affected the discovery of submerged plants. The oxygen weed *Egeria densa* was identified as the dominant macrophyte in the lower part of the lake, and *Ceratophyllum demersum* (hornwort) in parts of the mid-section. No other species was recorded as dominant, and only one other species, *Glossostigma elatinoides*, was found. *Lagarosiphon major*, which had been recorded in all previous surveys was not found, possibly as a result of the high turbidity. This is the third record of hornwort in Lake Rotorangi. In addition to those species recorded by the Council, an additional three new species were recorded by NIWA in April 2012 when commissioned by TrustPower to assess the hornwort community within the lake. It is unlikely that these other species will ever become abundant. Hornwort on the other hand is considered highly invasive, and is expected to eventually become dominant, out-competing *E. densa* and *L. major,* although this had not occurred at the time of the October 2018 survey. While this is not expected to cause significant impacts on the ecology of Lake Rotorangi or on the hydroelectric scheme, there is now greater potential for it to spread to nearby lakes, where such impacts could be much more severe e.g. Lake Rotokare. The next survey is due to be performed in the 2020-2021 period.

Appropriate warning signs about aquatic weeds, positioned at the three principal boat ramps along the lake's length, publicise the problems that could result from the introduction of further nuisance aquatic plants by recreational users, and their responsibilities for preventing the transportation of aquatic plants between the waterways. These were updated during the 2015-2016 period, with particular reference to hornwort.

A very sparse macroinvertebrate fauna, but with an absence of oligochaete (tubificids) worms, has been recorded from the fine sediments of the lake bed between 1996-2017 at the mid lake site and at the lower lake site consistent with periodic occurrences of anoxic or oxygen depleted conditions recorded at these two relatively deep sites. This component of the programme is next due in the 2020-2021 monitoring period.

4.2 2016-2018 Report's recommendations

The recommendation contained in the 2016-2018 Annual Reports based upon the monitoring programme results was:

1. THAT the Lake Rotorangi physicochemical and biological water quality monitoring programme continue on an annual basis as a component of the Council's State of the Environment monitoring programme, with every third year of the programme also undertaken in conjunction with the Patea Hydro Electric Power Scheme - aquatic monitoring plan (next in 2020-2021), and that the requisite macrophyte and benthic macroinvertebrate surveys be components of the 2020-2021 programme.

This recommendation (1) was implemented with the continuation of a State of the Environment monitoring programme to include the physicochemical and biological water quality monitoring including the triennial performance of the macrophyte survey. Once every three years this will be undertaken at TrustPower's expense, as required by consent 0489, and this is included in the Patea Hydro Electric Power Scheme - aquatic monitoring plan.

4.3 Alterations to monitoring programme for 2019-2020

In the case of the State of the Environment monitoring programme for Lake Rotorangi, it is considered that the current monitoring is generally appropriate, with every third year of the programme to be performed in conjunction with the Patea Hydro Electric Power Scheme - aquatic monitoring plan, which is next to be conducted in the 2020-2021 period. The exception to this is the VHOD calculation as discussed in Sections 3.1.2 and 4.1.1.

No alterations are required to the 2019-2020 programme, although the data will no longer be used to calculate VHOD given the shortcomings of this parameter. It is noted that the designated macrophyte survey will next be undertaken in early 2021 and the benthic macroinvertebrate survey in spring 2020.

Recommendations to this effect are attached to this report.

5 Recommendations

The following recommendations are based on the results of the 2018-2019 water quality and biological monitoring programmes and the contractual requirements of the resource consents held by Trustpower for the Patea Hydro Electric Power Scheme on Lake Rotorangi:

1. THAT the Lake Rotorangi physicochemical and biological water quality monitoring programme continue on an annual basis as a component of the Council's State of the Environment monitoring programme, with every third year of the programme also undertaken in conjunction with the Patea Hydro Electric Power Scheme - aquatic monitoring plan (next in 2020-2021), and that the requisite macrophyte and benthic macroinvertebrate surveys be components of the 2020-2021 programme.
2. THAT the calculation of VHOD rates as a component of the Lake Rotorangi physicochemical and biological water quality monitoring programme be discontinued due to the inaccuracies and shortfalls of the calculation method.

6 Acknowledgements

The programme Job Manager was Sheree Tidswell (Environmental Scientist). The principal author of the Annual Report was Katie Blakemore (Technical Officer), who provided the statistical trend analyses. Field lake sampling were performed by Sheree Tidswell assisted by boatperson Regan Diggelmann. Hydrological data was provided by Fiona Jansma (Data Analyst). All water quality analytical work was performed by Hill Laboratories. Phytoplankton analyses were performed by Darin Sutherland and Brooke Thomas (Environmental Scientists) in the Council's biology laboratory.

Glossary of common terms and abbreviations

The following abbreviations and terms are used within this report:

anoxia	absence of dissolved oxygen
aquatic macrophyte	water plants
benthic	bottom living
black/secchi disc	measurement of visual clarity (metres) through the water (horizontally/vertically)
biomonitoring	assessing the health of the environment using aquatic organisms
chlorophyll-a	productivity using measurement of phytoplankton pigment (mg/m^3)
cumec	volumetric measure of flow (cubic metre per second)
conductivity	Conductivity, an indication of the level of dissolved salts in a sample, usually measured at 25°C and expressed in µS/cm
DO	dissolved oxygen measured as g/m^3 (or saturation (%))
DRP	dissolved reactive phosphorus
E.coli	*Escherichia coli*, an indicator of the possible presence of faecal material and pathological micro-organisms. Expressed as the number of organisms per 100ml
epilimnion	lake zone above the thermocline (mixed surface layer)
faecal coliforms	an indicator of the possible presence of faecal material and pathological micro-organisms. Expressed as the number of organisms per 100ml
fresh	elevated flow in a stream, such as after heavy rainfall
g/m^3	grammes per cubic metre, and equivalent to milligrammes per litre (mg/L). In water, this is also equivalent to parts per million (ppm), but the same does not apply to gaseous mixtures
hypolimnion	zone below the thermocline in a stratified lake
l/s	litres per second
mesotrophic	intermediate condition of nutrient enrichment between oligotrophic and eutrophic in lakes
mS/m	millisiemens per metre
µS/cm	Microsiemens per centimetre.
NH_4	ammonium, normally expressed in terms of the mass of nitrogen (N)
NO_3	nitrate, normally expressed in terms of the mass of nitrogen (N)
NTU	Nephelometric Turbidity Unit, a measure of the turbidity of water
overturn	remixing of a lake after stratification
pH	a numerical system for measuring acidity in solutions, with 7 as neutral. Numbers lower than 7 are increasingly acidic and higher than 7 are increasingly alkaline. The scale is logarithmic i.e. a change of 1 represents a ten-fold change in strength. For example, a pH of 4 is ten times more acidic than a pH of 5
photic zone	upper section of lake penetrated by light

physicochemical	measurement of both physical properties(e.g. temperature, clarity, density) and chemical determinants (e.g. metals and nutrients) to characterise the state of an environment
plankton	plants and animals freely moving in open water
resource consent	refer Section 87 of the RMA. Resource consents include land use consents (refer Sections 9 and 13 of the RMA), coastal permits (Sections 12, 14 and 15), water permits (Section 14) and discharge permits (Section 15)
RMA	Resource Management Act 1991 and subsequent amendments
SS	suspended solids
stratification	formation of thermal layers in lakes
temp	temperature, measured in °C (degrees Celsius)
thermocline	zone of most rapid temperature change in stratified lakes
trophic level	amount of nutrient enrichment of a lake
turb	turbidity, expressed in NTU
UI	Unauthorised Incident
UIR	Unauthorised Incident Register – contains a list of events recorded by the Council on the basis that they may have the potential or actual environmental consequences that may represent a breach of a consent or provision in a Regional Plan
VHOD	Volumetric hypolimnetic oxygen depletion. The note of dissolved oxygen decrease in the lower layer of the lake under stratified conditions. A measure of lake productivity
water column	water overlying the lake bed

Bibliography and references

Adam, D and Grant, M; 2003: 'Lake Rotorangi'. NZ kayak magazine Issue 19, pgs 10-11.

BTW Company, 2008: 'Lake Rotorangi cross-section profiles 2008'. BTW Co report.

BTW Company, 2009: 'Lake Rotorangi cross-section profiles 2009'. BTW Co report.

BTW Company, 2010: 'Lake Rotorangi cross-section profiles 2010'. BTW Co report.

Burns, N M; 1995: 'Using hypolimnetic dissolved oxygen depletion rates for monitoring lakes'. NZ Journal of Marine and Freshwater Research. 29:1-11.

Burns, N M; 1995: 'Results of monitoring the water quality of Lake Rotorangi'. NIWA Consultancy Report TRC 302.

Burns, NM; 1999: 'The trophic status of Lake Rotorangi'. Lakes Consulting Client Report: 99/2.

Burns, NM; 2006: 'Water quality trends in Lake Rotorangi, 1990-2006.' Lakes Consulting Client Report 2006/2.

Burns, N M, Bryers G and Bowman E; 2000: 'Protocol for monitoring trophic levels of New Zealand lakes and reservoirs. MfE publication.

Burns, N M and Rutherford, J C; 1998: 'Results of monitoring New Zealand lakes'. NIWA Hamilton Report No MfE 80216.

Charteris, S C; 2002: Spawning, egg development and recruitment of diadromous galaxiids in Taranaki, New Zealand. Unpublished MSc thesis, Massey University, Palmerston North, New Zealand.

Coffey, B T and Clayton, J S, 1988: 'New Zealand Water Plants, A Guide to Plants Found in New Zealand Freshwaters'. Ruakura Agricultural Centre, Hamilton.

Duggan, I C, Green, J D and Shiel, R J; 2001: 'Distribution of rotifers in North Island, New Zealand, and their potential use as bioindicators of lake trophic status'. Hydrobiologia 446/447, 155-164.

Duggan, I C, Green, J D and Shiel, R J; 2002: 'Distribution of rotifer assemblages in North Island, New Zealand, lakes: relationships to environmental and historical factors'. Freshwater Biology 47, 195-206.

Duggan, I C, Green, J D, Thompson, K and Shiel, R J; 1998: 'Rotifers in relation to littoral ecotone structure in Lake Rotomanu, North Island, New Zealand'. Hydrobiologia 387/388, 179-197.

Forsyth, D J; 1975: 'The benthic fauna in 'New Zealand Lakes'. Ed by V H Jolly and JMA Brown. Auckland/Oxford University Press.

Forsyth, D J; 1977: 'Benthic macroinvertebrates in seven New Zealand lakes'. NZ Journal of Marine and Freshwater Research 12(1) 41-49.

Fugro BTW Ltd., 2006: ' Lake Rotorangi siltation survey – Patea HEPS'. Fugro BTW Field Report No 1.

Fugro BTW Ltd., 2008: 'Report for the singlebeam bathymetry survey of cross sectional profiles of Lake Rotorangi'. Furgo BTW Ltd Job No. 08003.

Hicks, BJ and Bell, DG; 2003: 'Electrofishing survey of the Manawatu, Whanganui and Mokau Rivers and Lake Rotorangi, Patea River. DOC Client Report. CBER University of Waikato.

McDowell, RM; 1990: New Zealand Freshwater Fishes, a natural history and guide. Heinemann Reed, Auckland.

Martin, M, Boubee, J, Bowman, E and Griffin, D, 2006: 'Recruitment of Freshwater Eels: 2004-2005 and 2005-2006'. NIWA Research Progress Report for MoF Res. Project EEL 2004-01.

MfE, 2003: Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. Ministry for the Environment and Ministry of Health, Wellington.

Moore, S; 2000: 'Photographic Guide to Freshwater Algae of New Zealand'. Otago Regional Council.

Pridmore, R D; 1987: 'Phytoplankton: survey and interpretation'. In 'Lake Managers' Handbook'. W N Vant Ed, Water and Soil Miscellaneous Publication No 103.

Rutherford, J C; 1982: 'Deoxygenation rates in twelve New Zealand lakes'. In 'Aquatic oxygen seminar proceedings, Hamilton 1980'. Water and Soil Miscellaneous Publication 29.

Taranaki Catchment Board 1988: 'Lake Rotorangi - monitoring a new hydro lake'. Taranaki Catchment Board, Stratford.

Taranaki Catchment Board 1989: 'Water right compliance monitoring programme Egmont Electric Power Board Patea Dam'. Taranaki Catchment Board, Stratford.

Taranaki Regional Council 1990: 'Egmont Electricity Lake Rotorangi 1989/90 Monitoring Report'. Taranaki Regional Council Technical Report 90-30.

Taranaki Regional Council 1991a: 'Egmont Electricity Lake Rotorangi 1990/91 Monitoring Annual Report. Water Quality and Biological Programmes'. Taranaki Regional Council Technical Report 91-21.

Taranaki Regional Council 1991b: 'Egmont Electricity Patea Hydro Riverbed Monitoring Annual Report 1990/91.' Taranaki Regional Council Technical Report 91-39.

Taranaki Regional Council 1992a: 'Egmont Electricity Ltd Lake Rotorangi 1991/92 Monitoring Annual Report. Water Quality and Biological Programmes'. Taranaki Technical Report 92-30.

Taranaki Regional Council 1992b: 'Egmont Electricity Patea Riverbed Monitoring Annual Report 1991/92'. Taranaki Regional Council Technical Report 92-39.

Taranaki Regional Council 1993: 'Egmont Electricity Ltd Lake Rotorangi 1992/93 Monitoring Annual Report Water Quality and Biological Programmes'. Taranaki Regional Council Technical Report 93-37.

Taranaki Regional Council 1994: 'Patea River Catchment Water Management Plan'. Taranaki Regional Council, Stratford.

Taranaki Regional Council 1994: 'Egmont Electricity Ltd Lake Rotorangi 1993/94 Monitoring Annual Report Water Quality and Biological Programmes'. Taranaki Regional Council Technical Report 94-41.

Taranaki Regional Council 1994a: 'Regional Policy Statement for Taranaki'. Taranaki Regional Council.

Taranaki Regional Council 1995: 'Egmont Electricity Ltd Lake Rotorangi 1994/95 Monitoring Annual Report Water Quality and Biological Programmes'. Taranaki Regional Council Technical Report 95-18.

Taranaki Regional Council 1996: 'Egmont Electricity Ltd Lake Rotorangi 1995/96 Monitoring Annual Report Water Quality and Biological Programmes'. Taranaki Regional Council Technical Report 96-57.

Taranaki Regional Council, 1996a: 'State of the Environment: Taranaki Region'. Taranaki Regional Council. 95pp.

Taranaki Regional Council 1997: 'Egmont Electricity Ltd Lake Rotorangi 1996/97 Monitoring Annual Report Water Quality and Biological Programmes'. Taranaki Regional Council Technical Report 97-78.

Taranaki Regional Council 1998: 'Powerco Ltd Lake Rotorangi 1997/98 Monitoring Annual Report Water Quality and Biological Programmes'. Taranaki Regional Council Technical Report 98-78.

Taranaki Regional Council, 1999: Powerco Ltd and Taranaki Generation Ltd Lake Rotorangi 1998-1999 Monitoring Programme. Water Quality and Biological Programmes. Taranaki Regional Council Technical Report 99-89.

Taranaki Regional Council, 2000: Taranaki Generation Ltd Lake Rotorangi 1999-2000 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2000-90.

Taranaki Regional Council, 2001: Taranaki Generation Ltd Lake Rotorangi 2000-2001 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2001-78.

Taranaki Regional Council, 2002: Taranaki Generation Ltd Lake Rotorangi 2001-2002 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2002-36.

Taranaki Regional Council, 2003: Taranaki Generation Ltd Lake Rotorangi 2002-2003 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2003-24.

Taranaki Regional Council, 2003a: Taranaki – our place, our future, Report on the state of the environment of the Taranaki region – 2003. Taranaki Regional Council, 206pp.

Taranaki Regional Council, 2004: Taranaki Generation Ltd Lake Rotorangi 2003-2004 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2004-69.

Taranaki Regional Council, 2005: Taranaki Generation Ltd Lake Rotorangi 2004-2005 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2005-76.

Taranaki Regional Council, 2006: Taranaki Generation Ltd Lake Rotorangi 2005-2006 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2006-76.

Taranaki Regional Council, 2007: TrustPower Ltd Lake Rotorangi 2006-2007 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2007-91.

Taranaki Regional Council, 2008: TrustPower Ltd Lake Rotorangi 2007-2008 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2008-45.

Taranaki Regional Council, 2008a: Recreational use of coast, rivers and lakes in Taranaki 2007-2008. Taranaki Regional Council Report.

Taranaki Regional Council, 2009: TrustPower Ltd Lake Rotorangi 2008-2009 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2009-50.

Taranaki Regional Council, 2009a: Taranaki Where We Stand. State of the Environment Report 2009. Taranaki Regional Council, 284p.

Taranaki Regional Council, 2010: TrustPower Ltd Lake Rotorangi 2009-2010 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2010-50.

Taranaki Regional Council, 2011: TrustPower Ltd Lake Rotorangi 2010-2011 Monitoring Programme. Water quality and biological programmes. Taranaki Regional Council Technical Report 2011-40.

Taranaki Regional Council, 2012: State of the environment monitoring of Lake Rotorangi: water quality and biological programme Annual Report 2011-2012. Taranaki Regional Council Technical Report 2012-08.

Taranaki Regional Council, 2013: State of the environment monitoring of Lake Rotorangi: water quality and biological programme Annual Report 2012-2013. Taranaki Regional Council Technical Report 2013-47.

Taranaki Regional Council, 2014: State of the environment monitoring of Lake Rotorangi: water quality and biological programme Annual Report 2013-2014. Taranaki Regional Council Technical Report 2014-22.

Taranaki Regional Council, 2015: State of the environment monitoring of Lake Rotorangi: water quality and biological programme Annual Report 2014-2015. Taranaki Regional Council Technical Report 2015-32.

Taranaki Regional Council, 2015a Taranaki as one. State of the Environment Report 2015. Taranaki Regional Council, 268p.

Taranaki Regional Council, 2016: State of the environment monitoring of Lake Rotorangi: water quality and biological programme Annual Report 2015-2016. Taranaki Regional Council Technical Report 2016-82.

Taranaki Regional Council, 2017a: Stratford District Council Stratford WWTP Monitoring Programme Annual Report 2016-2017. Taranaki Regional Council Technical Report 2017-106.

Taranaki Regional Council, 2017b: Regional Check Clean Dry Programme Evaluation Report, 14 November 2016 – 14 February 2017, 30p. Document No. 1814422.

Taranaki Regional Council, 2018: State of the Environment Monitoring of Lake Rotorangi: water quality and biological programme Annual Reports 2016-2018. Taranaki Regional Council Technical Report 2018-90.

Taranaki Regional Council, 2019: Freshwater contact recreational water quality at Taranaki sites. State of the Environment Monitoring Report 2018-2019. Technical Report 2019-01.

Taranaki Regional Council, 2018a: Stratford District Council Stratford WWTP Monitoring Programme Annual Report 2017-2018. Taranaki Regional Council Technical Report 2018-34.

Taranaki Regional Council, 2018b: Regional Check Clean Dry Programme Evaluation Report, 30 October 2017 – 19 January 2018, 30p. Document No. 1955224.

Vant, W (ed), 1987: Lake Managers Handbook. Water and Soil miscellaneous publication no. 103. National Water and Soil Conservation Authority: Wellington, New Zealand. 222p.

Williams, E and Boubee, J; 2003: Recruitment of Freshwater Eels, 2002-2003. Research Progress report for MOF Research Project EEL 200201. NIWA report. 92p.

Winterbourn, MJ and Mason, K; 1983: Mobil New Zealand Nature Series Freshwater Life Streams, ponds, swamps, lakes and rivers. AH and AW Reed Ltd. 76p.

Appendix I

Flow data for the Patea River at Skinner Road, the Mangaehu River at Raupuha Road bridge, and the synthesised inflow into Lake Rotorangi for the period 1 July 2018 to 30 June 2019

Appendix II

TRC Lake Rotorangi water quality trend analysis 1990-2018

MEMORANDUM
Policy & Planning

Date	1 September 2020
Subject:	**Annual Freshwater Ecological Monitoring (macroinvertebrate) 2018-2019**
Approved by:	G K Bedford, Director - Environment Quality
	M J Nield, Acting Chief Executive
Document:	2556475

Purpose

1. The purpose of this memorandum is to present the latest annual results of the Council's state of the environment monitoring programme for fresh water ecological health (macroinvertebrate monitoring).
2. A full report is available upon request, *Freshwater Macroinvertebrate Fauna Biological Monitoring Programme Annual State of the Environment Monitoring Report 2018-2019, Technical Report 19-52*, providing the details of the monitoring of the Council's SEM macroinvertebrate monitoring sites in the 2018-2019 year, and including analysis of trends in this data since 1995 and over the last ten years. This memorandum summarises the report's data and findings, and includes the Executive Summary and the Recommendations from the report as an appendix.

Executive summary

3. The Council's '*Regional Freshwater Plan for Taranaki*' (October 2001) states as two of its objectives for the region, '*to maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to land and water from point-sources.... and diffuse sources*' (Objectives 6.2.1 and 6.3.1). In doing so, the Council and community seek to provide for the values associated with surface water, and to ensure the maintenance of aquatic ecosystems (Environmental Results Anticipated ER1).
4. In order to ascertain the successful adoption and application or otherwise of the Council's policies and methods of implementation, the Council conducts 'state of the environment' (SEM) monitoring to obtain up to date and robust information for parameters that characterise the region's environment and resources. The results and findings of the SEM programme for the region's freshwater systems can be interrogated to determine trends and changes in trends in the quality of the region's freshwater resources, alongside the information on the current 'state' of the region's in-stream ecological health parameters that SEM generates. With SEM established in 1995, the database is extensive enough to allow regular robust statistically-based trend analysis,

conducted according to recognised and nationally adopted methodologies, to inform such reviews. The trend analyses cover both trends during the entire record, and trends in the most recent ten-year period. Using the data record from a shorter, more recent period sacrifices some certainty in the output results for the sake of identifying current rather than long-term trends.

5. The latest results describing the state of and trends in the state of the macroinvertebrate communities of the region's waterways are presented herein for the information of the Council.

6. The results for the cumulative (long-term) record continue to be overall as encouraging as in similar reports in the last few years and even more encouraging than those from earlier periods, with the positive trends that had become markedly better with each year that passes being maintained overall in the 2018-2019 year.

7. However, Council officers had observed that in the last few years, MCI scores at a number of sites had either plateaued or indeed had started to decline. This effect was particularly marked in the summer results from the year under review (spring survey results were better than typical). While the long-term trends were still largely unaffected, the emerging pattern and the most recent results were cause for further investigation.

8. No association with land use or changes in land use, position within a catchment, chemical measures of water quality, or grouping within specific areas could be identified. However, it was observed that in both 2017-18 and 2018-19, Taranaki was experiencing regional drought conditions at the time of the summer surveys. Further investigations identified the following common factors:
   - flows were much lower than usual for the 2019 summer season;
   - elapsed time since the last flushing flows were much longer than usual (months instead of weeks have elapsed), and further, have been getting more prolonged each year;
   - water temperatures at time of sampling have been warmer than usual for the season, by up to 1.4˚C; and
   - there has been a much greater proportion of extreme temperatures- those temperatures known to have a direct adverse effect upon macroinvertebrate communities.

9. Staff are therefore clear that the current cycle of adverse hydrological and climatic conditions are impacting the ecological condition of the region's macroinvertebrate communities.

10. In terms of Macroinvertebrate Community Index (MCI), the specific measure of the health of in-stream ecological communities, the study shows that in 2018-2019, spring survey MCI scores were overall significantly better than long-term median scores for spring surveys; while in summer the survey scores were lower than the long-term median scores. As is typical, the median spring MCI score was higher than in summer, although the difference was more pronounced this year- 8 MCI units, compared with 3 MCI units' difference between the two long-term seasonal medians.

11. Three of the 59 sites recorded new maximum MCI values in one or other of the two surveys, down from 7 new maxima in the last period, and there were 8 new minima (compared to one in the previous period).

12. The updated trend analysis for the full record (24 years) shows that at 46 of the 57 sites for which trends can be determined (81%), MCI scores give indications of improvement. Applying a more rigorous statistical evaluation to the long-term trend data, there are 25 sites in one of the two categories of strongly or very strongly significantly improving trends, and one site showing significant deterioration.
13. However, in terms of indicative changes over the most recent ten-year period, 20 sites were tending towards improvement and 36 towards decline (although no trends at all were evident after more rigorous analysis).
14. In summary, the findings of the macroinvertebrate monitoring programme demonstrate that the Council and regional community are continuing to meet the Long Term Plan (LTP) target, to maintain and enhance water quality in the region, even in the face of year by year fluctuations and subject to climatic cycles. The greatest proportion of the improving sites are located in mid to lower/mid-catchment reaches; and significant improvement at the lowest sites is now evident around the region, indicating that habitat improvement is occurring and drivers of cumulative adverse effects are being reduced throughout each catchment.
15. The cause of the positive trends is multi-faceted and complex. The maturing and extension of the riparian programme with established and extension planting and stock exclusion, continuing reductions in the number and improvements in the quality of discharges into waterways (e.g. through discharge of farm dairy effluent to land instead), and more rigorous compliance regimes will all be playing a role. With the continuation of these programmes, further consequential gains in water quality and in in-stream ecological health across the region and in particular extending into the lowest reaches of the region's streams and rivers should occur.
16. The report makes recommendations to continue the freshwater macroinvertebrate ('MCI') component of the SEM programme in a similar format and to update the trend analysis reports following analysis at the end of the 2019-2020 year.

Recommendations

That the Taranaki Regional Council:

a) receives this memorandum noting the preparation of a report into the state of and trends in regional in-stream macroinvertebrate community health data for Taranaki, for 2018-2019 and over the period 1995-2019;

b) notes the findings of the SEM programme; and

c) adopts the specific recommendations therein.

Background

17. This Committee has been regularly informed of the findings that emerge from the Council's various freshwater 'state of the environment' monitoring programmes. These programmes are important as indicators of the effectiveness of the Council's and community's interventions and resource management initiatives addressing freshwater quality and in-stream health in the region. Members will be aware that there is a high level of interest nationally in the state and management of the country's fresh water resources.
18. The Regional Fresh Water Plan for Taranaki contains objectives to manage the state of the region's surface freshwater. Objective 6.2.1 requires the Council and region '*to*

maintain and enhance the quality of the surface water resources of Taranaki by avoiding, remedying or mitigating the adverse effects of contaminants discharged to land and water from point sources', while Objective 6.3.1 is an equivalent objective for diffuse sources of contaminants. In Section 10.3 of the Plan, the Council commits to continued monitoring, research and investigations related to fresh water quality, to provide information on the state of freshwater in the region and the effectiveness of the Plan.

19. The Council's 2012-2022 LTP has, under the 'Levels of service' specified for resource management, a commitment to the '*protection of the life-supporting capacity of water, in-stream uses and values*'. The measure for this activity is: *'Macroinvertebrate Community Index (MCI) values (a measure of freshwater community richness and composition) at 50 regionally representative sites.'* The target throughout the duration of the LTP is that *'the proportion of sites showing a trend (whether significant or indicative) of improvements in MCI against a base year of 1995 to exceed the proportion showing decline over the same period.'*

20. Staff apply the software and methodology that has been used at national reporting level by NIWA for trend analysis of data related to freshwater systems, to ensure that data and analysis provided to the Council and the public of Taranaki is robust, defensible, and consistent with analyses delivered at a national level. In this way timely and reliable feedback on the quality and health of the region's streams and the effectiveness of stream health management in the region can be generated and utilised.

Discussion

21. One of the Council's 'State of the Environment' monitoring programmes measures the abundance and composition of macroinvertebrate communities on streambeds, as an indicator of stream ecological health, through twice-yearly surveys (spring and summer). The Council has delivered this programme for 24 years to date, i.e. since 1995. Staff have now reported the data for the 2018-2019 year, including an analysis of trends in stream ecological health for Taranaki both over the period 1995-2018 (the entire record) and over the last ten years. Biological surveys were performed in spring (October to November 2018) and summer (February to early March 2019).

22. The Executive Summary for the report is attached. In particular, it notes that 59 sites were surveyed, from 26 rivers and streams, and it explains the representative significance of each site. Each site and water course is chosen with regard to location, representativeness, regional variability in river environment, position within a catchment, and surrounding land use, and with regard to evaluating the effects of riparian management. Additional sites are being included to provide representative coverage of the region's Freshwater Management Units.

23. MCI values were significantly higher than typical in the spring (by 3 units on average) but generally below average (by 2 units) in the summer surveys in 2018-2019. Spatially, MCI scores were lower at sites located lower in catchments (as is usual- the consequence of more open and exposed stream beds, lower flows, higher temperatures, sedimentation on stream beds, and cumulatively higher levels of some contaminants, resulting in a shift in the proportion of more sensitive taxa). In spring, the better than typical results were spread evenly across all levels of catchments- upper, mid, and lower, but tended to be mid-catchment on the southern ring plain and lower catchment to the north. In the summer survey, results somewhat lower than normal tended to be found in north Taranaki (distributed from near the National Park, to urban and coastal sites).

24. Three of the 59 sites recorded new maximum MCI values in one or other of the two surveys, compared with 7 new maxima in the last period, and there were 8 new minima (one in the previous period). The highest MCI scores in the 2018-2019 year were found at the upper Punehu and Katikara Streams and upper Kaupokonui, Patea and Waingongoro Rivers. Each of these had spring scores in the range of 135- 138. Among these, the upper Punehu and upper Kaupokonui River sites had scores that were much better than usual. Lowest MCI scores were found in the lowest (urban) site in the Huatoki Stream (summer MCI of 56, compared to 98 in spring), the lower Waitara River (MCIs of 93 in spring and 64 in summer), and the mid-urban site on the Waiwhakaiho (89 in spring and 60 in summer). Results for every site are presented in full in Appendix II of the report.

25. The Government's National Policy Statement for Freshwater (2020) specifies that a council must establish '*methods…to respond to a Macroinvertebrate Community Index score below 90*'. The 2020 NPS has not yet come into effect. The NPS 2017 set a bottom line for MCI of 80. The NPS requires a council to take action if macroinvertebrate scores are below the bottom line. The grounds given for this requirement arise from the more general NPS-FM requirement that councils must manage ecosystem health in waterways. There are three sites that have a long-term median MCI value of less than 80 (the Mangati Stream sites and the upper Mangawhero Stream site, none of which are representative sites for a Freshwater Management Unit in any case). There are a further 8 sites that have long-term median MCI scores of between 80 and 90, individually scattered across various catchments. The Council is pursuing methods that are confidently expected to lift MCI values across the ring plain, namely the substantial elimination of discharges of dairy effluent to waterways together with the completion of the Council's riparian management programme in association with the farming community. Expert advice from both NIWA and the Cawthron Institute is that riparian fencing and planting is the key intervention to reducing stream temperatures and improving stream health.

26. The updated long-term trend analysis shows that at 46 of the 57 sites (81%) for which trends can be calculated, MCI scores are improving. While this is still a very high proportion, it is slightly below the 84% found last year. Ten sites are indicating possible deterioration over the long term, down from 13 when trend analysis began in 2008, but one more than last year.

27. Applying a more rigorous statistical evaluation of trend data, the number of sites with a 'positive and very significant' trend since 1995 is now 19, and there are a further 6 sites with a 'positive significant' trend, giving 25 sites now in either of the two positive categories of strong or very strong improvement. Last year there were 27 in either of these two categories. One site (the upper Katikara) showed a significant negative trend, a result similar to previous years. The ecological communities of the site in question have been adversely affected by headwater erosion events.

28. In the first trend analysis (undertaken in the 2006-2007 monitoring year), 13 sites were found to have strong or very strong improving trends in ecological health.

29. The ten sites that have shown the greatest long-term improvement are

- Kaupokonui Stream upstream of Fonterra, Kapuni factory
- Kapoaiaia Stream at Wiremu Road
- Kapoaiaia Stream at Wataroa Road
- Kurapete Stream downstream of Inglewood WWTP

- Mangati Stream at Bell Block
- Kaupokonui Stream at Kaponga
- Mangaehu River at Raupuha Road
- Punehu Stream at SH45
- Timaru Stream at SH45
- Kurapete Stream upstream of Inglewood WWTP

30. In terms of recent trends (the ten years' data to 2019), no sites had a significant trend once rigorous statistical tests were applied. In terms of indicative directions of change, 20 sites had a positive trend, 36 sites had a negative trend, and one site had an indeterminate trend (compared with 30 sites tending towards improvement and 27 towards decline, from results from the ten years to 2018).
31. Council officers had observed that in the last few years, MCI scores at a number of sites had either plateaued or indeed had started to decline. This effect was particularly marked in the summer results from the year under review (spring survey results were better than typical). While the long-term trends were still largely unaffected, the emerging pattern and the most recent results were cause for further investigation.
32. Staff could not identify any association with land use or changes in land use, position within a catchment, chemical measures of water quality, or grouping within specific areas. However, it was initially observed that in both 2017-18 and 2018-19, the region was experiencing drought conditions at the time of the summer surveys. Further investigations identified the following common factors:
    - flows were much lower than usual for summer for the 2019 survey (eg only 40-50% of the normal February average flows at over half of the Council's flow monitoring sites), which would mean less habitat availability and diversity;
    - elapsed time since the last flushing flows were much longer than usual (months instead of weeks had elapsed), and further, have been getting more prolonged each year. This in turn would mean less food supply; the possibility of siltation of streambeds with smothering of life cycle stages and loss of habitat; proliferation of benthic periphyton cover; and attenuation of community composition due to loss of diversity in stream conditions;
    - water temperatures at time of sampling have been warmer than usual for the summer season at most sites, by up to 1.4˚C, and this pattern has been consistent for the last 4 years; and
    - there has been a much greater proportion of extreme temperatures- those temperatures known to have an adverse effect upon macroinvertebrate communities (for example, the lower Waitara River had a drop of 18 units in its MCI score in summer 2019, co-incident with the duration of water temperatures above 20˚C rising from one-quarter to one-half of the entire summer period).
33. Staff are therefore clear that the current cycle of adverse hydrological and climatic conditions are impacting the ecological condition of the region's macroinvertebrate communities.

Conclusions

34. In terms of iwi and other public awareness of stream ecological health, the Committee can note that through the Council's last LTP submission process (2017), maintenance of the Council's macroinvertebrate programme was supported. While Ngāti Mutunga requested additional monitoring within their rohe, the Council noted that it has recently added an additional site in north Taranaki to represent the Freshwater Management Unit covering this part of the region. The Council continues to consider ways of expanding the monitoring network, whether by Council-based or community-based monitoring. Te Runanga o Ngāti Ruanui Trust supported the on-going management of water quality for future improvement, and the incorporation of culturally-based monitoring. While the Council has committed to developing appropriate indicators further, it is noted that stream health is a priority across all parties, and macroinvertebrate monitoring gives effect to this priority. Te Korowai o Ngāruahine Trust and Te Kotahitanga o Te Atiawa likewise expressed an interest in and support for the Council's stream health monitoring.
35. In simple terms, the latest results of SEM MCI monitoring have generally seen maintenance of improvements being found regionally in respect of the LTP target of maintaining or enhancing regional in-stream ecological health, once climatic and hydrological cycles are recognised. The Council is meeting its LTP and Regional Fresh Water Plan for Taranaki objectives. Over the long term, the implementation of additional measures such as more complete stock exclusion from waterways, the maturing and extension of riparian planting, and continuing reductions in the number and improvements in the quality of discharges into waterways, should see further consequential gains in water quality and in in-stream ecological health across the region and in particular extending into the lowest reaches of the region's streams and rivers. Provision of this memorandum, together with subsequent information sheets that the Council prepares each year, will keep the regional community informed on fresh water quality.

Decision-making considerations

36. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

37. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

38. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

39. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

40. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 2333422: Freshwater Macroinvertebrate Fauna Annual State of the Environment report 2018-2019: Executive summary and Recommendations

Executive summary

Section 35 of the Resource Management Act requires local authorities to undertake monitoring of the region's environment, including land, air, and fresh and marine water quality. The Taranaki Regional Council initiated the freshwater macroinvertebrate State of Environment Monitoring (SEM) programme for Taranaki in the 1995-1996 monitoring year.

Freshwater macroinvertebrates comprise a range of aquatic species including insects, crustacea, molluscs and worms. They have a crucial role in freshwater ecology and respond to changes in a variety of factors including water quality, hydrology and habitat. While a water sample will reveal water chemistry at the time of sampling, and thus give an indication of pressures on stream ecology, assessing the state of the freshwater macroinvertebrate communities will show the cumulative influences of these factors over the recent past as well as being a primary indicator of whether a stream is healthy or otherwise. The Macroinvertebrate Community Index (MCI) is a New Zealand version of an approach that is used internationally. Each taxa found at a stream monitoring site is scored according to its sensitivity or tolerance to the overall stream habitat, and the cumulative score then provides an index of stream health. The Government's National Policy Statement for Freshwater Management 2017 requires every regional council to monitor and report on stream health using the MCI.

This report covers the 2018-2019 monitoring year. Biological surveys were performed in spring (October to November 2018) and summer (February to March 2019). Each seasonal survey assessed the macroinvertebrate communities at 59 sites in 26 rivers and streams.

For sites located in lower reaches of catchments the proportion of 'sensitive' taxa in the macroinvertebrate communities generally have been lower in summer than in spring, coincident with lower flows, higher water temperatures, less scouring, and increased smothering of habitats by more widespread algal growth within rivers and streams in summer. While this is a generic pattern, in the 2018-2019 summer surveys the pattern was exacerbated by extended periods of higher than usual stream temperatures, a significant increase in the proportion of more extreme temperatures, and prolonged low flow periods. The summer period was particularly dry with some sites recording new records for time elapsed since a significant fresh, which was likely to be a significant factor in the lower than normal summer scores. In the 2018-2019 monitoring year the median spring MCI score (102 units) was eight units higher than the median summer score (94 units), while the mean (average) spring score (106 units) was nine units higher than the mean summer score (97 units). The seasonal difference in scores was highly statistically significant. The spring median score was three units higher than the historical spring median, while the summer median was two units lower than the historic summer median. Overall, the median for the current year (99 units) across both surveys was one unit higher than the historical median, indicating that the current monitoring year result was slightly better than previous years.

The proportion of 'sensitive' taxa in the macroinvertebrate communities usually decreased down the length of the waterways, which was reflected in the deterioration in generic stream 'health' from 'very good' in the upper reaches to 'good' through to 'fair' in mid-reaches to 'fair' in the lower reaches.

There were three new maxima and eight new minima MCI scores recorded during the 2018-2019 period. This result contrasts with the seven new maxima and one new minima recorded in the preceding 2017-2018 period. One of the three new maxima and one of the eight new minima were from one of the two relatively new sites established in the 2015-2016 period and hence was of little comparative significance.

There were six sites on five streams/rivers that had 'poor' scores and one site with a 'very poor' score. Of particular note was the Mangati Stream that had 'poor' scores for both spring and summer, which is known to have a variety of water quality issues, the lower Huatoki Stream site summer score of only 56 units, the lower Waiwhakaiho River site at Constance St summer score of 60 units, and the lower Waitara River site summer score of 64 units. The latter three sites had scores that were either new minima, or equalled historic minima. The low summer scores at the Huatoki, Waiwhakaiho and Waitara Rivers were possibly caused by the dry and warm summer causing unusually low flows, elevated in-stream temperatures, and a lack of significant freshes over atypically extended periods.

Temporal trend analysis was undertaken for sites with sufficient data. Taking into account the full historical record for each site, there are 57 sites with sufficient data, (at least 10 years' monitoring data), to perform a statistical analysis.

Forty-six sites display positive trends, with 25 of those sites having statistically significant improvements (after application of FDR tests1). Only ten sites had negative trends and only one of these was statistically significant. That site, along with two other sites with negative trends, were adversely affected by natural headwater erosion inside the National Park. However, the LOWESS graphs indicate several sites have unimodal trendlines, indicating that sites had improved in condition, had then plateaued, and now within the last couple of years are declining. There was one site with no trend either positive or negative.

There was little evidence of trends in macroinvertebrate health at sites in the upper reaches of catchments, which generally already had good macroinvertebrate health, while two-thirds of middle reach sites had significant improvement and nearly half the sites located in the lower reaches of catchments showed significant improvement. Generally, in lower catchment sites the macroinvertebrate communities tend to be 'tolerant' of the cumulative impacts of nutrient enrichment. Significant improvement of (predominantly 'fair') biological stream 'health' at the lower reach sites is unlikely to be detected until habitat improvements occur by way of substantial catchment-wide initiatives such as riparian planting and diversion of point source discharges and in urban and industrial areas better stormwater and wastewater management. It is noted that the Council is promoting these interventions with implementation by the regional community.

For the most recent ten-year data set, there were no sites that had a significant trend once FDR adjustment was applied. Prior to FDR adjustment being applied, there were no sites that showed a significant improvement and ten sites showed a significant decline. In total 20 sites had a positive trend, 36 sites had a negative trend, and one site had an indeterminate trend.

Trends have plateaued recently at some sites that have shown longterm improvements. This could be due to a variety of reasons. In some catchments riparian management initiatives have largely been completed and therefore stream health will likely have stabilised at monitoring sites. Some sites have shown step change improvements due to the removal of point source discharges such as wastewater treatment plant removal, with these improvements now resulting in a new baseline at those sites. There are also other factors that could be counteracting improvements such as increased agricultural inputs and/or warmer/drier weather. A specific analysis of the data for summer 2019 indicates that stream

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1 FDR= False Discovery Rate, one of several tests applied to the results to increase confidence in the results by eliminating apparent trends that are the results of coincidence and random distributions rather than genuine change.

health, as measured by MCI scores, was negatively correlated with the time between sampling and the last significant fresh. This is likely due to periphyton accrual and possibly fine sediment deposition though in some cases a significant interval between sampling and the last significant fresh may also be an indication of very low flows. A significant fresh that mobilises the streambed will remove the majority of periphyton and fine, deposited sediment and thus provide better habitat for macroinvertebrates. Other factors such as nutrients and temperature can have important interactive and antagonistic effects and therefore the importance of the preceding hydrological regime will vary at the site level. An additional analysis indicates that the time between sampling and the last significant fresh has been increasing, which might be influencing long-term trends at some sites.

The recommendations for the 2019-2020 monitoring year are for the freshwater biological component of the SEM monitoring to be maintained by way of the same macroinvertebrate faunal programme, and expanded by the inclusion of five Eastern Hill Country sites. One site is recommended to be removed as it is considered to have poor site-specific habitat that is not representative of the stream or catchment.

7. Recommendations for 2019-2020

It is recommended for 2019-2020:

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2019-2020 monitoring year by means of the same programme as that undertaken in 2018-2019, with some site changes. These changes are namely that five Eastern Hill Country sites be added to the programme to provide improved representation, and that the upper Mangawhero site is removed, as this site has very poor site-specific habitat and is not considered representative of the stream or catchment.
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

Freshwater Macroinvertebrate Fauna
Biological Monitoring Programme
Annual State of the Environment
Monitoring Report
2018-2019

Technical Report 2019-52
(and Report DS124)

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Executive summary

Section 35 of the Resource Management Act requires local authorities to undertake monitoring of the region's environment, including land, air, and fresh and marine water quality. The Taranaki Regional Council initiated the freshwater macroinvertebrate State of Environment Monitoring (SEM) programme for Taranaki in the 1995-1996 monitoring year.

Freshwater macroinvertebrates comprise a range of aquatic species including insects, crustacea, molluscs and worms. They have a crucial role in freshwater ecology and respond to changes in a variety of factors including water quality, hydrology and habitat. While a water sample will reveal water chemistry at the time of sampling, and thus give an indication of pressures on stream ecology, assessing the state of the freshwater macroinvertebrate communities will show the cumulative influences of these factors over the recent past as well as being a primary indicator of whether a stream is healthy or otherwise. The Macroinvertebrate Community Index (MCI) is a New Zealand version of an approach that is used internationally. Each taxa found at a stream monitoring site is scored according to its sensitivity or tolerance to the overall stream habitat, and the cumulative score then provides an index of stream health. The *Government's National Policy Statement for Freshwater Management 2017* requires every regional council to monitor and report on stream health using the MCI.

This report covers the 2018-2019 monitoring year. Biological surveys were performed in spring (October to November 2018) and summer (February to March 2019). Each seasonal survey assessed the macroinvertebrate communities at 59 sites in 26 rivers and streams.

For sites located in lower reaches of catchments the proportion of 'sensitive' taxa in the macroinvertebrate communities generally have been lower in summer than in spring, coincident with lower flows, higher water temperatures, less scouring, and increased smothering of habitats by more widespread algal growth within rivers and streams in summer. While this is a generic pattern, in the 2018-2019 summer surveys the pattern was exacerbated by extended periods of higher than usual stream temperatures, a significant increase in the proportion of more extreme temperatures, and prolonged low flow periods. The summer period was particularly dry with some sites recording new records for time elapsed since a significant fresh, which was likely to be a significant factor in the lower than normal summer scores. In the 2018-2019 monitoring year the median spring MCI score (102 units) was eight units higher than the median summer score (94 units), while the mean (average) spring score (106 units) was nine units higher than the mean summer score (97 units). The seasonal difference in scores was highly statistically significant. The spring median score was three units higher than the historical spring median, while the summer median was two units lower than the historic summer median. Overall, the median for the current year (99 units) across both surveys was one unit higher than the historical median, indicating that the current monitoring year result was slightly better than previous years.

The proportion of 'sensitive' taxa in the macroinvertebrate communities usually decreased down the length of the waterways, which was reflected in the deterioration in generic stream 'health' from 'very good' in the upper reaches to 'good' through to 'fair' in mid-reaches to 'fair' in the lower reaches.

There were three new maxima and eight new minima MCI scores recorded during the 2018-2019 period. This result contrasts with the seven new maxima and one new minima recorded in the preceding 2017-2018 period. One of the three new maxima and one of the eight new minima were from one of the two relatively new sites established in the 2015-2016 period and hence was of little comparative significance.

There were six sites on five streams/rivers that had 'poor' scores and one site with a 'very poor' score. Of particular note was the Mangati Stream that had 'poor' scores for both spring and summer, which is known to have a variety of water quality issues, the lower Huatoki Stream site summer score of only 56 units, the lower Waiwhakaiho River site at Constance St summer score of 60 units, and the lower Waitara River site summer score of 64 units. The latter three sites had scores that were either new minima, or equalled historic minima. The low summer scores at the Huatoki, Waiwhakaiho and Waitara Rivers were possibly caused by the dry and warm summer causing unusually low flows, elevated in-stream temperatures, and a lack of significant freshes over atypically extended periods.

Temporal trend analysis was undertaken for sites with sufficient data. Taking into account the full historical record for each site, there are 57 sites with sufficient data, (at least 10 years' monitoring data), to perform a statistical analysis.

Forty-six sites display positive trends, with 25 of those sites having statistically significant improvements (after application of FDR tests[1]). Only ten sites had negative trends and only one of these was statistically significant. That site, along with two other sites with negative trends, were adversely affected by natural headwater erosion inside the National Park. However, the LOWESS graphs indicate several sites have unimodal trendlines, indicating that sites had improved in condition, had then plateaued, and now within the last couple of years are declining. There was one site with no trend either positive or negative.

There was little evidence of trends in macroinvertebrate health at sites in the upper reaches of catchments, which generally already had good macroinvertebrate health, while two-thirds of middle reach sites had significant improvement and nearly half the sites located in the lower reaches of catchments showed significant improvement. Generally, in lower catchment sites the macroinvertebrate communities tend to be 'tolerant' of the cumulative impacts of nutrient enrichment. Significant improvement of (predominantly 'fair') biological stream 'health' at the lower reach sites is unlikely to be detected until habitat improvements occur by way of substantial catchment-wide initiatives such as riparian planting and diversion of point source discharges and in urban and industrial areas better stormwater and wastewater management. It is noted that the Council is promoting these interventions with implementation by the regional community.

For the most recent ten-year data set, there were no sites that had a significant trend once FDR adjustment was applied. Prior to FDR adjustment being applied, there were no sites that showed a significant improvement and ten sites showed a significant decline. In total 20 sites had a positive trend, 36 sites had a negative trend, and one site had an indeterminate trend.

Trends have plateaued recently at some sites that have shown longterm improvements. This could be due to a variety of reasons. In some catchments riparian management initiatives have largely been completed and therefore stream health will likely have stabilised at monitoring sites. Some sites have shown step change improvements due to the removal of point source discharges such as wastewater treatment plant removal, with these improvements now resulting in a new baseline at those sites. There are also other factors that could be counteracting improvements such as increased agricultural inputs and/or warmer/drier weather. A specific analysis of the data for summer 2019 indicates that stream health, as measured by MCI scores, was negatively correlated with the time between sampling and the last significant fresh. This is likely due to periphyton accrual and possibly fine sediment deposition though in some cases a significant interval between sampling and the last significant fresh may also be an indication of very low flows. A significant fresh that mobilises the streambed will remove the majority of periphyton and fine, deposited sediment and thus provide better habitat for macroinvertebrates. Other factors such as nutrients and temperature can have important interactive and antagonistic effects and therefore the importance of the preceding hydrological regime will vary at the site level. An additional analysis indicates that the time between sampling and the last significant fresh has been increasing, which might be influencing long-term trends at some sites.

[1] FDR= False Discovery Rate, one of several tests applied to the results to increase confidence in the results by eliminating apparent trends that are the results of coincidence and random distributions rather than genuine change.

The recommendations for the 2019-2020 monitoring year are for the freshwater biological component of the SEM monitoring to be maintained by way of the same macroinvertebrate faunal programme, and expanded by the inclusion of five Eastern Hill Country sites. One site is recommended to be removed as it is considered to have poor site-specific habitat that is not representative of the stream or catchment.

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1 Introduction

1.1 General

The *Resource Management Act 1991* (RMA) established new requirements for local authorities to undertake environmental monitoring. Section 35 of the RMA requires local authorities to monitor, among other things, the state of the environment of their region or district, to the extent that is appropriate to enable them to effectively carry out their functions under the Act.

To this effect, the Taranaki Regional Council (the Council) has established a state of the environment monitoring (SEM) programme for the region. This programme is outlined in the Council's 'State of the Environment Monitoring Procedures Document', which was prepared in 1997. The monitoring programme is based on the significant resource management issues that were identified in the *Council's Regional Policy Statement for Taranaki (1994)*.

The SEM programme is made up of a number of individual monitoring activities, many of which are undertaken and managed on an annual basis (from 1 July to 30 June). For these annual monitoring activities, summary reports are produced following the end of each monitoring year (i.e., after 30 June). Where possible, individual consent monitoring programmes have been integrated within the SEM programme to save duplication of effort and minimise costs. The purpose of annual SEM reports is to summarise regional environmental monitoring activity results for the year, and provide an interpretation of these results, together with an update of trends in the data.

Annual SEM reports act as 'building blocks' towards the preparation of the regional state of the environment report every five years. The Council's first, or baseline, state of the environment report was prepared in 1996 (TRC, 1996c), summarising the region's progress in improving environmental quality in Taranaki over the past two decades. The second report (for the period 1995-2000) was published in 2003 (TRC, 2003). Data spanning the ten-year period 1995 to 2005 have been used in the preparation of a trend report (TRC, 2006). The third State of the Environment report (for the period 1995 to 2007) was published (TRC, 2009a) and included trend reporting and the fourth report (for the 1995 to 2014 period) has been published (TRC, 2015a). The provision of appropriate computer software statistical procedures allows regular reporting on trends in the environmental quality over time, in relation to Council's ongoing monitoring activities, now that there has been an accumulation of a comprehensive dataset of sufficient duration to permit a meaningful analysis of trends (i.e. minimum of 10 years).

This report summarises the results for the sites surveyed in the freshwater macroinvertebrate SEM programme over the 2018-2019 monitoring year, the twenty-fourth year of this programme.

1.2 Background

Freshwater macroinvertebrates are a range of aquatic species that have a crucial role in freshwater ecology and that respond to changes in water quality or hydrological patterns or habitat. While a grab sample of water collected from a waterbody will reveal the water chemistry at the time of sampling, and thus give an indication of any contemporaneous pressures on the ecology of the stream, the alternative of directly assessing the state of the freshwater communities themselves will show the cumulative influences of these factors over the recent past as well as being a primary indicator of whether a stream can be considered healthy or otherwise. The Macroinvertebrate Community Index (MCI) is a New Zealand version of an approach that is used internationally. Each species found at a stream monitoring site is scored according to its sensitivity or tolerance, and the cumulative score then provides an index of stream health. The *Government's National Policy Statement for Freshwater Management 2017* made it compulsory for every regional council to monitor and report on stream health using the MCI.

The Cawthron Institute notes: Benthic macroinvertebrates are used worldwide as sub-indicators of stream ecosystem health as they respond to human pressures, are taxonomically diverse and easy to sample. The MCI is responsive to multiple stressors, but not all stressors, and as such provides a good indicator of the overall condition of the macroinvertebrate component of stream ecosystem health[2].

[2] Cawthron Institute Report 3073

2 Monitoring methodology

2.1 Programme design

The Council commenced the freshwater biological SEM programme in spring 1995. The 2018-2019 monitoring year was therefore the twenty-fourth year in which this SEM programme was undertaken. This report presents the results from the sites surveyed in the 2018-2019 monitoring year. Full details of the methodology for the programme can be found in TRC (1997b).

2.2 Site locations

A map of all sites monitored in the Taranaki freshwater biological SEM programme is shown in Figure 1, with site meta data given in Table 1. Various additions of sites have been implemented throughout the 24 years of the SEM programme, with details of site selections given in Appendix I.

The biological programme for the 2018-2019 period involved the continuation of a riparian vegetation monitoring component which incorporated five sites in the Kaupokonui River (see Table 1) and five sites in western Taranaki ring plain streams (Katikara Stream and Kapoaiaia Stream).

Most recently, the addition of further Eastern Hill country sites has been undertaken, in the light of the requirement of the National Policy Statement on Fresh Water that the Council undertakes representative monitoring across all Freshwater Management Units (FMUs) within the region. The Council has identified prospective FMUs and has adjusted its monitoring programmes in anticipation of these being confirmed in due course within the forthcoming *Regional Water and Land Plan* (in prep).

Table 1 Freshwater biological monitoring sites in the State of the Environment Monitoring programme

River/stream	Site	Site code	GPS location E	GPS location N	Spring date	Summer date
Hangatahua (Stony) R	Mangatete Road	STY000300	1677460	5657823	25-Oct-18	18-Feb-19
Hangatahua (Stony) R	SH45	STY000400	1674632	5661558	25-Oct-18	18-Feb-19
Herekawe S	Centennial Drive	HRK000085	1688283	5674972	10-Oct-18	14-Feb-19
Huatoki S	Hadley Drive	HTK000350	1693349	5671486	10-Oct-18	14-Feb-19
Huatoki S	Huatoki Domain	HTK000425	1693041	5673404	10-Oct-18	14-Feb-19
Huatoki S	Molesworth St	HTK000745	1692800	5676424	10-Oct-18	14-Feb-19
Kapoaiaia S	Wiremu Road	KPA000250	1678009	5652025	26-Oct-18	18-Feb-19
Kapoaiaia S	Wataroa Road	KPA000700	1672739	5652272	26-Oct-18	18-Feb-19
Kapoaiaia S	Cape Egmont	KPA000950	1665690	5652452	26-Oct-18	18-Feb-19
Katikara S	Carrington Road	KTK000150	1683566	5657855	25-Oct-18	18-Feb-19
Katikara S	Beach	KTK000248	1676597	5667473	25-Oct-18	18-Feb-19
Kaupokonui R	Opunake Road	KPK000250	1698088	5639231	5-Oct-18	5-Mar-19
Kaupokonui R	U/s Kaponga oxi ponds	KPK000500	1698609	5634423	5-Oct-18	5-Mar-19
Kaupokonui R	U/s Lactose Co.	KPK000660	1697613	5629791	5-Oct-18	5-Mar-19
Kaupokonui R	Upper Glenn Road	KPK000880	1693026	5622705	5-Oct-18	5-Mar-19
Kaupokonui R	Near mouth	KPK000990	1691209	5620444	5-Oct-18	5-Mar-19
Kurapete S	U/s Inglewood WWTP	KRP000300	1705087	5665510	10-Oct-18	26-Feb-19
Kurapete S	D/s Inglewood WWTP	KRP000660	1709239	5667481	10-Oct-18	26-Feb-19
Maketawa S	Opp Derby Road	MKW000200	1702192	5656304	20-Nov-18	18-Feb-19
Maketawa S	Tarata Road	MKW000300	1708784	5665231	20-Nov-18	18-Feb-19
Mangaehu R	Raupuha Rd	MGH000950	1726300	5639062	8-Oct-18	11-Feb-19
Manganui R	SH3	MGN000195	1708871	5651282	20-Nov-18	18-Feb-19
Manganui R	Bristol Road	MGN000427	1711210	5667887	20-Nov-18	18-Feb-19
Mangaoraka S	Corbett Road	MRK000420	1702538	5676320	10-Oct-18	15-Feb-19
Mangati S	D/s railway line	MGT000488	1700095	5678043	21-Nov-18	20-Feb-19
Mangati S	Te Rima Pl, Bell Block	MGT000520	1699385	5679103	21-Nov-18	20-Feb-19
Mangawhero S	U/s Eltham WWTP	MWH000380	1712475	5633431	16-Oct-18	6-Mar-19
Mangawhero S	D/s Mangawharawhara S	MWH000490	1710795	5632738	16-Oct-18	6-Mar-19
Mangorei S	SH3	MGE000970	1696094	5671500	20-Nov-18	8-Feb-19
Patea R	Barclay Rd	PAT000200	1702620	5646598	7-Nov-18	4-Mar-19
Patea R	Swansea Rd	PAT000315	1711801	5644382	7-Nov-18	4-Mar-19
Patea R	Skinner Rd	PAT000360	1715919	5644681	7-Nov-18	4-Mar-19
Punehu S	Wiremu Rd	PNH000200	1687323	5637020	11-Oct-18	5-Mar-19
Punehu S	SH45	PNH000900	1677946	5627786	11-Oct-18	5-Mar-19
Tangahoe R	Upper Valley	TNH000090	1725340	5626101	4-Oct-18	7-Mar-19
Tangahoe R	Tangahoe Vly Rd bridge	TNH000200	1719126	5622681	4-Oct-18	7-Mar-19
Tangahoe R	d/s rail bridge	TNH000515	1715751	5612470	4-Oct-18	7-Mar-19
Timaru S	Carrington Road	TMR000150	1684423	5659634	25-Oct-18	18-Feb-19
Timaru S	SH45	TMR000375	1679509	5665554	25-Oct-18	18-Feb-19
Waiau S	Inland North Road	WAI000110	1714587	5680018	10-Oct-18	15-Feb-19
Waimoku S	Lucy's Gully	WMK000100	1681324	5666240	25-Oct-18	14-Feb-19
Waimoku S	Beach	WMK000298	1681725	5669851	25-Oct-18	14-Feb-19

River/stream	Site	Site code	GPS location		Spring date	Summer date
			E	N		
Waingongoro R	700m d/s Nat Park	WGG000115	1700835	5645086	16-Oct-18	6-Mar-19
Waingongoro R	Opunake Rd	WGG000150	1705692	5642523	16-Oct-18	6-Mar-19
Waingongoro R	Eltham Rd	WGG000500	1710576	5634824	16-Oct-18	6-Mar-19
Waingongoro R	Stuart Rd	WGG000665	1709784	5632049	16-Oct-18	6-Mar-19
Waingongoro R	SH45	WGG000895	1704042	5618667	16-Oct-18	6-Mar-19
Waingongoro R	Ohawe Beach	WGG000995	1702531	5617624	16-Oct-18	6-Mar-19
Waiokura S	Skeet Rd	WKR000500	1698807	5628892	5-Oct-18	5-Mar-19
Waiokura S	Manaia Golf Course	WKR000700	1697636	5622019	5-Oct-18	5-Mar-19
Waiongana S	SH3a	WGA000260	1705159	5669554	21-Nov-18	14-Feb-19
Waiongana S	Devon Road	WGA000450	1704063	5680381	21-Nov-18	14-Feb-19
Waitara R	Autawa Road	WTR000540	1720719	5663669	22-Nov-18	14-Feb-19
Waitara R	Mamaku Road	WTR000850	1708384	5678739	22-Nov-18	14-Feb-19
Waiwhakaiho R	National Park	WKH000100	1696096	5658351	20-Nov-18	8-Feb-19
Waiwhakaiho R	SH3 (Egmont Village)	WKH000500	1698297	5666893	20-Nov-18	8-Feb-19
Waiwhakaiho R	Constance St (NP)	WKH000920	1695827	2677271	20-Nov-18	8-Feb-19
Waiwhakaiho R	Adjacent to L Rotomanu	WKH000950	1696587	2678336	20-Nov-18	8-Feb-19
Whenuakura R	Nicholson Rd	WNR000450	1732757	5598479	4-Oct-18	7-Mar-19

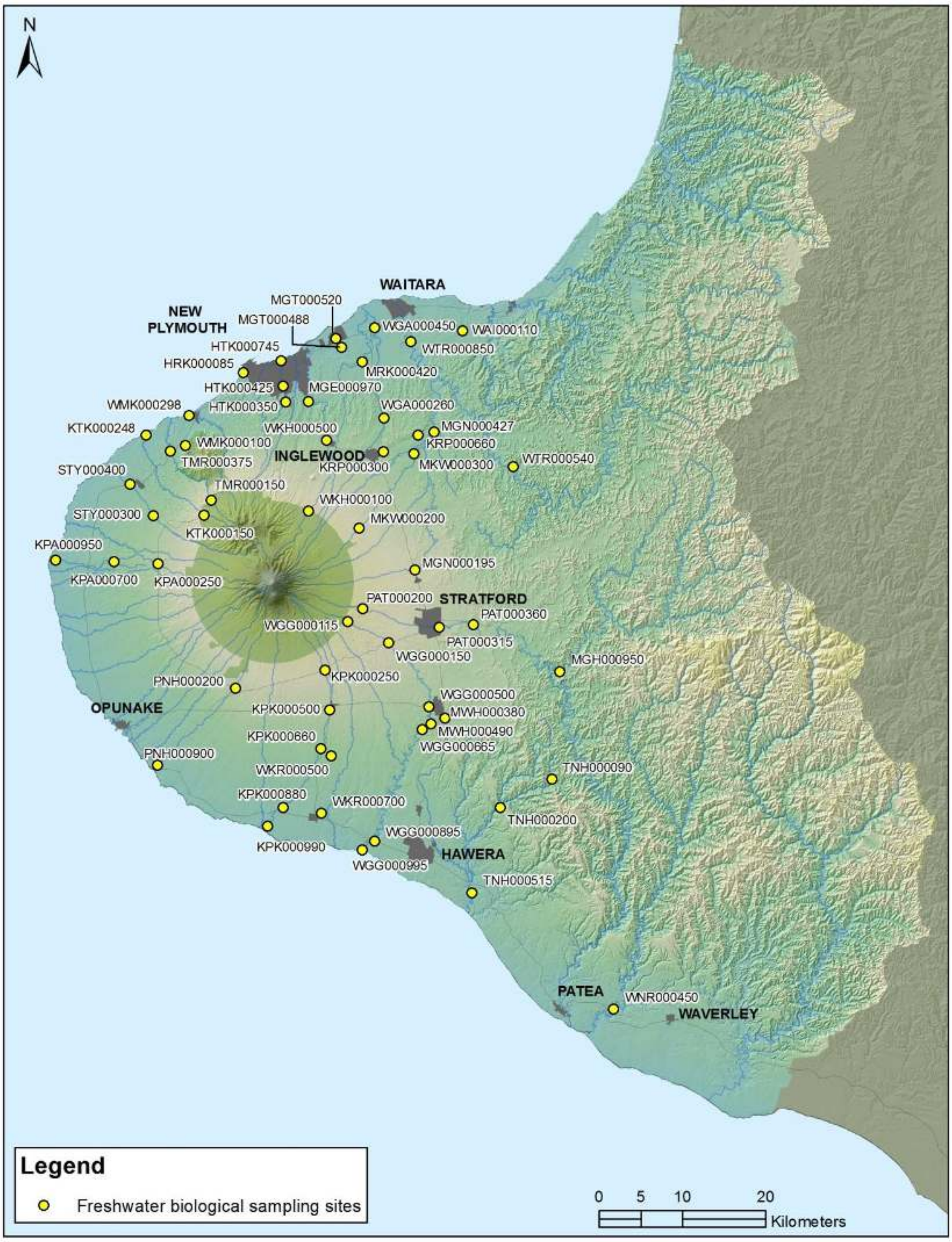


Figure 1 Location of macroinvertebrate fauna sampling sites for the 2018-2019 SEM programme

2.3 Sample collection and analysis

The standard '400 ml kick-sampling' and occasionally the '400 ml sweep-net- sampling' techniques were used to collect streambed (benthic) macroinvertebrates from various sampling sites in selected catchments in the Taranaki region (detailed in section 2.4 and TRC, 1997b). The 'kick-sampling' technique is very similar to Protocol C1 (hard-bottomed, semi-quantitative) and the 'sweep-net- sampling' technique is very similar to Protocol C2 of the New Zealand Macroinvertebrate Working Group (NZMWG) protocols for macroinvertebrate samples in wadeable streams (Stark et al, 2001). Surveys of all sites are normally performed twice during the monitoring year, once during spring (October to December) and once during summer (February and March). An audit of the macroinvertebrate samples used for SEM purposes was undertaken this monitoring year, as it had been noted that some surveys in the database did not appear to be for SEM purposes. A very small number of surveys were found to be wrongly assigned as SEM surveys and have since been removed from the analysis. Further information outlining this can be found at TRC, 2019. Sampling dates for each site are detailed in Table 1.

Samples were preserved using Kahle's Fluid, for later sorting and identification. This was carried out using a stereomicroscope, and following Taranaki Regional Council methodology, using protocol P1 of NZMWG protocols for sampling macroinvertebrates in wadeable streams (Stark et al. 2001). Macroinvertebrate taxa were placed in abundance categories for each sample (Table 2).

Table 2 Macroinvertebrate abundance categories

Abundance category	Number of individuals
R (rare)	1-4
C (common)	5-19
A (abundant)	20-99
VA (very abundant)	100-499
XA (extremely abundant)	500+

2.4 Environmental parameters and indicators

2.4.1 Taxonomic richness

The number of macroinvertebrate taxa found in each sample is used as an indicator of the richness of the community at each site. However, a high taxonomic richness does not necessarily mean a pristine, healthy community. Sites with mild nutrient enrichment will often have higher taxonomic richness than pristine sites, and therefore caution is required when evaluating sites based on taxonomic richness (Stark and Maxted, 2007).

2.4.2 Macroinvertebrate Community Index (MCI)

Stark (1985) developed a scoring system for macroinvertebrate taxa according to their sensitivity to organic pollution in stony New Zealand streams. Highly 'sensitive' taxa are assigned the highest scores of 9 or 10, while the most 'tolerant' forms score 1. For studies undertaken in the Taranaki, the sensitivity scores for certain taxa have been modified in accordance with Taranaki experience (see TRC, 1997b). The Macroinvertebrate Community Index (MCI) value is calculated by averaging the scores obtained from a list of taxa taken from one site, and multiplying by a scaling factor of 20. The MCI is a measure of the overall sensitivity of macroinvertebrate communities to the effects of organic pollution. Communities that are more 'sensitive' inhabit less polluted waterways.

2.4.3 Semi Quantitative MCI (SQMCI)

A semi-quantitative MCI value (SQMCI) (Stark 1998 & 1999) is also calculated from the taxa present at each site. The SQMCI is calculated by multiplying each taxon score by a loading factor (related to its abundance), summing these products, and dividing by the sum of the loading factors (Stark, 1998, 1999). The loading factors are 1 for rare (R), 5 for common (C), 20 for abundant (A), 100 for very abundant (VA) and 500 for extremely abundant (XA). Unlike the MCI, the SQMCI is not multiplied by a scaling factor of 20. As a result, its corresponding range of values is 20x lower than MCI. A difference in SQMCI of more than 0.83 units is considered as statistically significant. However, Stark and Maxted (2007) considered the MCI to be a more appropriate index than the SQMCI for State of the Environment monitoring and discussion, and in this report, emphasis is placed on the MCI.

2.4.4 MCI Classification

A refinement of Stark's classification (Stark, 1985, Boothroyd and Stark, 2000; and Stark and Maxted, 2007) has been made in order to grade the biological 'health' based upon MCI and SQMCI ranges. This classification system is presented in Table 3.

Table 3 Generic MCI gradation of biological water quality conditions adapted for Taranaki streams and rivers

TRC Grading	MCI	SQMCI	Colour Code	Stark's classification
Excellent	≥140	≥7.00		Excellent
Very Good	120-139	6.00-6.99		
Good	100-119	5.00-5.99		Good
Fair	80-99	4.00-4.99		Fair
Poor	60-79	3.00-3.99		Poor
Very Poor	<60	<3.00		

This adapted system is considered to provide more resolution of stream 'health', in the context of more precise upper and lower MCI and SQMCI score bands, than the earlier grading classification (Stark and Fowles, 2015). Despite the acknowledgement that the boundaries between grades may be fuzzy (Stark and Maxted, 2007), classifying the data into grades can assist with the assessment of trends in long term temporal data.

When the same number of replicate samples are collected per site, it is possible to use the detectable difference method to assess the significance of MCI score differences. Stark (1998) provides statistically significant detectable differences for the protocols used by TRC (10.8 MCI units). Therefore, if the difference between MCI scores is greater than ten units, then the scores can be considered significantly different. In practice, this means a result more than 10 units above a score is regarded as significantly higher, and a result more than 10 units below a score is significantly lower. Between-season and long-term median MCI scores and/or taxa richness may also be compared using t-tests (Stark and Maxted, 2007).

2.4.5 Predictive measures using the MCI

Measured MCI values at each site are compared against two separate predictive models.

The first model establishes a relationship between MCI scores and the distance of ringplain sites from the National Park boundary. The resulting empirical model for MCI in ringplain streams/rivers is:

$MCI = 131.717 – 25.825 \log_{10} D$ [where D = distance from source (km)]

This model is based upon more than 2400 TRC surveys, including around 300 ringplain 'control' sites, with data collected over the period 1980 to 2008. This generic predictive relationship has a margin of error of ±10 units (Stark and Fowles, 2009).

Leathwick et al. (2009) has also developed a model for predicting MCI scores, based upon the River Environmental Classification (REC) system for New Zealand rivers and streams (Snelder et al, 2004). The REC classifies and maps river and stream environments in a spatial framework for management purposes. It provides a context for inventories of river/stream resources and a spatial framework for effects assessment, policy development, developing monitoring programmes, and interpretations of state of the environment reporting.

2.5 Trend analysis

State of the environment (SEM) macroinvertebrate data collected under standard TRC programme protocols, over the full twenty-four year (1995-2019), and last ten-year (2009-2019), periods, are analysed for trends over time. The MCI, a surrogate for stream health, is used as the most appropriate index for the assessment of time trends (following Stark and Maxted, 2007).

MCI trend data is first visually inspected using a scatter plot of MCI data vs time, with a LOWESS [Locally Weighted Scatterplot] fit (tension of 0.4) implemented to create a smoothed, moving average trend line.

The MCI data, for sites that have a minimum of ten-years continuous data, is then statistically analysed for trends over time using a Mann-Kendall test, followed by false discovery rate (FDR) analysis (Stark and Fowles, 2006). The significance of a site's trend (i.e. the strength of the trend) is assessed according to the statistical probability of occurrence (p-value), with comparisons between sites valid so long as similar numbers of samples have been collected for analysis at each site. This has been the case with the TRC programme. A Kendall tau coefficient is also produced, which indicates whether the trend is positive or negative, and gives a measure of the magnitude of the trend.

A trend may be statistically significant but have no ecological importance, or vice versa. The assessment of ecological importance may be made using the best professional judgment (BPJ) of a freshwater ecologist who has knowledge of the region's rivers and streams. However, it is likely that the strongest trends (lowest p-values) also have the greatest ecological importance.

To place these trends in perspective, each site may be categorised into graduations (bands of MCI values) of stream health. In this instance, Stark's (1985) categories have been refined (using BPJ), as illustrated in Table 3 in Section 2.2.1.2 (Stark & Fowles, 2015).

3 Results and discussion

3.1 Flows

Hydrological flow recorders continuously monitor water levels in the Mangaoraka, Waiongana, Punehu, and Kapoaiaia, Waiokura Streams, and the Waiwhakaiho, Manganui, Patea, Mangaehu, Waingongoro, Kaupokonui, Waitara, and Whenuakura Rivers. The proximity of previous freshes (elevated flows), for each site surveyed, are summarised in Table 4. Flow assessments are extrapolated from nearby catchments for sites where flow recorders do not exist.

Table 4 Duration since freshes at sampling sites in the 2018-2019 SEM biomonitoring programme

River/stream	Site	Spring survey (days after flow above)		Summer survey (days after flow above)	
		3 x median	7 x median	3 x median	7 x median
Hangatahua (Stony) R	Mangatete Road	(13)	(13)	(25)	(74)
Hangatahua (Stony) R	SH45	(13)	(13)	(25)	(74)
Herekawe S	Centennial Drive	(9)	(51)	(97)	(97)
Huatoki S	Hadley Drive	(9)	(51)	(97)	(97)
Huatoki S	Huatoki Domain	(9)	(51)	(97)	(97)
Huatoki S	Molesworth St	(9)	(51)	(97)	(97)
Kapoaiaia S	Wiremu Road	13	13	63	63
Kapoaiaia S	Wataroa Road	13	13	63	63
Kapoaiaia S	Near coast	13	13	63	63
Katikara S	Carrington Road	(13)	(13)	(25)	(74)
Katikara S	Near mouth	(13)	(13)	(25)	(74)
Kaupokonui R	Opunake Rd	17	31	49	182
Kaupokonui R	U/s Kaponga oxi ponds	17	31	49	182
Kaupokonui R	U/s Lactose Co.	19	31	49	182
Kaupokonui R	Glenn Rd	19	31	49	182
Kaupokonui R	Beach	17	31	49	182
Kurapete S	U/s Inglewood WWTP	(9)	(51)	(172)	(172)
Kurapete S	6 km d/s Inglewood WWTP	(9)	(51)	(172)	(172)
Maketawa S	Opp Derby Road	(10)	(11)	(34)	(76)
Maketawa S	Tarata Road	(10)	(11)	(34)	(76)
Mangaehu R	Raupuha Road	45	90	93	162
Manganui R	SH3	10	10	34	34
Manganui R	Bristol Road	10	10	55	76
Mangaoraka S	Corbett Road	9	51	161	161
Mangati S	D/s railway line	(11)	(12)	(100)	(101)
Mangati S	Te Rima Pl, Bell Block	(11)	(12)	(100)	(101)
Mangawhero S	U/s Eltham WWT Plant	(27)	(129)	(50)	(260)
Mangawhero S	D/s Mangawharawhara S	(27)	(129)	(50)	(260)
Mangorei S	SH3	(10)	(11)	(161)	(161)
Patea R	Barclay Rd	10	11	90	127
Patea R	Swansea Rd	10	11	90	127
Patea R	Skinner Rd	10	11	90	127
Punehu S	Wiremu Rd	9	35	65	65
Punehu S	SH45	9	35	65	65

River/stream	Site	Spring survey (days after flow above)		Summer survey (days after flow above)	
		3 x median	7 x median	3 x median	7 x median
Tangahoe R	Upper Valley	(29)	(42)	(51)	(117)
Tangahoe R	Tangahoe Valley Road	(29)	(42)	(51)	(117)
Tangahoe R	D/s railbridge	(29)	(42)	(51)	(117)
Timaru S	Carrington Road	(13)	(13)	(25)	(74)
Timaru S	SH45	(13)	(13)	(25)	(74)
Waiau S	Inland North Road	(9)	(51)	(161)	(161)
Waimoku S	Lucy's Gully	(13)	(13)	(97)	(97)
Waimoku S	Beach	(13)	(13)	(97)	(97)
Waingongoro R	900m d/s Nat Park	28	44	119	187
Waingongoro R	Opunake Rd	28	44	119	187
Waingongoro R	Eltham Rd	28	44	119	182
Waingongoro R	Stuart Rd	28	44	119	182
Waingongoro R	SH45	28	44	124	129
Waingongoro R	Ohawe Beach	28	44	124	129
Waiokura S	Skeet Road	(17)	(360)	(98)	(511)
Waiokura S	Manaia Golf-Course	(17)	(360)	(98)	(511)
Waiongana S	SH3a	11	11	31	72
Waiongana S	Devon Road	11	11	31	72
Waitara	Autawa Road	11	90	55	174
Waitara	Mamaku Road	11	12	95	97
Waiwhakaiho R	National Park	10	10	15	64
Waiwhakaiho R	SH3 (Egmont Village)	10	10	15	64
Waiwhakaiho R	Constance St (NP)	10	11	16	82
Waiwhakaiho R	Adjacent Lake Rotomanu	10	11	16	82
Whenuakura R	Nicholson Road	29	42	51	117

NB: ( ) = extrapolation from nearby catchment

Flow protocols prevent sampling within seven days after a 3x median fresh or ten days after a 7x median fresh, as higher flows disturb community composition and abundance. For this monitoring period, spring surveys were performed 9 to 45 days after a moderate fresh (> 3x median flow), while the summer 2019 surveys were undertaken 15-172 days after a moderate fresh.

3.2 Macroinvertebrate communities

Lists of the taxa found during spring 2018 and summer 2019 surveys, together with taxa richness, MCI scores and other appropriate indices for each site can be found in Appendix II. These results are discussed below, on a stream-by-stream basis, for the sites and seasons (spring and summer) in which the surveys were conducted. The data from previous surveys is also presented for each site, and results to date are illustrated as appropriate.

3.2.1 Hangatahua (Stony) River

The Hangatahua (Stony) River is a ringplain river whose source is located within Egmont National Park. The lower part of the river has a very narrow catchment and generally good water quality. There are two sites monitored for SEM purposes on the Hangatahua (Stony) River.

In the winter of 1996 a massive drift of sand moved down the Hangatahua River, following a major erosion event in the headwaters of the river. This devastated macroinvertebrate communities, with few macroinvertebrate taxa found in the river in the spring of 1996 (Figure 2 and Figure 4). Since then sand has continued to affect the macroinvertebrate communities of the river, although some recovery was observed in the communities in March and November 1997, January and February 1999, late 2000, and again in 2002-2003. At these times greater numbers and varieties of macroinvertebrates were recorded on the riverbed. The very high MCI score of 160 recorded at SH45 in November 1998 (Figure 2) was the result of a community consisting of only one taxon (and just a single individual) which was highly sensitive to pollution. The MCI is not a good indicator of water quality when only a small number of taxa are present and is not typically the index used to assess the impacts of sedimentation in stony streams. However, the MCI has some value in the assessment of recovery of the faunal community with time and has some value in trend evaluation.

A further massive sand drift moved down the river following very heavy February 2004 rainfall and significant flood flows in late February, some three weeks prior to the summer 2004 survey. An additional survey was performed in late winter 2004 to document the continuing effects of sand/sediment drift (see Figures 2 and 3), some three months prior to the late spring survey. Further erosion effects occurred in late 2006 delaying the spring 2006 survey and during the latter months of 2007 while significant sand and scoria bed scouring and sedimentation occurred down the river in mid-year and again in spring 2008 delaying the 'spring' survey until early in 2009. No large-scale significant headwater erosion events were recorded between spring 2009 and summer 2014 but there was a headwater erosion event in February 2014. There have been no major headwater erosion events since February 2014 though minor bed scouring and sedimentation effects continued to impact during the 2018-2019 period.

3.2.1.1 Mangatete Road site (STY000300)

3.2.1.1.1 Taxa richness and MCI

Forty-four SEM surveys have been undertaken in the Stony River at this mid-reach site between October 1995 and February 2019. These results are summarised in Table 5, together with results from the current period, and illustrated in Figure 2.

Table 5 Results from SEM surveys performed in the Stony River at Mangatete Road together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
STY000300	44	1-21	10	64-140	112	13	109	16	108

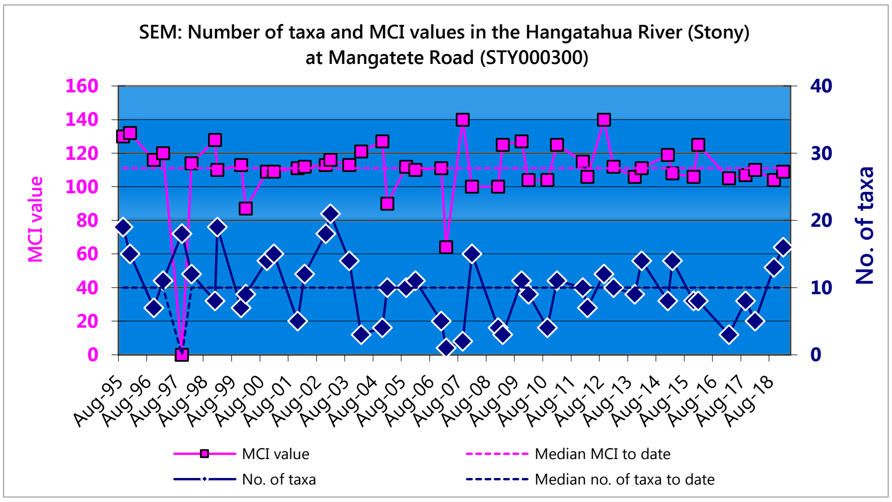


Figure 2 Numbers of taxa and MCI values in the Hangatahua (Stony) River at Mangatete Road

A wide range of richness (1 to 21 taxa) has been recorded as a consequence of extensive headwater erosion impacts on the river's communities with a historical median richness of only 10 taxa, far fewer than might be expected for a ringplain river site at this altitude (160 masl). In the 2018-2019 period, richness was higher than the median, indicative of lessening erosion impacts of scouring, finer sediment deposition, and bed movement.

There are significant limitations when using the MCI for community compositions affected by sedimentation and erosion events (e.g. scores show considerable significant variability when relatively few taxa are present). Values at this site have ranged widely between 64 and 140 units with a historical median MCI value of 112 units. The spring and summer scores were not significantly lower than the historical median. The summer score categorised this site as having 'good' health (Table 3). The median MCI score placed this site's river health in the 'good' category. The paucity of the communities in terms of richness in particular must be taken into account at the site, where headwater erosion effects have been very pronounced and the substrate remains relatively mobile and well scoured.

3.2.1.1.2 Predicted river 'health'

The Stony River at Mangatete Road is 7.3 km downstream of the National Park boundary at an altitude of 160 masl. A relationship for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 109 for this site. The historical site median was not significantly different (Stark and Fowles, 2009) to the predictive value. The spring 2018 and summer 2019 survey scores were also not significantly different to the predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 128 units. The historical site median was significantly lower than this value but the scores recorded in the year under review were both not significantly different.

3.2.1.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced for the full dataset (Figure 3). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 24 years of SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Stony River at Mangatete Road.

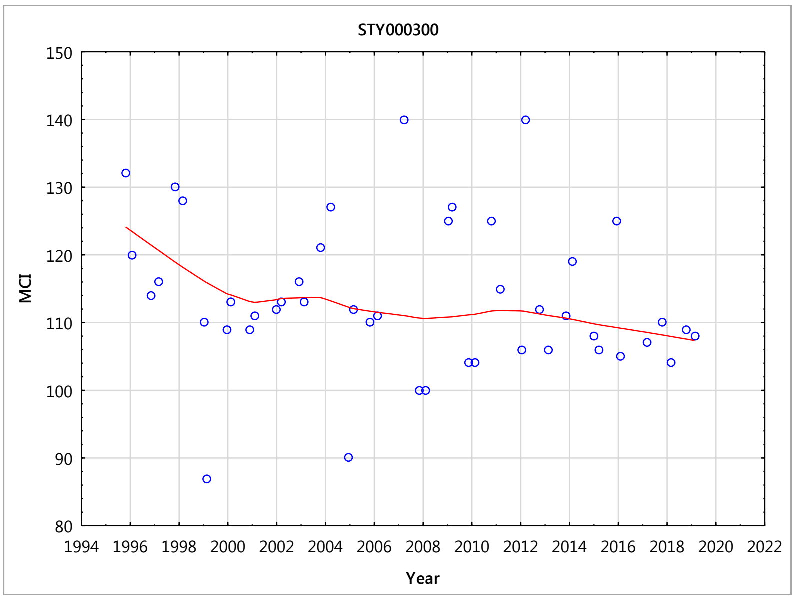


Figure 3 LOWESS trend plot of MCI data at Mangatete Road site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

Although a decreasing trend in MCI scores has been found for the full dataset, particularly over the first six years, this trend was close to being statistically significant after FDR application and continued deterioration in the future will likely produce a statistically significant trend. The trendline at this site has a range of MCI scores of about 15 units indicative of some important ecological variability over the period, not surprisingly given the erosion effect documented earlier and further emphasised by the wide range of individual scores, particularly since 2004. Overall, the trendline shows 'good' generic river 'health'; deteriorating slightly from 'very good' (prior to 1997). However, the majority of the variability was caused by severe headwater erosion events at varying intervals over the period.

A slight negative trend in MCI scores has been found at this site for the ten-year dataset. However, this has not been statistically significant. Overall, the ten-year trendline shows 'good' generic river 'health'.

3.2.1.2 SH 45 site (STY000400)

3.2.1.2.1 Taxa richness and MCI

Forty-four surveys have been undertaken in the Stony River at this lower reach site between October 1995 and February 2018. These results are summarised in Table 6, together with results from the current period, and illustrated in Figure 4.

Table 6 Results from SEM surveys performed in the Stony River at SH 45 together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2019		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
STY000400	44	0-18	9	0-150	108	13	118	16	110

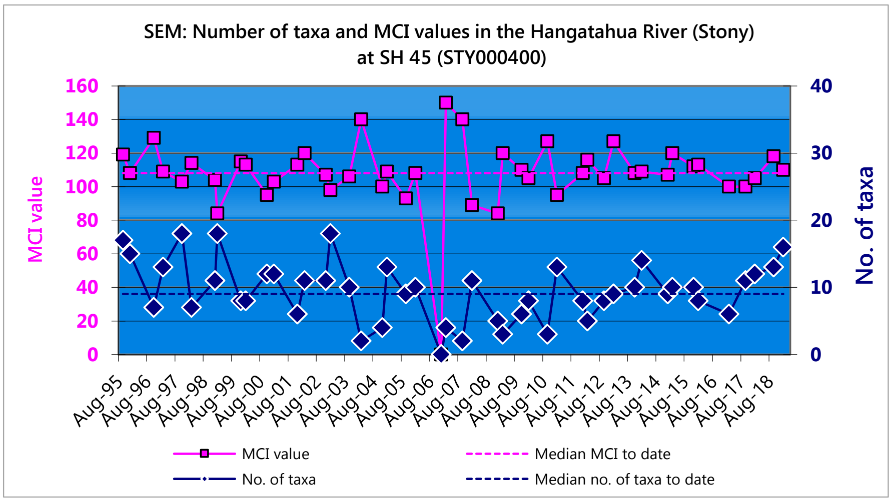


Figure 4 Numbers of taxa and MCI values in the Hangatahua (Stony) River at SH 45

A wide range of richness (0 to 18 taxa) has been recorded mainly as a consequence of extensive headwater erosion impacts on the river's communities, with a median richness of only nine taxa, far fewer than would be expected for a ringplain river site at this altitude (70 m asl). In the 2018-2019 period richness was moderately low with only 13 and 16 taxa recorded in spring and summer respectively suggestive of continuing but not severe erosion impacts of scouring, finer sediment deposition, and bed movement at this site.

There are significant limitations when using the MCI for community compositions affected by sedimentation and erosion events (e.g. scores show considerable variability when relatively few taxa are present). Values at this site have ranged widely between 0 and 150 units with a median MCI value of 110 units. The MCI scores for the spring 2018 survey (118 units) and summer 2019 survey (110 units) were not significantly higher than the historical median (Figure 4). The score categorised this site as having 'good' health (Table 3). However, the paucity of numbers and richness should be recognised in this assessment given the historical impacts of headwater erosion effects along the length of the river channel and the persistently high rainfall that occurred preceding this survey.

3.2.1.2.2 Predicted river 'health'

The Stony River at SH 45 is 12.5 km downstream of the National Park boundary at an altitude of 70 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict an MCI value of 103 for this site. The spring score was significantly higher than (Stark, 1998) the distance predictive value. The historical median, spring and summer scores were not significantly different to the REC predicted score (Leathwick, et al. 2009) of 115 units.

3.2.1.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced using the full dataset (Figure 5). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 24 years of SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Stony River at SH 45.

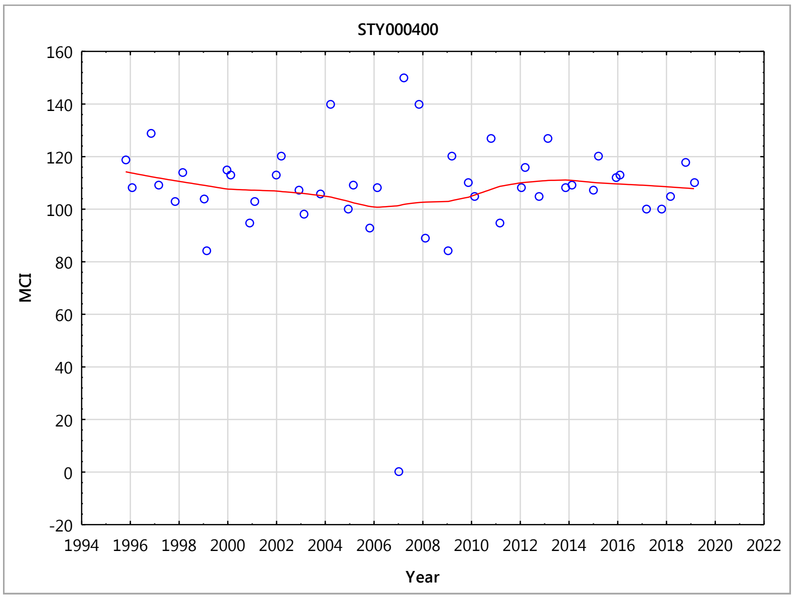


Figure 5 LOWESS trend plot of MCI data at SH 45 site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A slightly increasing trend in MCI scores over the period has not been statistically significant. The trendline at the site has a MCI range of about 16 units indicative of some important ecological variability over the period for the same reasons as those responsible for variability at the upstream site (Mangatete Rd). This was a similar trend to that found at the upstream mid-reach (Mangatete Road) site. Greater variability in scores has been apparent since 2004 with the majority of the variability in MCI scores associated with headwater erosion events. Overall, the trendline shows 'good' generic river 'health'.

There has been a minor negative trend in MCI scores over the ten-year period which was not statistically significant. Overall, the trend line shows 'good' generic river 'health'.

3.2.1.3 Discussion

Due to the major influence of historical and relatively frequent headwater erosion events, scouring, and instability of the river bed; seasonal and spatial differences in macroinvertebrate communities in the Stony River often have not been as abundant or diverse as elsewhere in ringplain streams.

Taxa richness at both sites were moderately low but slightly higher than historic medians. This was likely due to continuing but less severe erosion events impacting on the macroinvertebrate communities.

MCI scores indicted that macroinvertebrate communities were in 'good' health for both sites and were not significantly different to historical medians. There was a non-significant increase in MCI scores at the downstream site indicating little change in macroinvertebrate health in a downstream direction.

3.2.2 Herekawe Stream

One site in this small lowland coastal ringplain stream on the western perimeter of New Plymouth City was incorporated into the SEM programme in 2008 for the purpose of monitoring a newly-developed walkway and associated riparian planting initiatives in the lower reaches of the stream. Consent monitoring has been performed at this 'control' site in spring and summer throughout the period from 1995 to 2019 (and dates back to 1986).

3.2.2.1 Centennial Drive site (HRK000085)

3.2.2.1.1 Taxa richness and MCI

Forty-five surveys have been undertaken between February 1995 and February 2018 in this lower-reach site in the Herekawe Stream. These results are summarised in Table 7, together with the results from the current period, and illustrated in Figure 6.

Table 7 Results of previous surveys performed in Herekawe Stream at Centennial Drive, together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HRK000085	45	13-29	19	68-100	89	20	92	18	96

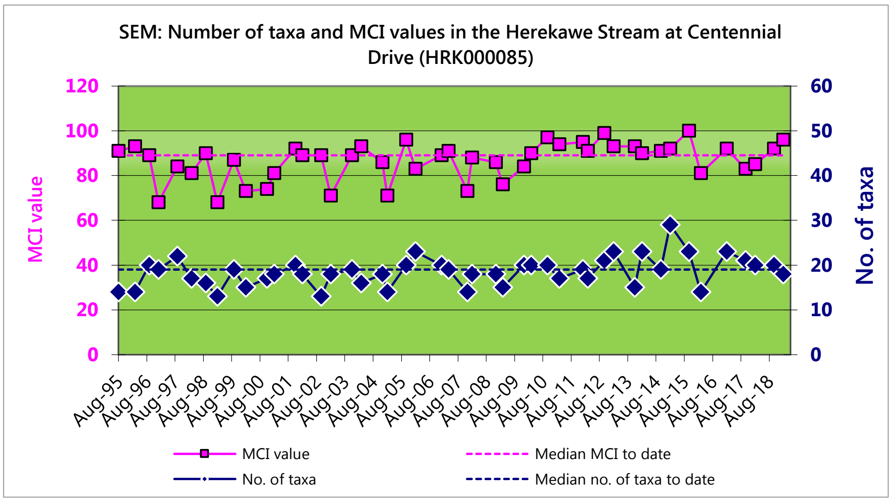


Figure 6 Numbers of taxa and MCI values in the Herekawe Stream upstream of Centennial Drive

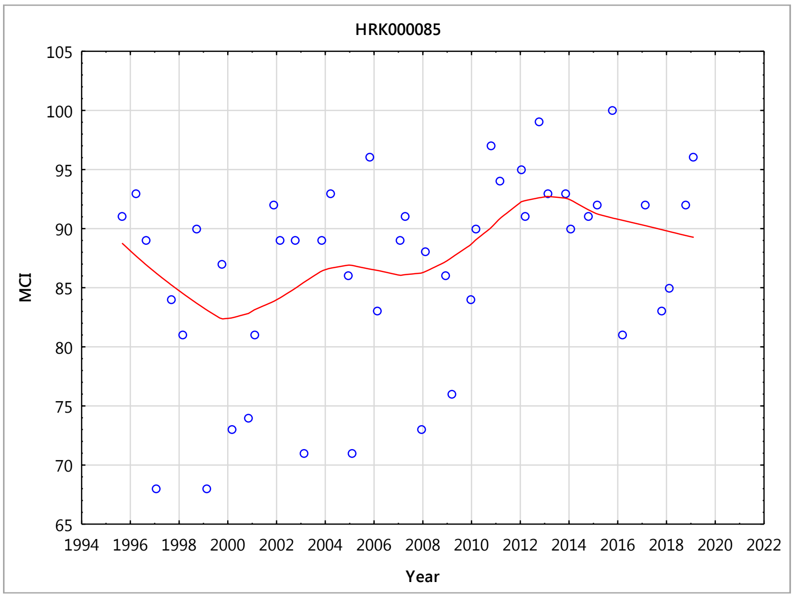
A moderate range of richness (13 to 29 taxa) had been found, with a median richness of 19 taxa which has been more representative of typical richness in small lowland coastal streams. During the current period, spring (20 taxa) and summer (18 taxa) richness were similar to the median richness for the site. MCI values have had a relatively wide range (32 units) at this site. The historical median value (89 units) is above scores typical of lower reach sites elsewhere in small lowland coastal streams. The spring (92 units) and summer (96 units) scores were not significantly different (Stark, 1998) to the historical median. These scores categorised this site as having 'fair' health generically (Table 3). The historical median score (89 units) placed this site in the 'fair' category.

3.2.2.1.2 Predicted stream 'health'

The Herekawe Stream rises as seepage near the coast on the ringplain and the site at Centennial Drive, Omata is in the lower reaches near the mouth at an altitude of 5 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 89 units. The historical median, and spring and summer scores were not significantly different (Stark, 1998) to this value.

3.2.2.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 7). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on 24 years of SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from Herekawe Stream at Centennial Drive.



N = 47
Kendall tau = 0.28
p level = 0.01
FDR p = 0.02

N = 19
Kendall tau = -0.08
p level = 0.64
FDR p = 0.84

Figure 7 LOWESS trend plot of MCI data in the Herekawe Stream at the Centennial Drive site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

There was a positive significant trend in MCI scores across the full dataset at this site, which is situated in the lower reaches of the stream, immediately downstream of a recently constructed walkway. Trends have varied at this site, with a general trend of improvement since 2000, and particularly after 2008 More recently there has been stability, but with some wide variations in individual MCI scores. The trendline variation (10 units) indicates some ecological variability. The trendline was indicative of 'fair' stream health.

A negative non-significant trend in MCI scores has been found over the ten-year period, in contrast with the significant positive result found in the full dataset. The ten-year dataset trend shows an increase from 2009 to 2012, but overall the trendline change was negligible. The trendline was indicative of 'fair' health.

3.2.2.2 Discussion

Spring and summer values are typically very similar at this site with seasonal median MCI values being identical over the 24-year period (Appendix II). The survey results were within expected parameters with the site having 'fair' health and not having any significant differences between the current score and median and predicted results.

3.2.3 Huatoki Stream

The Huatoki Stream is a small ringplain stream arising outside Egmont National Park that flows south to north with the middle and lower parts of the catchment in the New Plymouth city area. There are three SEM sites on the stream.

3.2.3.1 Hadley Drive site (HTK000350)

3.2.3.1.1 Taxa richness and MCI

Forty-three surveys have been undertaken, between December 1996 and February 2018, at this lower mid-reach, unshaded site, draining open developed farmland, on the outskirts of New Plymouth city. These results are summarised in Table 8, together with the results from the current period, and illustrated in Figure 8.

Table 8 Results of previous surveys performed in the Huatoki Stream at Hadley Drive together with 2018-2019 results

Site code	SEM data (1996 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000350	43	19-34	26	79-115	97	23	109	20	89

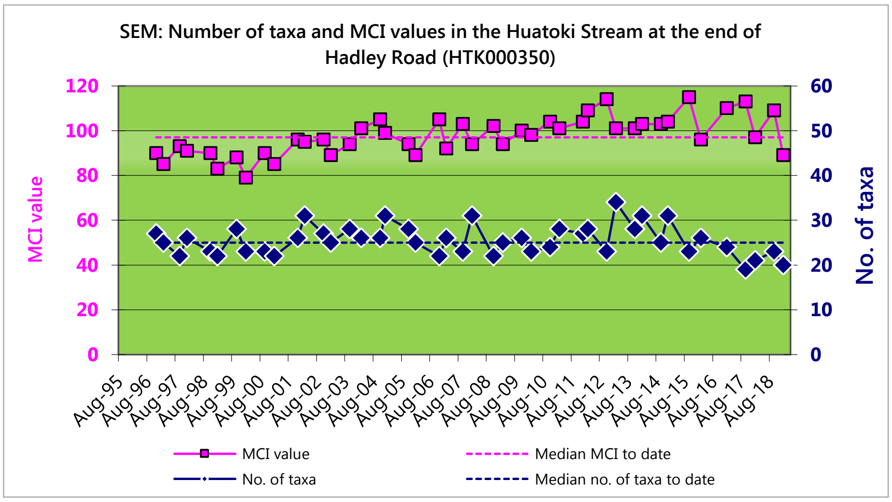


Figure 8 Numbers of taxa and MCI values in the Huatoki Stream at the end of Hadley Drive

A moderate range of richness (19 to 34 taxa) has been found with a relatively high median richness of 26 taxa, relatively typical of richness in the mid to lower reaches of ringplain streams rising outside of the National Park. During the 2018-2019 period spring (23 taxa) and summer (20 taxa) richness were slightly lower than the historical median richness.

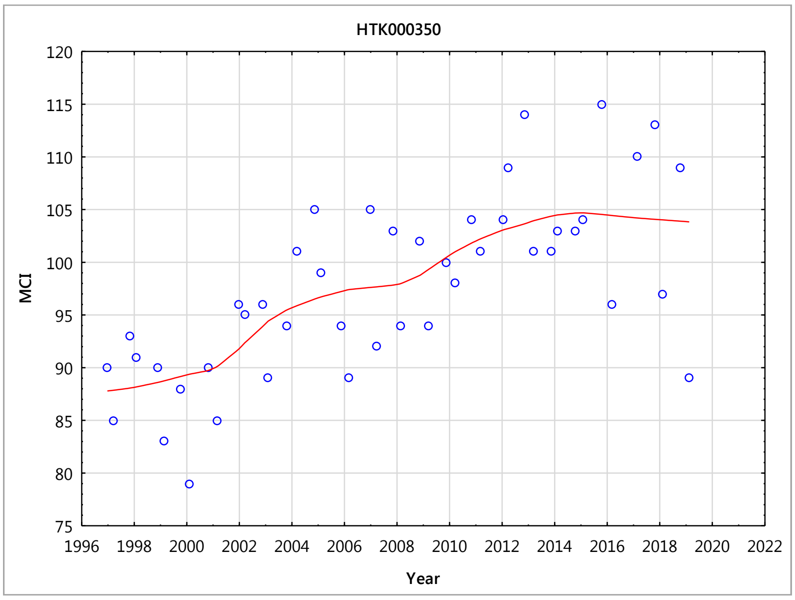
MCI values have had a relatively wide range (36 units) at this site, typical of mid to lower reach sites on the ringplain. The spring 2018 (109 units) score was significantly higher (Stark, 1998) than the historical median by 12 units, while the summer 2019 (89 units) score was not significantly different to the historical median score. The spring and summer scores respectively categorised this site as having 'good' and 'fair' health generically (Table 3). The historical median score (97 units) placed this site in the 'fair' category for generic health.

3.2.3.1.2 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site at Hadley Drive is in the lower mid-reaches at an altitude of 60 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 95 units. The summer score was significantly higher than the REC predicted value while there was no significant difference for the spring and historic median scores (Stark, 1998).

3.2.3.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 9). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1996-2019) and the most recent ten-years of results (2009-2019) from the site in the Huatoki Stream at Hadley Drive.



N = 45
Kendall tau = 0.51
p level < 0.01
FDR p < 0.01

N = 19
Kendall tau = 0.09
p level = 0.59
FDR p = 0.83

Figure 9 LOWESS trend plot of MCI data in the Huatoki Stream at the Hadley Drive site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A strong significant improvement ($p < 0.01$) in MCI scores, particularly since 2000 has been illustrated at this site on the outskirts of New Plymouth over the 23-year period. This may have been related to improvements in farming practices (including more recent riparian fencing) and/or wastes disposal in the rural catchment between the stream's seepage sources (below the National Park) and urban New Plymouth. The wide trendline range of MCI scores (16 units) indicates some changes of ecological importance. MCI scores have been indicative of 'fair' generic stream health almost throughout the period improving to 'good' health since 2010.

A non-significant trend in MCI scores has been found over the ten-year period in contrast with the significant positive result found in the full dataset. The trendline was mostly indicative of 'good' health.

3.2.3.2 Huatoki Domain site (HTK000425)

3.2.3.2.1 Taxa richness and MCI

Forty-three surveys have been undertaken at this lower middle reach site in the Huatoki Stream toward the downstream boundary of the Huatoki Domain between December 1996 and February 2018. These results are summarised in Table 9, together with the results from the current period, and illustrated in Figure 10.

Table 9 Results of previous surveys performed at Huatoki Stream in Huatoki Domain, together with the 2018-2019 results

Site code	SEM data (1996 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000425	43	17-32	25	91-117	104	23	106	20	103

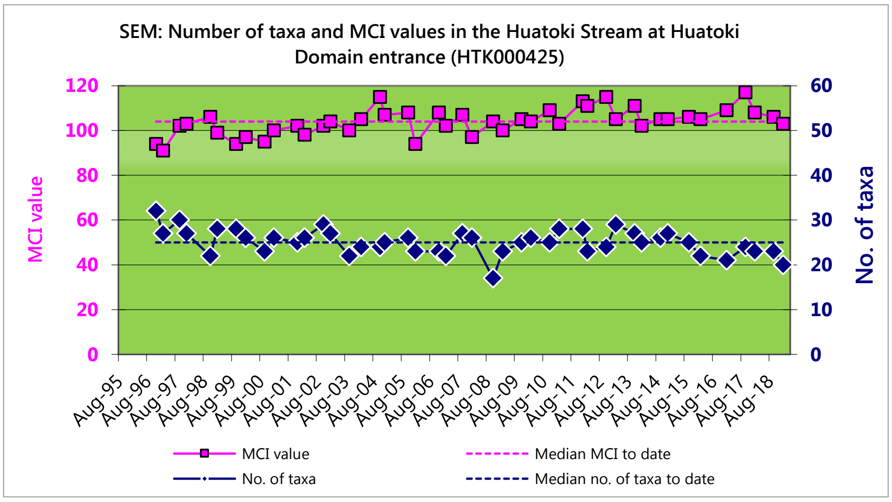


Figure 10 Numbers of taxa and MCI values in the Huatoki Stream at the Huatoki Domain

A moderate range of richness (17 to 32 taxa) has been found, with a median richness of 25 taxa (more representative of typical richness for the lower reaches of ringplain streams rising outside the National Park boundary). During the current period spring (23 taxa) and summer (20 taxa) richness were only slightly taxa lower than the historical median richness.

MCI values have had a moderately wide range (26 units) at this site. The median value (104 units) has been higher than typical of lower reach sites elsewhere on the ringplain however. The spring (106 units) score was a significant 13 units higher than the historical median (Stark 1998), while the summer (103 units) score was not significantly different to the historical median value. The spring and summer scores categorised this site as having 'good' health generically (Table 3). The historical median score (104 units) also placed this site in the 'good' category for generic health.

3.2.3.2.2 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site at Hadley Domain is in the lower mid-reaches at an altitude of 30 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical, spring and summer scores were all significantly higher than the REC value (Stark, 1998).

3.2.3.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 11). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1996-2019) and the most recent ten-years of results (2009-2019) from the site in the Huatoki Stream at Huatoki Domain.

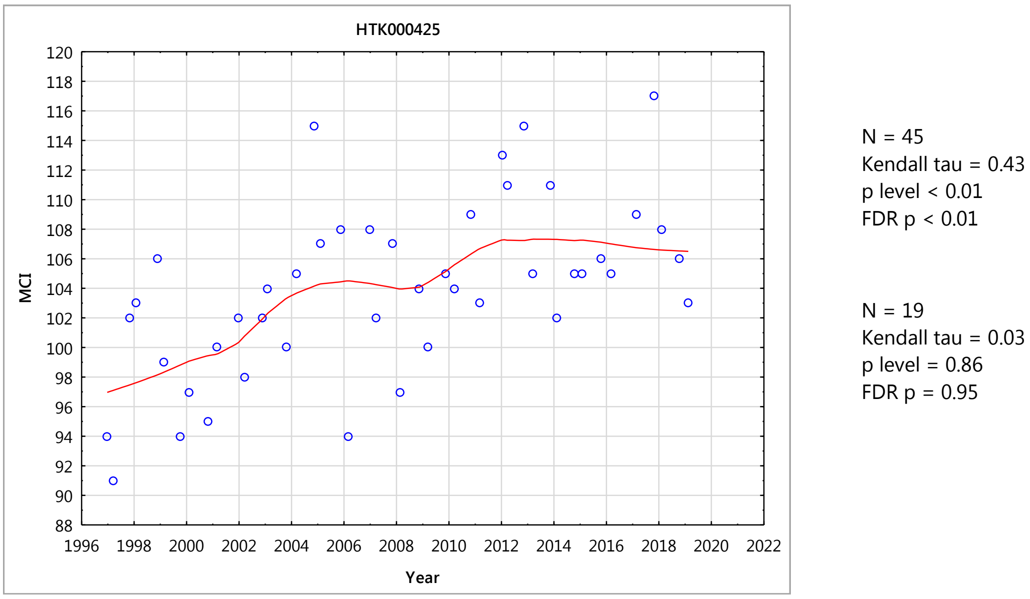


Figure 11 LOWESS trend plot of MCI data in the Huatoki Stream for the Huatoki Domain site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A similar temporal trend of a marked improvement in MCI scores, but not as strong as that found at the upstream site (at Hadley Drive), was identified at this site in the Domain although scores peaked with small decreases after 2006 and 2012. The overall trend has been very significant after FDR application ($p < 0.01$) and the trendline range of scores (12 units) indicates some ecological variation. The improving trend has probably been related to the upstream catchment activities noted above as no nearby habitat changes have been recorded within the Domain.

The trendline MCI scores indicated 'fair' generic stream health early in the monitoring period, improving to 'good' stream health since 2002.

A highly non-significant trend in MCI scores has been found over the ten-year period suggesting little recent change has occurred. The trendline was indicative of 'good' health.

3.2.3.3 Site near coast (HTK000745)

3.2.3.3.1 Taxa richness and MCI

Forty-three surveys have been undertaken at this lower reach site in the Huatoki Stream between December 1996 and February 2019. These results are summarised in Table 10, together with the results from the current period, and illustrated in Figure 12.

Table 10 Results of previous surveys performed in Huatoki Stream at the site near the coast, together with the 2018-2019 results

Site code	SEM data (1996 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
HTK000745	43	11-27	22	62-102	86	18	98	14	56

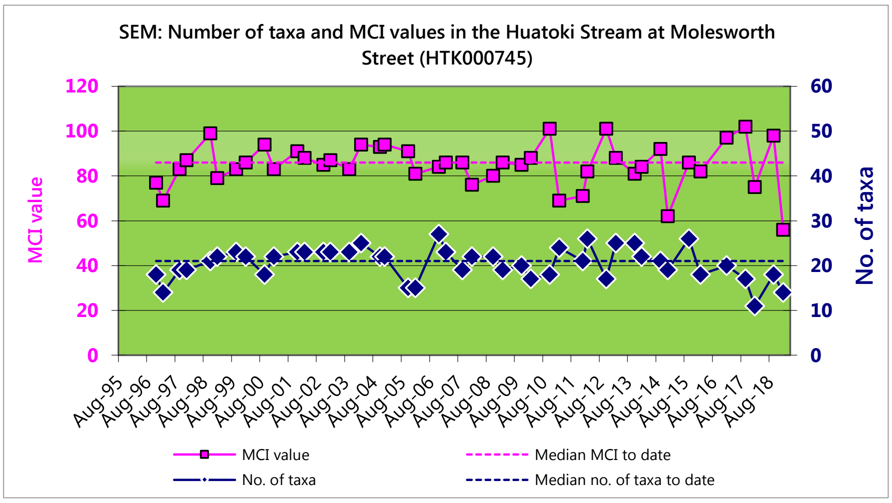


Figure 12 Numbers of taxa and MCI values in the Huatoki Stream at Molesworth Street (near coast)

A moderate range of richness (11 to 27 taxa) has been found, with a median richness of 22 taxa (more representative of typical richness in the lower reaches of ringplain streams rising outside the National Park boundary). During the 2018-2019 period spring (18 taxa) was four taxa less than historical median richness, while summer (14 taxa) richness was a substantial eight taxa lower than the historical median richness. The summer richness was also the second equal lowest richness recorded at this site to date.

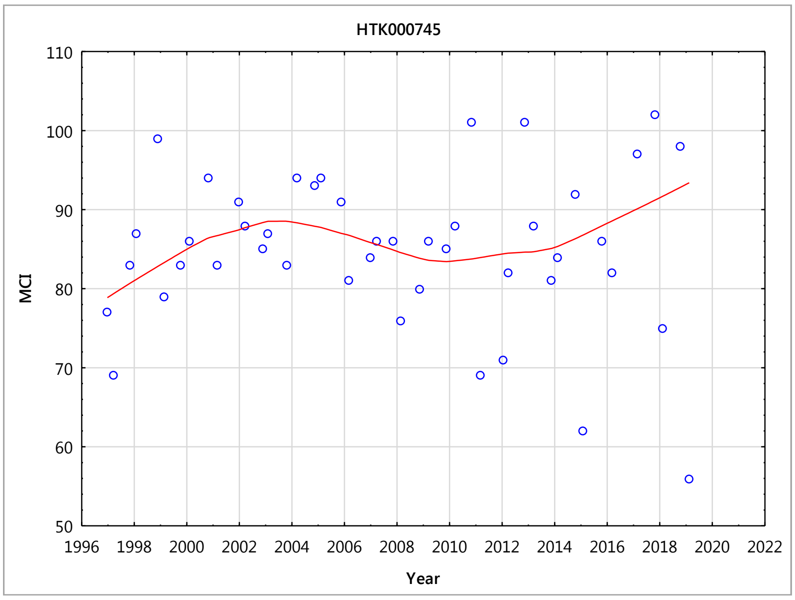
MCI values have had a relatively wide range (30 units) at this site. However, the median value (86 units) has been typical of lower reach sites elsewhere on the ringplain. The scores recorded in the current period showed substantial variation. The spring (98 units) score was significantly higher (Stark, 1998) than the median by 12 units. However, the summer (56 units) score was significantly (Stark, 1998) lower than the historical median by a very large 30 units and the lowest score recorded at the site to date. The MCI scores in spring and summer respectively categorised this site as having 'fair' and 'very poor' health generically (Table 3). The historical median score (86 units) placed this site in the 'fair' category for generic health.

3.2.3.3.2 Predicted stream 'health'

The Huatoki Stream rises below the National Park boundary and the site near the coast is in the lower reaches at an altitude of 5 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 93 units. The historical and spring scores were not significantly different to the REC value but the summer score was significantly lower (Stark, 1998).

3.2.3.3.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 13) using the full dataset. A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1996-2019) and the most recent ten-years of results (2009-2019) from the site in the Huatoki Stream near the coast.



N = 45
Kendall tau = 0.017
p level = 0.873
FDR p = 0.900

N = 19
Kendall tau = 0.01
p level = 0.95
FDR p = 0.95

Figure 13 LOWESS trend plot of MCI data for the site in the Huatoki Stream near the coast for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A trend of steady improvement in smoothed MCI scores had occurred at this urbanised site until 2004 after which scores trended downward until plateauing more recently (with much more variability amongst individual scores) following the pulsed flows and subtle habitat changes caused by the beautification project which involved construction of a weir and a fishpass. Overall, there was a slight positive non-significant trend. The wide trendline range of scores (13 units) probably related in part to those activities noted for the two sites further upstream in the Huatoki catchment, the quality of stormwater dischargers entering the stream and the stream enhancement project specific to the reach immediately upstream of this site. The trendline scores were indicative of 'fair' generic stream health.

A non-significant positive trend in MCI scores has been found over the ten-year period congruent with the result found in the full dataset. The trendline was indicative of 'fair' health.

3.2.3.4 Discussion

Historically, there have been small summer decreases of MCI scores (Appendix II) in the Huatoki Stream but for the current monitoring period there were significant decreases in MCI scores from spring to summer at the top and bottom sites but not the middle, well shaded site. The seasonal change was probably the result of dry weather causing more stable flows and increased periphyton growth for the upper site. However, the new record low for the bottom site may well have been caused by poor preceding water quality rather than low flows as the site was not adversely affected by periphyton, though fine sediment was present which a fresh would help to remove.

As was normal, the two up sites at Hadley Drive and Huatoki Domain, had higher macroinvertebrate health than the lower site on Molesworth Street. There was little difference in the overall health between the two upstream communities in spring but the Huatoki Domain site had a significantly higher MCI score than the upper Hadley Drive site in summer, probably as a result of the Huatoki Domain site having better shading which helped to minimise periphyton growth. The significant decrease at the lower site can be attributed to increased urbanisation, habitat modification and deterioration in water quality.

3.2.4 Kapoaiaia Stream

The Kapoaiaia Stream is a small ringplain stream running in a westerly direction with a source situated inside Egmont National Park. This stream was selected for the purpose of monitoring a western Taranaki ringplain catchment with minimal existing riparian vegetation cover. Three sites in the Kapoaiaia Stream were included in the SEM programme commencing in the 2000-2001 year. These were located at Wiremu Road (in open farmland nearly 6 km below the National Park boundary), Wataroa Road bridge (nearly 8 km further downstream), and about 0.8 km from the coast (8 km further downstream, i.e. 25 km below the National Park boundary).

3.2.4.1 Wiremu Road site (KPA000250)

3.2.4.1.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Kapoaiaia Stream between March 1998 and February 2018 at this open, upper mid-reach site in farmland, 5.7 km downstream of the National Park. These results are summarised in Table 11 together with the results from the current period, and illustrated in Figure 14.

Table 11 Results of previous surveys performed in the Kapoaiaia Stream at Wiremu Road together with the 2018-2019 results

Site code	SEM data (1998 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000250	38	19-31	25	83-131	117	25	127	23	107

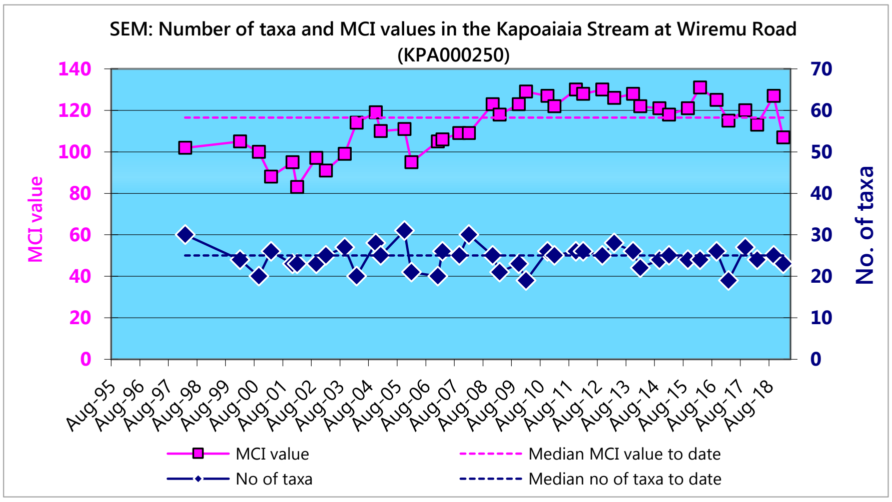


Figure 14 Numbers of taxa MCI values in the Kapoaiaia Stream at Wiremu Road

A moderate range of richness (19 to 31 taxa) has been found with a median richness of 25 taxa (more typical of richness in the mid-reaches of ringplain streams and rivers). During the current period, spring (25 taxa) and summer (23 taxa) richness were very similar to the historical median.

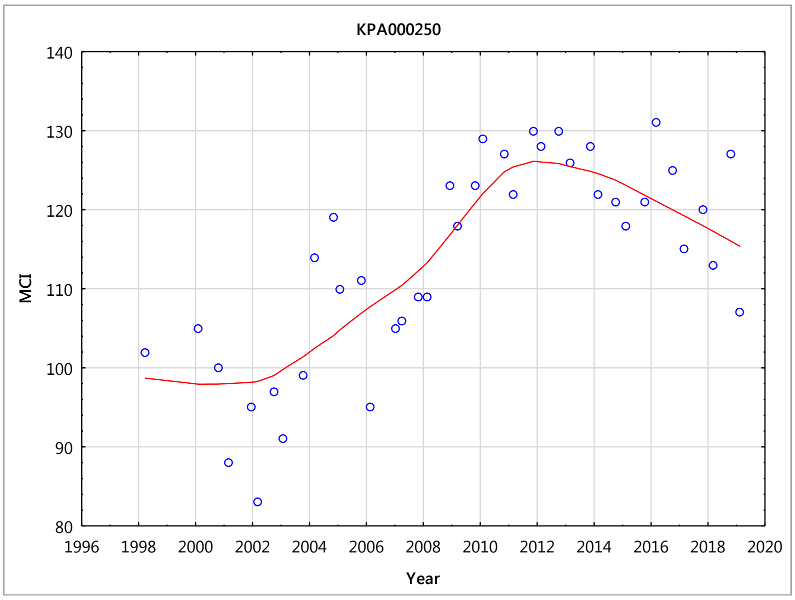
MCI values have had a wide range (48 units) at this site, wider than typical of a site in the upper mid-reaches of a ringplain stream although this site is in a reach of very open farmland, nearly 6km downstream from the National Park boundary. The spring (127 units) and summer (107 units) scores were not significantly different from the historical median. These scores categorised this site as having ‘very good’ generic health (Table 3) in spring and 'good health' in summer. The historical median score (117 units) placed this site in the 'good' generic health category.

3.2.4.1.2 Predicted stream 'health'

The Kapoaiaia Stream site at Wiremu Road is 5.7 km downstream of the National Park boundary at an altitude of 240 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 112 for this site. The historical site median and summer survey were not significantly different from the distance predictive value and the spring score was significantly higher. The REC predicted MCI value (Leathwick, et al. 2009) was 111 units. The historical site median and summer survey were not significantly different from the REC predictive value and the spring score was significantly higher.

3.2.4.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 15) using the full dataset. A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 21 years of SEM results (1998-2019) and the most recent ten-years of results (2009-2019) from the site in the Kapoaiaia Stream at Wiremu Road.



N = 40
Kendall tau = 0.45
p level < 0.01
FDR, p < 0.01

N = 20
Kendall tau = -0.42
p level = 0.01
FDR, p = 0.14

Figure 15 LOWESS trend plot of MCI data in the Kapoaiaia Stream at the Wiremu Road site

A very significant trend of improvement in MCI scores has been found over the 21-year duration of this monitoring period (FDR p < 0.01). There has been ecologically important variability in the extremely wide (28 units) range of trendline scores at this site also. This appears to have been related to farming practices, particularly variations in fertiliser usage, through the open reach between the National Park boundary and this upper site, which may have been exacerbated by the lack of riparian vegetation along this reach.

The trendline scores were indicative of generic stream health varying between 'fair' and 'very good' have been slightly lower than might be expected at times (particularly prior to 2004) at this site approximately 6 km below the National Park. A strong improvement has been obvious between 2007 and 2012 when it plateaued with some deterioration in 'health' over the 2013 to 2019 period.

A non-significant negative trend in MCI scores has been found over the ten-year period in contrast with the result found in the full dataset. The trendline was mostly indicative of 'very good' health for the most recent ten-year period but since 2017 has decreased to 'good' health.

3.2.4.2 Wataroa Road site (KPA000700)

3.2.4.2.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Kapoaiaia Stream at this mid-reach site at Wataroa Road between December 1996 and February 2018. These results are summarised in Table 12, together with the results from the current period, and illustrated in Figure 16.

Table 12 Results of previous surveys performed in the Kapoaiaia Stream at Wataroa Road, together with 2018-2019 results

Site code	SEM data (1996 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000700	38	12-30	21	78-118	97	20	105	21	94

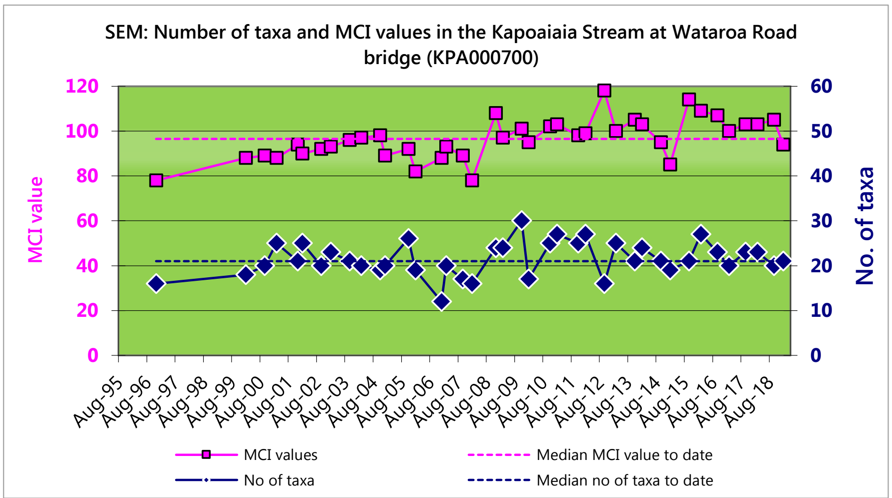


Figure 16 Numbers of taxa and MCI values in the Kapoaiaia Stream at Wataroa Road

A wide range of richness (12 to 30 taxa) has been found, with a median richness of 21 taxa, relatively typical of richness in the mid-reaches of ringplain streams and rivers. During the current period, spring (20 taxa) and summer (21 taxa) richness were similar to the historical median. MCI values have had a relatively wide range (40 units) at this site, more so than typical of many sites in the mid-reaches of ringplain rivers. The historical median value (97 units) is lower than values typical of mid-reach sites elsewhere on the ringplain. The spring (105 units) and summer (94 units) scores were similar to the historical median. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (97 units) placed this site in the 'fair' category for generic health.

3.2.4.2.2 Predicted stream 'health'

The Kapoaiaia Stream site at Wataroa Road, is 13.5 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 103 for this site. The historical site median, spring and summer scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 105 units. The historical median, spring and summer scores were all not significantly different to the REC predictive value.

3.2.4.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 17). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of SEM results (1996-2019) and the most recent ten-years of results (2009-2019) from the site in the Kapoaiaia Stream at Wataroa Road.

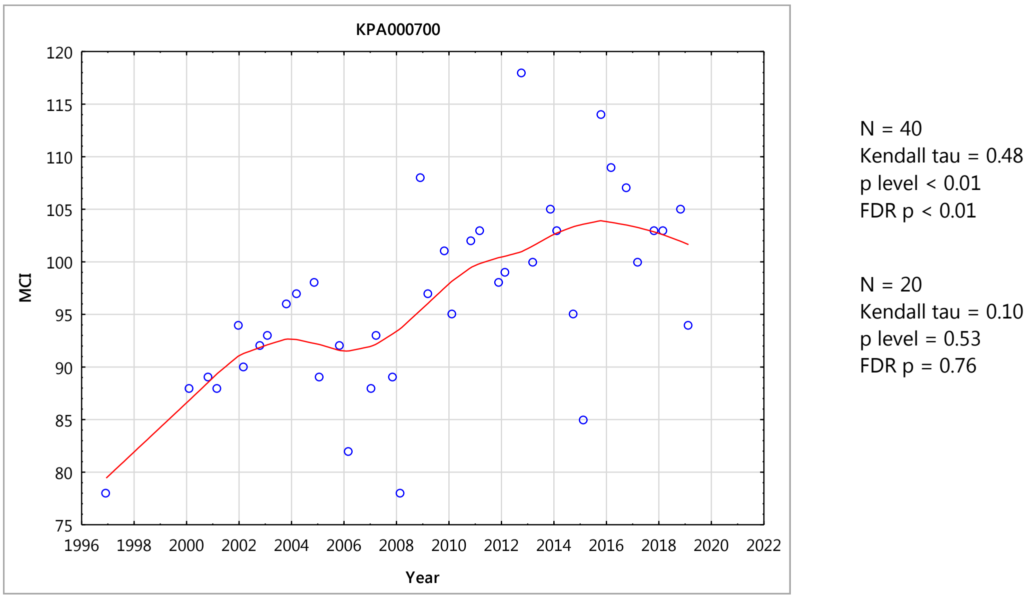


Figure 17 LOWESS trend plot of MCI data in the Kapoaiaia Stream at the Wataroa Road site

There was a significant positive trend over the 23-year period (FDR p < 0.01). Although the initial six years of the monitoring programme indicated a significant temporal improvement in MCI scores, these tended to decline between 2004 and 2007. However, more recent improvement have continued a positive trend. The range of trendline scores (28 units) have been ecologically important. This improvement has probably been influenced by the same drivers as the Wiremu Road site upstream. MCI scores across the trendline have consistently indicated 'fair' generic stream health at this mid-catchment site, improving to 'good' from 2012 onwards.

A non-significant positive trend in MCI scores has been found over the ten-year period. The trendline was mostly indicative of 'good' health for the most recent ten-year period.

3.2.4.3 Upstream of coast site (KPA000950)

3.2.4.3.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken at this lower reach site near the coast in the Kapoaiaia Stream between December 1996 and February 2018. These results are summarised in Table 13, together with the results from the current period, and illustrated in Figure 18.

Table 13 Results of previous surveys performed in the Kapoaiaia Stream at the site upstream of the coast together with 2018-2019 results

Site code	SEM data (1996 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPA000950	38	15-25	19	76-101	87	18	86	19	89

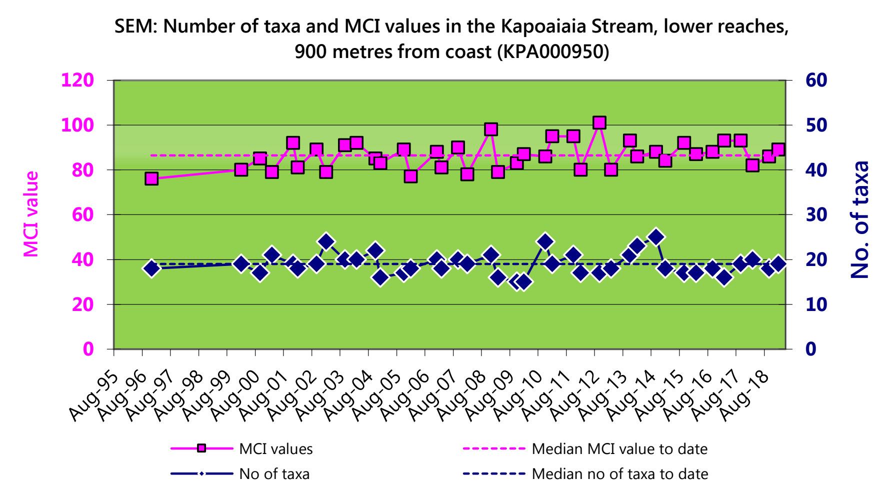


Figure 18 Numbers of taxa and MCI values in the Kapoaiaia Stream at the Cape Egmont (upstream of coast) site

A moderate range of richness (15 to 25 taxa) has been found with a median richness of 19 taxa relatively typical of richness in the lower reaches of ringplain streams and rivers. During the current period, spring (18 taxa) and summer (19 taxa) richness were similar to the historical median.

MCI scores have had a moderate range (25 units) at this site, slightly narrower than typical of sites in the lower reaches of ringplain streams. However, the median value (87 units) has been relatively typical of lower reach sites elsewhere on the ringplain. The spring (86 units) and summer (89 units) scores were not significantly different from the historical median. The MCI scores categorised this site as having 'fair' (spring and summer) health generically (Table 3). The historical median score (87 units) also placed this site in the 'fair' category for generic health.

3.2.4.3.2 Predicted stream 'health'

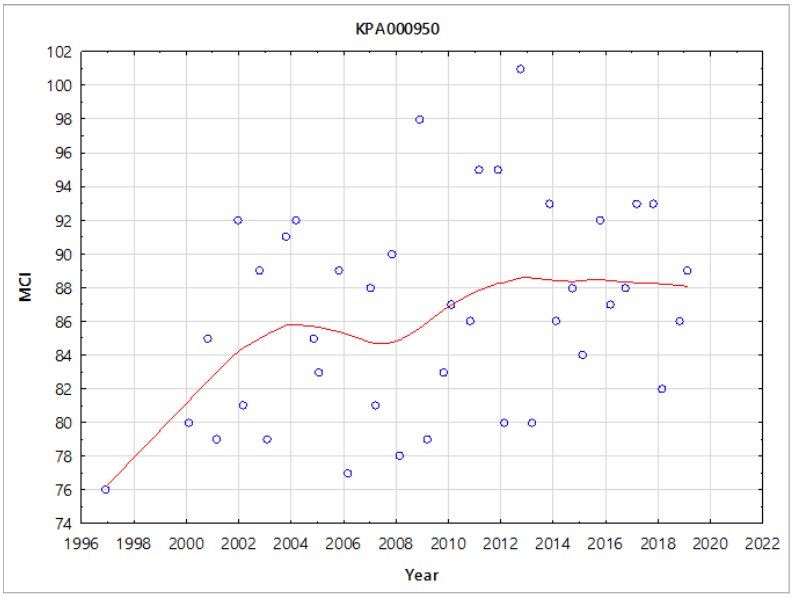
The Kapoaiaia Stream site near the coast is 25.2 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 96 for this site. The historical site median, spring and summer scores were not significantly different to the distance predictive value.

The REC predicted MCI value (Leathwick, et al. 2009) was 99 units. The historical median and spring scores were significantly lower than the REC value while the summer score was not significantly different.

3.2.4.3.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 19). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 23 years of

SEM results (1996-2019) and the most recent ten-years of results (2009-2019) from the site in the Kapoaiaia Stream at near the coast.



N = 40
Kendall tau = 0.23
p level = 0.04
FDR p = 0.08

N = 20
Kendall tau = 0.04
p level = 0.79
FDR p = 0.94

Figure 19 LOWESS trend plot of MCI data at the site upstream of the coast

The positive trend was close to being statistically significant after FDR application and continued improvement in the future will likely produce a statistically significant trend. There has been a similar, although more pronounced, trend at the mid-catchment site at Wataroa Road. However, there has been an ecologically important range (of 13 units) across the trendline, influenced by the low initial score, but not as wide as the range at the nearest upstream site. Subsequent to the December 1996 survey, no usage of the Pungarehu Dairy Factory (between the two sites) has occurred and since 2000 there has been a narrower, ecologically insignificant, range of MCI scores (eight units). In more recent years, there has been an increase in water abstraction in the lower reaches for irrigation purposes. The trendline range of MCI scores have consistently been indicative of 'fair' generic stream health although individual scores prior to 2010 have occasionally indicated 'poor' health, invariably under summer (warmer and lower) flow conditions.

A non-significant positive trend in MCI scores has been found over the ten-year period congruent with the full dataset though with a far weaker p value indicating a weaker trend and smaller dataset. The trendline was indicative of 'fair' health for the most recent ten-year period.

3.2.4.4 Discussion

MCI scores showed a significant decrease in a downstream direction for both spring and summer surveys. MCI scores at the upper site were 'very good' to 'good', 'good' to 'fair' at the middle site and 'fair' at the lower site indicating a deterioration in macroinvertebrate health. The deterioration in macroinvertebrate health was likely due to impacts associated with agriculture as the mid to lower reaches of the stream are in an agriculture dominated catchment. However, the two upper sites had significant positive trends indicating long term improvement and the lower site also appeared to be improving, but not to the same degree as the upper sites.

3.2.5 Katikara Stream

The Katikara Stream is a ringplain stream running in a westerly direction and arises within Egmont National Park. Two sites in the Katikara Stream, one located near the headwaters (just inside the National Park) and the other near the coast, were first included in the SEM programme in the 2000-2001 year, for the purpose of long term monitoring of the progressive impacts of riparian vegetation planting initiatives within this north-western Taranaki catchment. In the 2008-2009 period severe headwater erosion events impacted upon the macroinvertebrate communities of the upper reaches of this stream (TRC, 2009).

3.2.5.1 Carrington Road site (KTK000150)

3.2.5.1.1 Taxa richness and MCI

Thirty-seven surveys have been undertaken at this upper reach site in the Katikara Stream inside the National park boundary at Carrington Road between September 1999 and February 2018. These results are summarised in Table 14 together with the results from the current period, and illustrated in Figure 20.

Table 14 Results of previous surveys performed in the Katikara Stream at Carrington Road, together with 2018-2019 results

Site code	SEM data (1999 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KTK000150	37	11-38	28	112-148	135	26	135	25	125

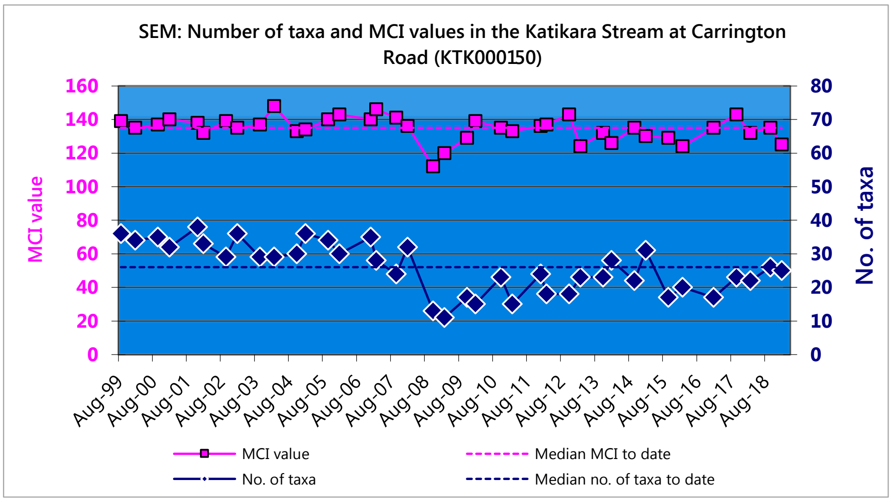


Figure 20 Numbers of taxa and MCI values in the Katikara Stream at Carrington Road

A very wide range of richness (11 to 38 taxa) has been found; wider than might be expected, due to the impacts of significant headwater erosion over the 2008-2009 period and subsequent recovery from these effects. The median richness of 28 taxa has been far more representative of typical richness in ringplain streams and rivers near the National Park boundary. During the current period spring (26 taxa) and summer (25 taxa) richness was recorded which was only slightly lower than the long-term median richness indicative of the site having largely recovered from the headwater erosion event.

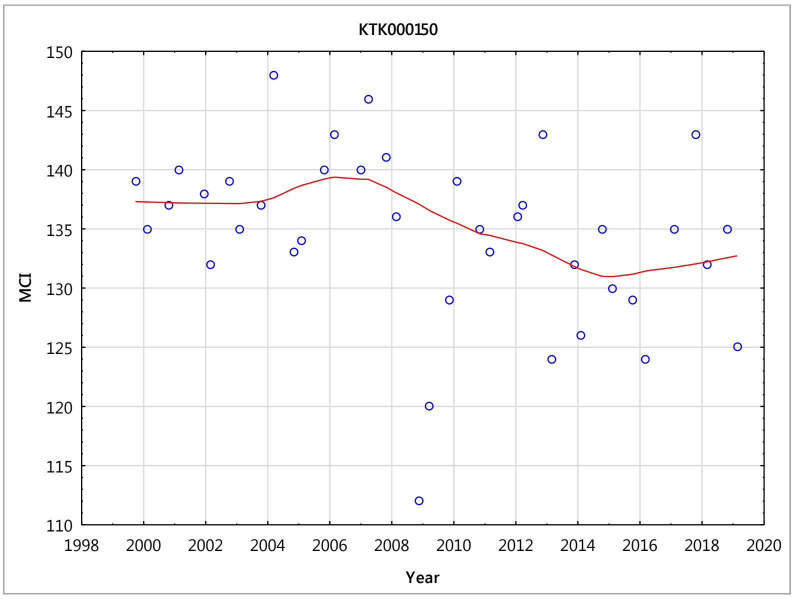
MCI values at this site have had a wider range (36 units) than typical of a National Park boundary site, due in part to atypically lower values for a short period and on other isolated occasions since the 2008-2009 headwater erosion event. The median value (135 units) has been typical of upper reach sites (near or within the National Park) elsewhere on the ringplain. The spring (132 units) and summer (137 units) scores were not significantly different to the historical median (135 units). The spring and summer scores categorised this site as having 'very good' health generically (Table 3). The historical median score (135 units) also placed this site in the 'very good' category for the generic health.

3.2.5.1.2 Predicted stream 'health'

The Katikara Stream at Carrington Road is within the National Park boundary at an altitude of 420 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI value of 132 for this site. The historical site median, spring and summers scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 131 units. Again, the historical, spring and summer scores were not significantly different to the REC value (Stark, 1998).

3.2.5.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 21). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 20 years of SEM results (1999-2019) and the most recent ten-years of results (2009-2019) from the site in the Katikara Stream at Carrington Road.



N = 39
Kendall tau = -0.258
p level = 0.02
FDR p = 0.04

N = 19
Kendall tau = -0.151
p level = 0.37
FDR p = 0.64

Figure 21 LOWESS trend plot of MCI data in the Katikara Stream at the Carrington Road site for the full dataset and a Mann-Kendall test for the full and ten-year dataset

A negative significant trend was found for the full dataset. Relatively stable MCI scores over the first four years of the period at this pristine site inside the National Park were followed by a very gradual rise. The subsequent downward trend has been due to significant headwater erosion effects during 2008, and subsequent limited recovery. The range of scores found across the trendline (8 units) over the period has been of marginal ecological importance with the range having widened appreciably since the erosion event. However, the trendline was indicative of 'very good' generic stream health throughout the period, bordering on 'excellent' in the 2006-2007 period.

There was a non-significant negative trend in MCI scores over the most recent ten-year period. The trendline was indicative of 'very good' health for the most recent ten-year period.

3.2.5.2 Coastal site (KTK000248)

3.2.5.2.1 Taxa richness and MCI

Thirty-five surveys have been undertaken in the Katikara Stream at this lower reach site near the coast between October 2000 and February 2018. The exact position of the site has been shifted slightly upstream from the summer 2016 survey onwards to avoid being flooded when the stream outlet blocks during low summer flows. The results of the thirty-seven surveys are summarised in Table 15, together with the results from the current period, and illustrated in Figure 22.

Table 15 Results of previous surveys performed in the Katikara Stream near the coast together with 2018-2019 results

Site code	SEM data (2000 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KTK000248	35	17-31	25	87-118	102	19	102	18	80

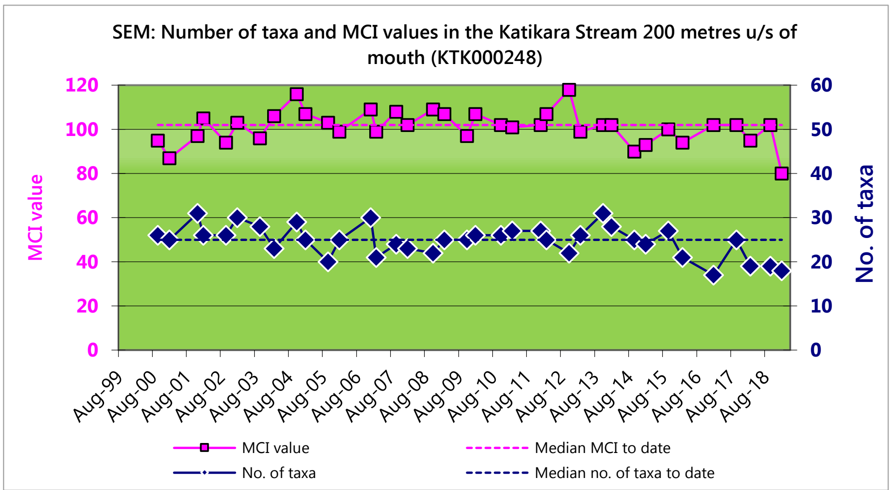


Figure 22 Numbers of taxa and MCI values in the Katikara Stream 200m u/s of the coast

A moderate range of richness (17 to 31 taxa) has been found with the headwater erosion events having a noticeable but less severe effect than that noted at the upstream site. The median richness of 25 taxa has been more representative of typical richness elsewhere in the lower reaches of ringplain streams and rivers. During the current period, spring taxa richness (18 units) and summer taxa richness (18 taxa) were seven taxa lower than the historical median indicating that headwater erosion was having a negative effect on taxa richness.

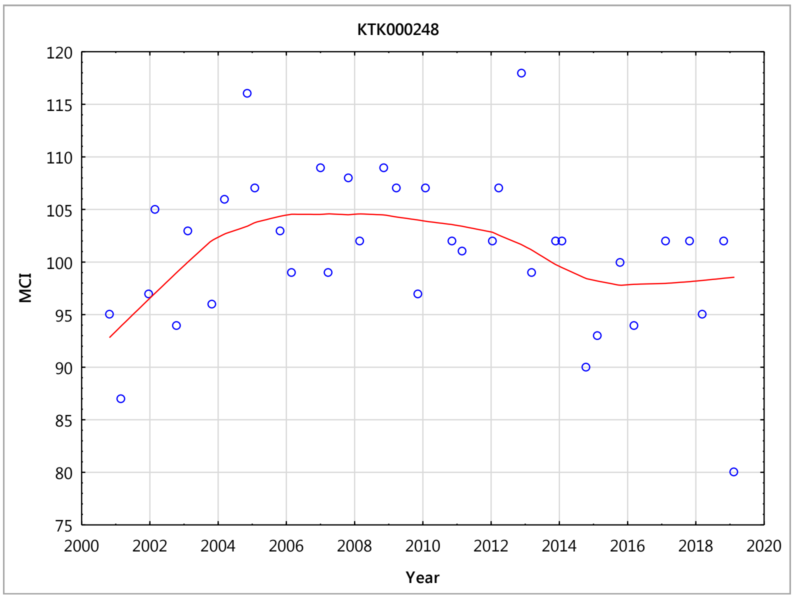
MCI values have had a wide range (38 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (102 units) has been higher than typical of lower reach sites elsewhere on the ringplain. The spring score (102 units) was not significantly different from the historical median but the summer score (80 units) was a significant 22 units lower and was the lowest score recorded to date at the site. The MCI scores in spring and summer respectively categorised this site as having ‘good’ and ‘fair’ health (Table 3). The historical median score (102 units) also placed this site in the ‘good’ category for generic health.

3.2.5.2.2 Predicted stream 'health'

The Katikara Stream at the site near the coast is 18.1 km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009); predict a MCI value of 99 for this site. The spring score and historical site median were not significantly different from the distance predictive value but the summer score was significantly lower than the predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 96 units. Again, the historical and spring scores were not significantly different to the REC value but the summer score was significantly lower (Stark, 1998).

3.2.5.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 23). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 19 years of SEM results (2000-2019) and the most recent ten-years of results (2009-2019) from the site in the Katikara Stream near the coast.



N = 37
Kendall tau = -0.099
p level = 0.39
FDR p = 0.48

N = 19
Kendall tau = -0.26
p level = 0.12
FDR p = 0.40

Figure 23 LOWESS trend plot of MCI data in the Katikara Stream at the coastal site for the full dataset and a Mann-Kendall test for the full and ten-year dataset

The trend over the 19-year period has not been significant (FDR p > 0.05). A relatively strong improvement in MCI scores has been recorded from 2000 to 2006 but then plateaued from 2006-2008 before decreasing from 2008 onwards coincident with the headwater erosion event also decreasing MCI scores and taxa richness at the upstream site. There had been a positive significant improvement at the site before the prolonged effects of the headwater erosion event had decreased MCI scores and the wide range of MCI scores (11 units) found throughout the trendline have been of ecological importance coincidentally with retirement and riparian planting of the margins of the lower reaches of this stream. The trendline range of scores indicative of 'fair' generic stream health have improved to 'good' health after 2003 where they remained until a return to 'fair' health most recently.

There was a non-significant negative trend in MCI scores over the most recent ten-year period. The trendline was indicative of 'good' health deteriorating to 'fair' health post 2013 for the most recent ten-year period.

3.2.5.3 Discussion

Historically, seasonal median scores have remained very similar at the National Park and coastal sites indicative of little change between spring and summer. However, the results from the current period showed a distinct decline between spring and summer, with the upper site having a non-significant difference but the lower site having a large, 22-unit decline. MCI scores fell significantly in a downstream direction over a stream distance of 18.1 km downstream from the National Park boundary. MCI scores for the upper site indicated 'very good' macroinvertebrate health while the lower site indicated 'good' to 'fair' health. The deterioration in macroinvertebrate health was likely due to impacts associated with agriculture as the mid to lower reaches of the stream are in an agriculture dominated catchment.

3.2.6 Kaupokonui River

The Kaupokonui River is a ringplain river with its source inside Egmont National Park that flows in a southerly direction. Five sites located along the length of the Kaupokonui River were included in the SEM programme, commencing in the 1999-2000 year for the purpose of long term monitoring of the impacts of riparian vegetation planting initiatives throughout this catchment. Two sites, at Opunake Road (KPK000250) and near the coast (KPK000990), were established specifically for this purpose, while the remaining three sites were components of existing consent monitoring programmes.

3.2.6.1 Opunake Road site (KPK000250)

3.2.6.1.1 Taxa richness and MCI

Thirty-nine surveys have been undertaken in the Kaupokonui River at this upper mid-reach site at Opunake Road (draining relatively open farmland approximately 3.3 km downstream of the National Park) between March 1998 and February 2018. These results are summarised in Table 16, together with the results from the current period, and illustrated in Figure 24.

Table 16 Results of previous surveys performed in the Kaupokonui River at Opunake Road, together with spring 2018 and summer 2019 results

Site code	SEM data (1998 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000250	39	20-36	27	124-139	130	20	135	27	127

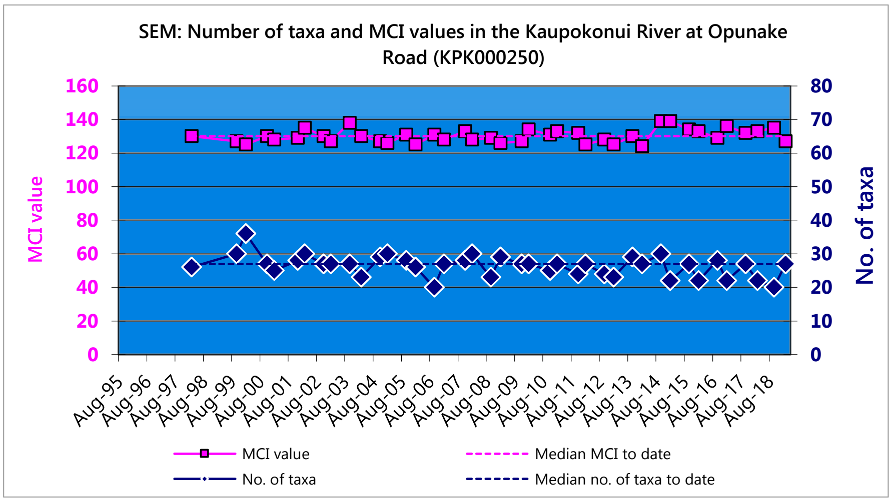


Figure 24 Numbers of taxa and MCI values in the Kaupokonui River at Opunake Road

A relatively wide range of richness (20 to 36 taxa) has been found; wider than might be expected, with a median richness of 27 taxa (more representative of typical richness in the upper mid-reaches of ringplain streams and rivers). During the current period spring (20 taxa) richness was lower than the historic median while the summer (27 taxa) richness was the same as the historical median.

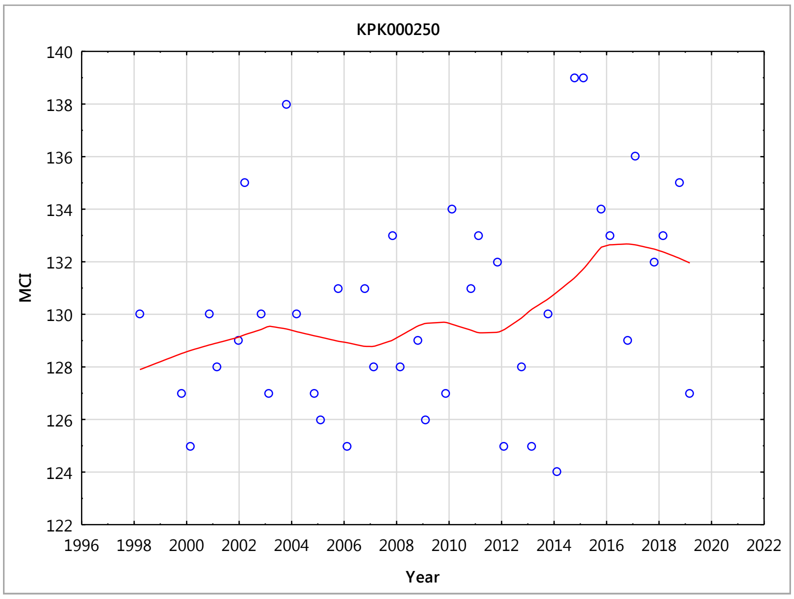
MCI values have had a narrow range (15 units) at this site, more typical of sites in the upper reaches of ringplain rivers. The median value (130 units) has been higher than typical of mid-reach sites elsewhere on the ringplain. The spring (135 units) and summer (127 units) scores were non-significantly different to each other and to the historical median. These scores categorised this site as having 'very good', (spring and summer) health generically (Table 3). The historical median score (130 units) placed this site in the 'very good' category for generic health.

3.2.6.1.2 Predicted stream 'health'

The Kaupokonui River site at Opunake Road is 3.3 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 118 for this site. The spring and historical site median were significantly higher (Stark, 1998) than the distance predictive value while the summer score was not significantly higher. The REC predicted MCI value (Leathwick, et al. 2009) was 137 units. The historical, spring and summer scores were not significantly different to the REC value (Stark, 1998).

3.2.6.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 25). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 21 years of SEM results (1998-2019) and the most recent ten-years of results (2009-2019) from the site in the Kaupokonui River at Opunake Road.



N = 41
Kendall tau = 0.19
p level = 0.08
FDR p = 0.14

N = 20
Kendall tau = 0.13
p level = 0.43
FDR p = 0.69

Figure 25 LOWESS trend plot of MCI data in the Kaupokonui River at the Opunake Road site for the full dataset and a Mann-Kendall test for the full and ten-year dataset

MCI scores have not been statistically significant at this site in the upper mid-reaches of the river over the 21-year monitoring period. The trendline was has been narrow and not ecologically important. The trendline was indicative of 'very good' generic river health.

There was a non-significant positive trend in MCI scores over the most recent ten-year period congruent with the full dataset. The trendline was indicative of 'very good' health for the most recent ten-year period.

3.2.6.2 Site upstream of the Kaponga oxidation ponds system (KPK000500)

3.2.6.2.1 Taxa richness and MCI

Forty-two surveys have been undertaken in the Kaupokonui River at this mid-reach site at the site upstream of the Kaponga oxidation ponds system between February 1996 and February 2018. These results are summarised in Table 17, together with the results from the current period, and illustrated in Figure 26.

Table 17 Results of previous surveys performed in the Kaupokonui River at the site upstream of the Kaponga oxidation ponds system together with 2018-2019 results

Site code	SEM data (1996 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000500	42	20-33	26	98-133	117	21	138	23	104

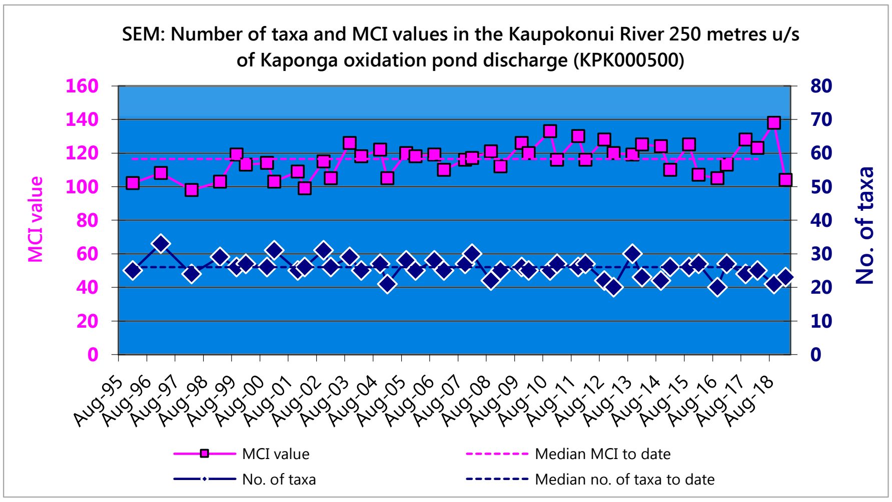


Figure 26 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kaponga oxidation pond system

A moderate range of richness (20 to 33 taxa) has been found with a median richness of 26 taxa, typical of richness in the mid reaches of ringplain streams and rivers. During the current period, spring (21 taxa) and summer (23 taxa) richness were very similar to each other and slightly lower than the historical median.

MCI values have had a relatively wide range (35 units) at this site, slightly wider than typical of sites in the mid-reaches of ringplain rivers. The historic median value (117 units) has been very slightly higher than typical of mid-reach sites elsewhere on the ringplain. The spring score (138 units) was significantly higher than the median value and the highest score recorded to date at the site but the summer score (104 units) was significantly lower than both the median and summer score (Stark, 1998). The MCI scores categorised this site as having 'very good' spring health in spring and 'good' health in summer (Table 3). The historical median score (117 units) placed this site in the 'good' category for generic health.

3.2.6.2.2 Predicted stream 'health'

The Kaupokonui River site upstream of the Kaponga oxidation pond system is 9.2 km downstream of the National Park boundary at an altitude of 260 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 107 for this site. The historical site median (117) is nine units higher than the distance predictive value. The spring score was significantly higher than this value, while the summer score was significantly lower and the historic median was not significantly higher than the predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 127 units. The spring score was significantly higher than this value, while the summer score was significantly lower and the historic median was not significantly lower than the predictive value (Stark, 1998).

3.2.6.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 27). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1996-2019) and the most recent ten-years of results (2009-2019) from the site in the Kaupokonui River upstream of the Kaponga oxidation ponds system.

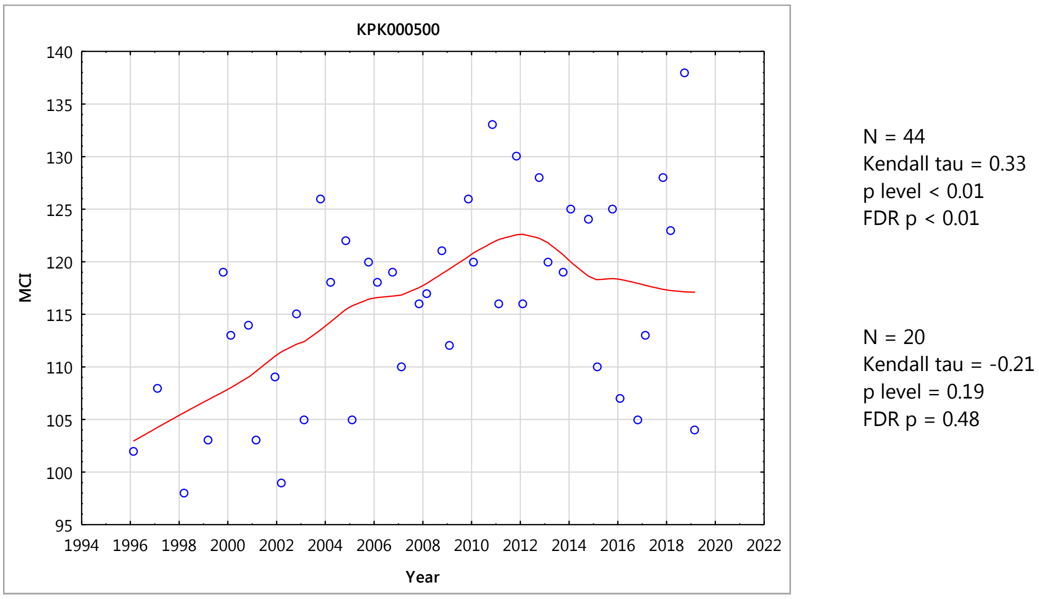


Figure 27 LOWESS trend plot of MCI data at the site in the Kaupokonui River upstream of the Kaponga oxidation ponds system for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A highly significant positive trend in MCI scores has been found over the entire period. Improvements may have been related partly to improved dairyshed wastes disposal consents' compliance reported in this catchment. Trendline scores consistently indicated 'good' generic river health with a brief period of 'very good' health from 2010-2014.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, in contrast to the full dataset, due to a decline in MCI scores for the most recent surveys. The trendline for the most recent ten-year period was mostly indicative of 'good' health with a brief period of 'very good' health from 2010-2014.

3.2.6.3 Site upstream of Kapuni railbridge (KPK000660)

3.2.6.3.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Kaupokonui River at this mid-reach site upstream of the Kapuni railbridge between December 1995 and March 2018. These results are summarised in Table 18, together with the results from the current period, and illustrated in Figure 28.

Table 18 Results of previous surveys performed in the Kaupokonui River upstream of Kapuni railbridge, together with 2018-2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000660	46	15-32	24	71-128	103	19	118	26	110

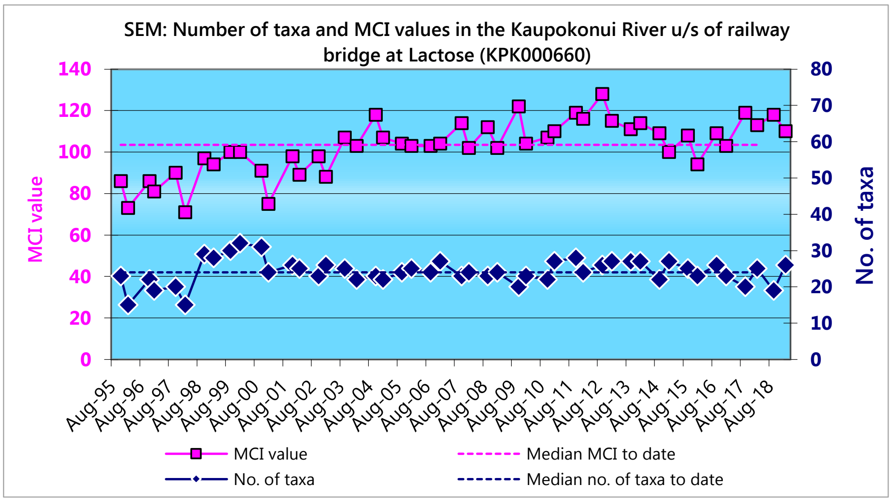


Figure 28 Numbers of taxa and MCI values in the Kaupokonui River upstream of Kapuni railbridge

A wide range of richness (15 to 32 taxa) has been found with a median richness of 24 taxa (more representative of typical richness in the mid reaches of ringplain streams and rivers). During the current period spring (19 taxa) and summer (26 taxa) richness were relatively similar to each other and the historical median.

MCI values have had a very wide range (57 units) at this site, much wider than typical of sites elsewhere in the mid reaches of ringplain rivers. However, the median value (103 units) has been relatively typical of mid reach sites elsewhere on the ringplain. The spring (118 units) and summer (110 units) scores were not significantly different from each other, and only the spring score was significantly different to the historical median (Stark, 1998).

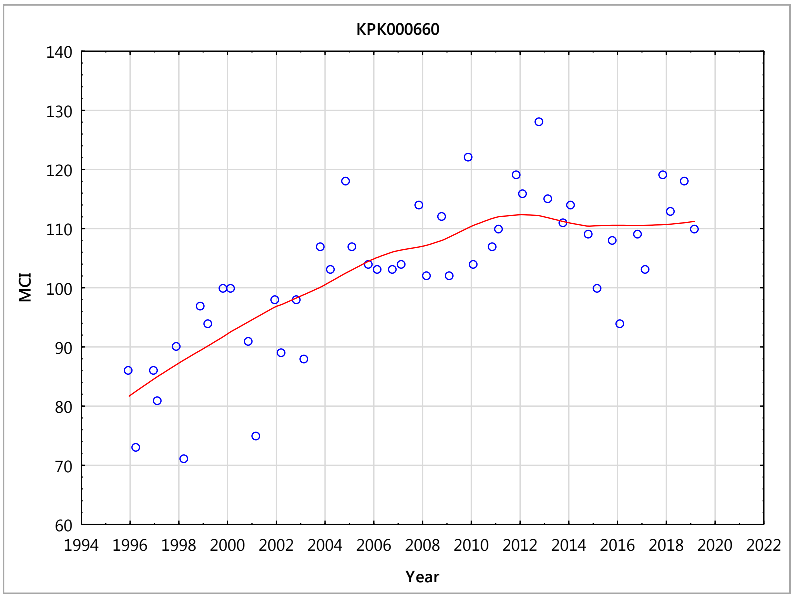
These scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (103 units) placed this site in the 'good' category for generic health.

3.2.6.3.2 Predicted stream 'health'

The Kaupokonui River site upstream of the Kapuni railbridge is 15.5 km downstream of the National Park boundary at an altitude of 170 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 101 for this site. The spring score was significantly higher than the predictive value while the summer score and historic median were not significantly different. The REC predicted MCI value (Leathwick, et al. 2009) was 122 units. The spring score was not significantly different to this value but the summer score and historic median were significantly lower than the REC value (Stark, 1998).

3.2.6.3.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 29). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Kaupokonui River upstream of the Kapuni railbridge.



N = 48
Kendall tau = 0.54
p level < 0.01
FDR p < 0.01

N = 20
Kendall tau = -0.12
p level = 0.45
FDR p = 0.70

Figure 29 LOWESS trend plot of MCI data in the Kaupokonui River at the site upstream of Kapuni railbridge for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A highly significant improvement in MCI scores has been found over the entire period at this mid-catchment site (FDR p < 0.01). This trendline has a wide range (31 units) which has been ecologically important. Fonterra factory wastewater irrigation activities nearby in this catchment have been better managed during this period and surveillance monitoring has reported improved dairy shed waste treatment ponds systems compliance upstream of this site. The trend in generic river health has moved from 'fair' to 'good' where it has remained since 2003.

There was a non-significant negative trend in MCI scores over the most recent ten-year period in contrast to the full dataset due to a decline in MCI scores for the most recent surveys. The trendline for the most recent ten-year period was mostly indicative of 'good' health. Since 2012, the MCI scores have largely plateaued and were in the 'good' category.

3.2.6.4 Upper Glenn Road site (KPK000880)

3.2.6.4.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Kaupokonui River at this lower reach site at Upper Glenn Road between 1995 and March 2018. These results are summarised in Table 19, together with the results from the current period, and illustrated in Figure 30.

Table 19 Results of previous surveys performed in the Kaupokonui River at Upper Glenn Road, together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000880	46	14-31	19	66-110	91	17	92	16	81

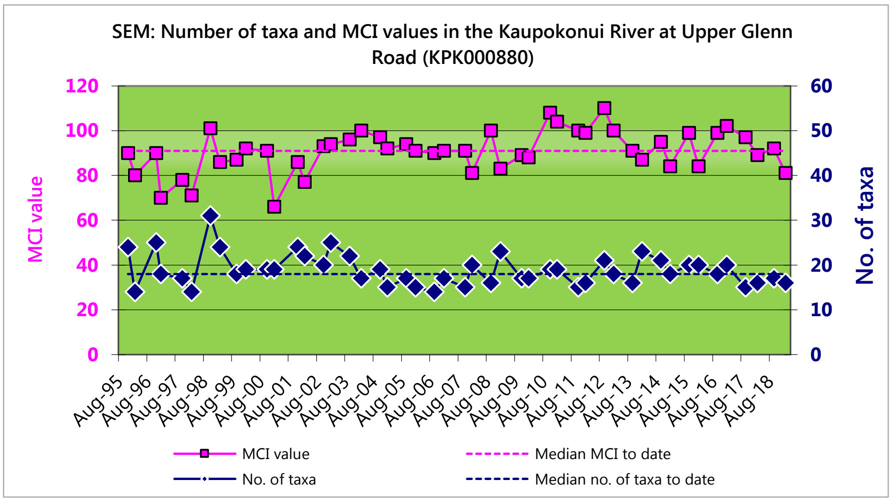


Figure 30 Numbers of taxa and MCI values in Kaupokonui River at Upper Glenn Road

A wide range of richness (14 to 31 taxa) has been found with a median richness of 19 taxa (typical of richness in the lower reaches of ringplain streams and rivers). During the current period spring (17 taxa) and summer (16 taxa) richness were similar to each other and to the historical median taxa number.

MCI values have had a very wide range (44 units) at this site, more typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been slightly lower than typical of scores at lower reach sites elsewhere on the ringplain. The spring (92 units) and summer (81 units) scores were not significantly different from the historical median score. These scores categorised this site has having 'fair' health in both spring and summer (Table 3). The historical median score (91 units) also placed this site in the 'fair' category for generic health.

3.2.6.4.2 Predicted stream 'health'

The Kaupokonui River site at Upper Glenn Road is 25.7 km downstream of the National Park boundary at an altitude of 60 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 95 for this site. The spring, summer and historic median were not significantly different to the predictive distance value. The REC predicted MCI value (Leathwick, et al. 2009) was 106 units. The spring, summer and historic medians scores were all significantly lower than the REC value (Stark, 1998).

3.2.6.4.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 31). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 24 years of SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Kaupokonui River at Upper Glenn Road.

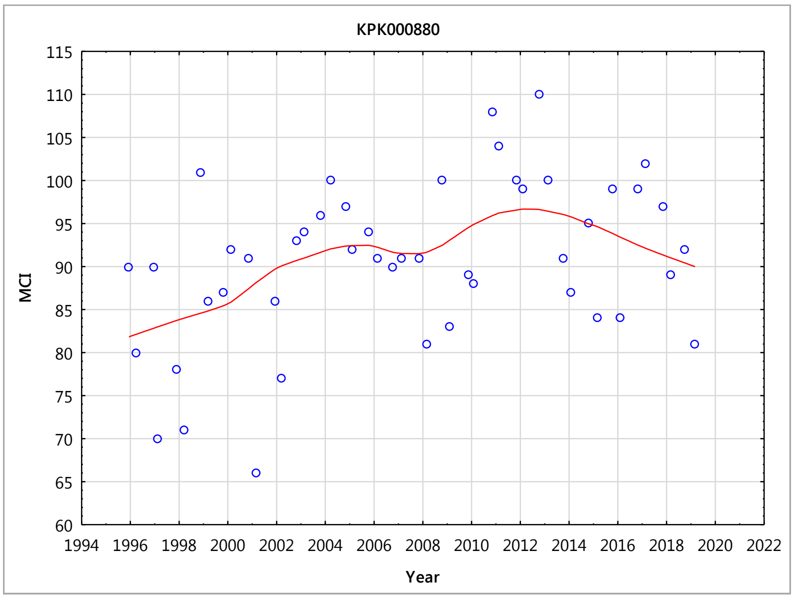


Figure 31 LOWESS trend plot of MCI data in the Kaupokonui River at the Upper Glenn Road site for the full dataset with a Mann-Kendall test for the full and ten-year dataset

A non-significant improvement in MCI scores was found at this site (FDR p = 0.05) after applying FDR. There has mostly been an increasing trend up until 2012, with a decreasing trend found since. The trendline range of MCI scores (15 units) has been ecologically important but nowhere near as wide as that upstream. The overall positive trend was due to improved wastes management further upstream in the catchment but more particularly in relation to a reduction in heat input (via cooling water) to the river at the Fonterra, Kapuni factory. The trendline MCI scores have consistently indicated 'fair' generic river health throughout the period.

There was a non-significant negative trend in MCI scores over the most recent ten-year period in contrast to the full dataset, due to a decline in MCI scores since 2012. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.6.5 Kaupokonui Beach site (KPK000990)

3.2.6.5.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in the Kaupokonui River at this lower reach site at Kaupokonui Beach between 1999 and February 2018. These results are summarised in Table 20, together with the results from the current period, and illustrated in Figure 32.

Table 20 Results of previous surveys performed in the Kaupokonui River at the Kaupokonui Beach site, together with 2018-2019 results

Site code	SEM data (1999 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KPK000990	38	11-26	19	69-103	91	20	93	15	80

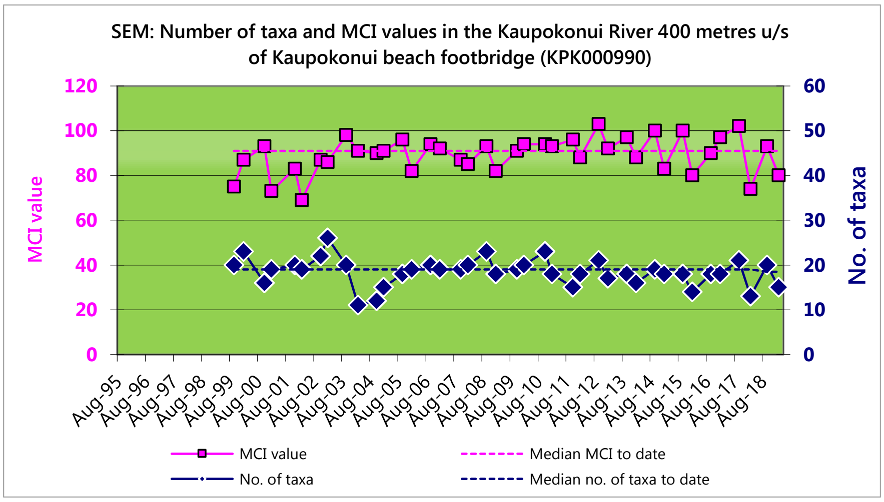


Figure 32 Numbers of taxa and MCI values in the Kaupokonui River at the Kaupokonui Beach site

A wide range of richness (11 to 26 taxa) has been found, with a median richness of 19 taxa. During the current period spring (20 taxa) and summer (15 taxa) richness were different from each other by five taxa but differed only slightly from the historical median richness.

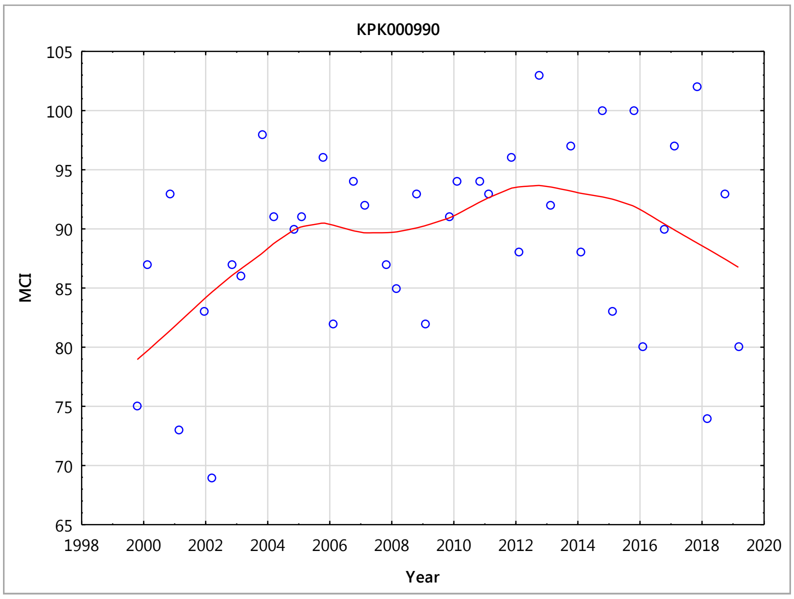
MCI values have had a moderate range (34 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been typical of scores at lower reach sites elsewhere on the ringplain. The spring (93 units) and summer (80 units) scores varied widely and were significantly different from each other with the summer score also significantly lower than the historical median. The MCI scores categorised this site as having 'fair' health for both spring and summer (Table 3). The historical median score (91 units) placed this site in the 'fair' category for generic health.

3.2.6.5.2 Predicted stream 'health'

The Kaupokonui River at the Kaupokonui Beach site is 31.1 km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams and rivers developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 93 for this site. The spring and historic median scores were not significantly different to the distance value, while the summer score was significantly lower than the distance value. The REC predicted MCI value (Leathwick, et al. 2009) was 96 units. Again, the spring and historic median scores were not significantly different to the REC predicted MCI value), while the summer score was significantly lower than the REC value (Stark, 1998).

3.2.6.5.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 33). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 20 years of SEM results (1999-2019) and the most recent ten-years of results (2009-2019) from the site in the Kaupokonui River at Kaupokonui Beach.



N = 40
Kendall tau = 0.21
p level = 0.05
FDR p = 0.09

N = 20
Kendall tau = -0.13
p level = 0.43
FDR p = 0.69

Figure 33 LOWESS trend plot of MCI data in the Kaupokonui River at the Kaupokonui Beach site for the full dataset with Mann-Kendall test for the full and ten-year dataset

There was a positive improvement over the 19 year time period ($p = 0.05$) which was very close to being statistically significant (e.g. $p < 0.05$) after FDR application. The trendline has largely increased since 1999 to 2012 apart from a small dip from 2005-2008, but since 2012 has started to decline. The trendline had an ecologically important range of scores (14 units), although much narrower than ranges at the two nearest upstream sites, possibly reflecting certain upstream improvements in waste disposal management (documented earlier) which have had reduced impacts with greater distance downstream. The trendline range has been indicative of 'fair' generic river health throughout the period.

There was a non-significant minor negative trend in MCI scores over the most recent ten-year period. Since 2012, the trend has started to decline. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.6.6 Discussion

MCI scores deteriorated in a downstream direction for the current monitoring period with the upper site recording 'very good' health while the bottom site recording 'fair' health. MCI scores typically fall in a downstream direction between the upper site and the furthest downstream site by 44 units over a river distance of 27.8 km. MCI scores were typical for all the sites when seasonal variation was taken into account except the Kaponga oxidation ponds system site in spring, which had a significantly higher result, even with seasonal variation taken into account. The general deterioration in macroinvertebrate health was likely due to cumulative inputs from point and diffuse sources in a catchment dominated by agriculture but which also has some industrial and urban influence.

Time trend analysis showed the majority of sites had significant positive trends over the full dataset indicating that macroinvertebrate communities have been getting healthier over time. However, there were no significant trends over the most recent ten-year period. All sites, except the most upstream site, showed a decreasing trendline from 2012 onwards indicating that improvements in macroinvertebrate communities have plateaued.

3.2.7 Kurapete Stream

The Kurapete Stream is a ringplain seepage-sourced stream running in an easterly direction that flows into the Manganui River, which is itself a tributary of the Waitara River. Two sites, one located immediately upstream of the Inglewood Wastewater Treatment Plant (WWTP) and the other nearly six km downstream, were included in the SEM programme for the purposes of long term monitoring of the impacts of the removal of the treated wastewater discharge from the stream and also, riparian vegetation planting initiatives in the catchment.

3.2.7.1 Site upstream of Inglewood WWTP (KRP000300)

3.2.7.1.1 Taxa richness and MCI

Forty-five surveys have been undertaken, between 1995 and March 2018, at this mid-reach, shaded site, draining developed farmland, downstream of Inglewood, but immediately upstream of the WWTP. These results are summarised in Table 21, together with the results from the current period, and illustrated in Figure 34.

Table 21 Results of previous surveys performed in the Kurapete Stream upstream of Inglewood WWTP, together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KRP000300	45	12-32	22	80-107	95	23	98	12	98

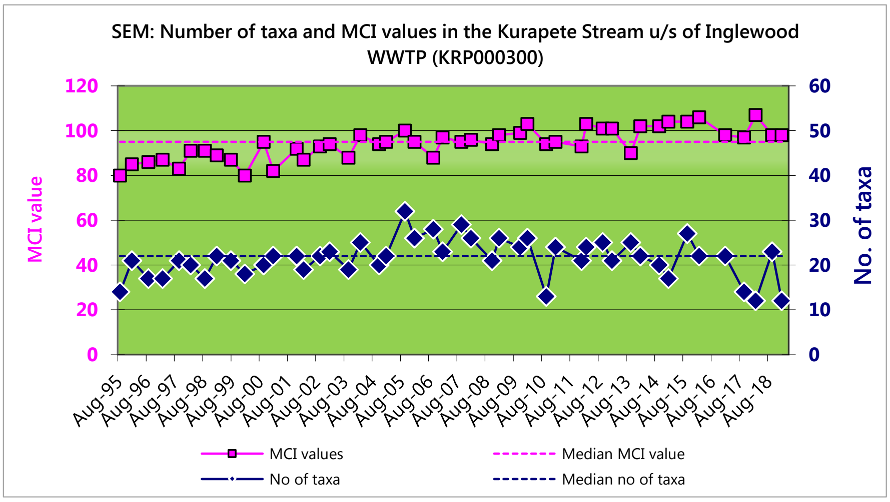


Figure 34 Numbers of taxa and MCI values in the Kurapete Stream upstream of the Inglewood WWTP

A relatively wide range of richness (13 to 32 taxa) has been found with a moderate median richness of 22 taxa, relatively typical of richness in the mid reaches of ringplain streams rising outside the National Park boundary. During the current period spring richness (23 taxa) was very similar to the historic median but the summer richness (12 taxa) was substantially lower than both the historic median and spring richness and was the lowest richness recorded to date for the site.

MCI values have had a moderate range (27 units) at this site, typical of mid-reach sites in seepage streams on the ringplain. The spring and summer scores (98 units) were not significantly different to the historical median (Stark, 1998). The scores categorised this ringplain stream site as having 'fair' health (Table 3). The historical median score (95 units) placed this site in the 'fair' category for generic health.

3.2.7.1.2 Predicted stream 'health'

The Kurapete Stream rises below the National Park boundary and the site upstream of the Inglewood WWTP is in the mid-reaches at an altitude of 180 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The spring, summer and historical median scores were not significantly different to the REC value (Stark, 1998).

3.2.7.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 35). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 24 years of SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Kurapete Stream upstream of the Inglewood WWTP.

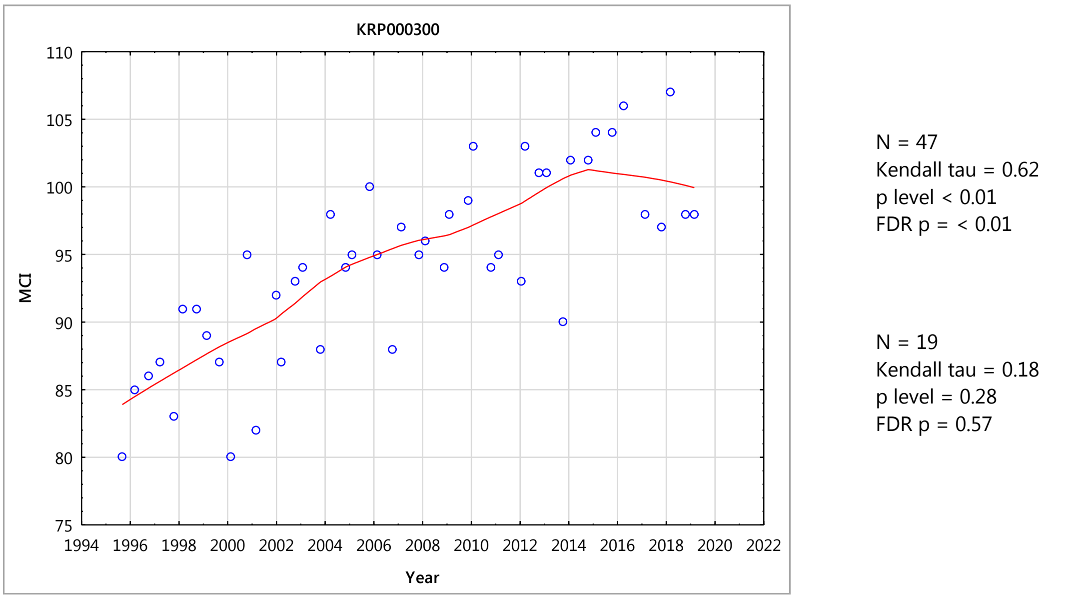


Figure 35 LOWESS trend plot of MCI data in the Kurapete Stream at the site upstream of the Inglewood WWTP for the full dataset with Mann-Kenndall tests for the full and ten-year dataset

The very strong positive temporal trend in MCI scores has been highly significant at this site (FDR $p < 0.01$) immediately upstream of the Inglewood WWTP discharge but below the tributary inflow draining the old Inglewood landfill. This improvement has followed the diversion of the iron-oxide laden drainage out of the stream and into the WWTP system, which markedly reduced sediment deposition on the streambed. The strong earlier trend tended to ease between 2004 and 2009 with a subsequent increase in improvement more recently. The overall range of MCI scores across the trendline (18 units) has been ecologically important. The trendline range of MCI scores have been indicative of 'fair' generic stream health throughout the period until recently where it is now of 'good' health.

There was a non-significant positive trend in MCI scores over the most recent ten-year period. The trendline for the most recent ten-year period was indicative of 'fair' health changing to 'good' health since 2013.

3.2.7.2 Site approximately 6km downstream of the Inglewood WWTP outfall (KRP000660)

3.2.7.2.1 Taxa richness and MCI

Forty-five surveys have been undertaken at this lower reach site in the Kurapete Stream 6 km downstream of the Inglewood WWTP outfall (KRP000660) between 1995 and March 2018. These results are summarised in Table 22, together with the results from the current period, and illustrated in Figure 36.

Table 22 Results of previous surveys performed in the Kurapete Stream at the site 6 km downstream of the Inglewood WWTP outfall together with the 2018-1019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
KRP000660	45	18-30	25	74-112	94	24	98	23	93

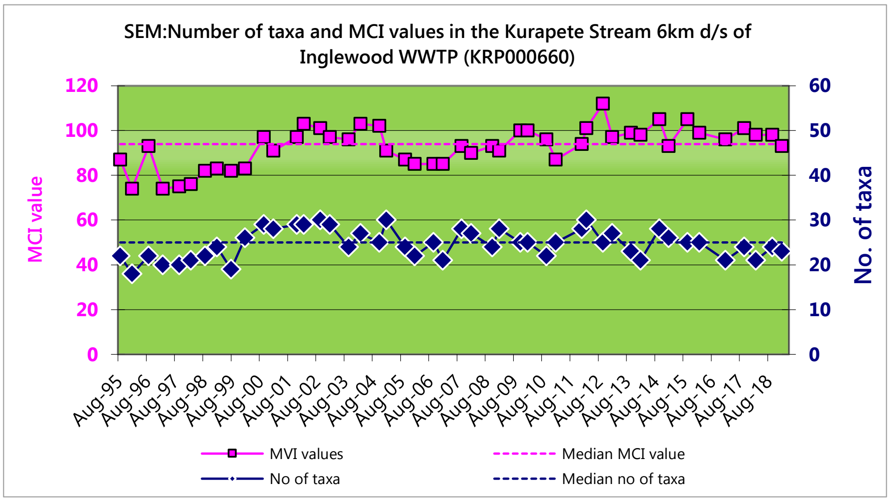


Figure 36 Numbers of taxa and MCI values in the Kurapete Stream, 6 km downstream of the Inglewood WWTP outfall

A moderate range of richness (18 to 30 taxa) has been found, with a median richness of 25 taxa (slightly higher than typical of richness for the lower mid-reaches of ringplain streams rising outside the National Park boundary. During the current period spring (24 taxa) and summer (23 taxa) richness were slightly lower than the historical median.

MCI values have had a wide range (42 units) at this site. The median value (94 units) has been typical of lower mid-reach sites in similar seepage-fed streams elsewhere on the ringplain. The spring (98 units) and summer (93 units) score was not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'fair' health for spring and summer (Table 3). The historical median score (94 units) placed this site in the 'fair' category for generic health.

3.2.7.2.2 Predicted stream 'health'

The Kurapete Stream rises below the National Park boundary and the site 6 km downstream of the Inglewood WWTP outfall is in the lower mid-reaches at an altitude of 120 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 102 units. The spring, summer and historical median scores were not significantly different from this value (Stark, 1998).

3.2.7.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 37). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 24 years of SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Kurapete Stream at the site six km downstream of the Inglewood WWTP outfall.

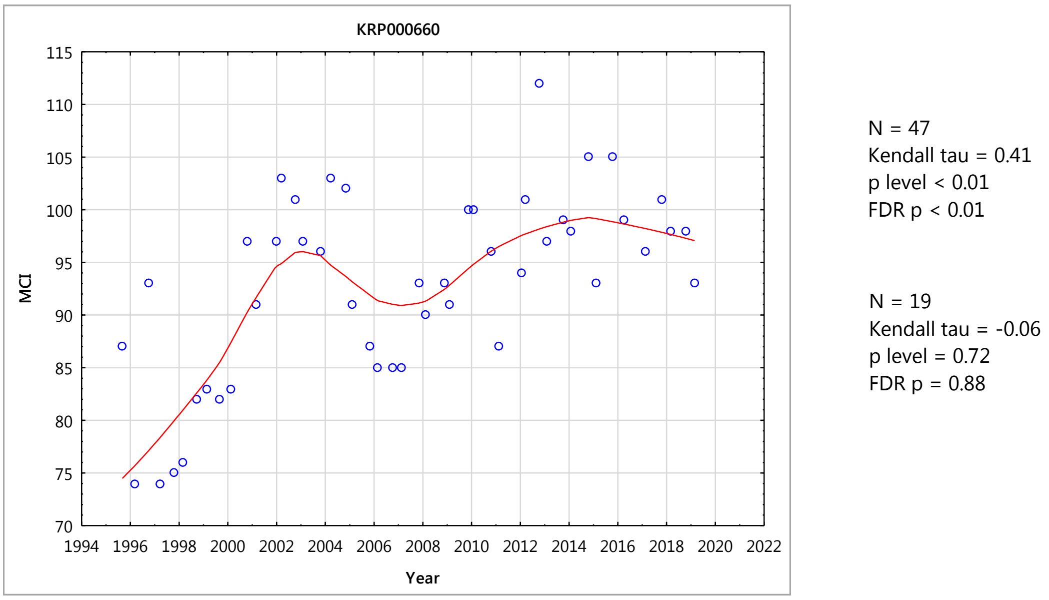


Figure 37 LOWESS trend plot of MCI data in the Kurapete Stream for the site 6 km downstream of the Inglewood WWTP outfall for the full dataset with Mann-Kendall test for the full and ten-year dataset

There has been a highly significant positive trend of MCI score improvement (FDR p < 0.01). There was a noticeably increase in the steepness of the trend after 2000 (following diversion of all Inglewood WWTP wastes out of the stream (to the New Plymouth WWTP) which was emphasised by an ecologically important increase in score of 24 units. A decreasing trend in scores has been followed by a steady recovery since 2007 coincident with relatively few consented municipal wastes short-duration discharge overflows to the stream during recent years. Overall, the trendline scores indicated improving stream health from 'poor' to 'fair' indicative of the positive effects of diversion of the Inglewood WWTP discharge out of the stream.

There was a non-significant minor negative trend in MCI scores over the most recent ten-year period even though there was a relatively large increase in the trendline from 2009 to 2014. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.7.3 Discussion

MCI scores indicated that both sites had 'fair' macroinvertebrate health with little difference between the two sites. MCI scores were typical for the two sites with little difference from historical medians. Taxa richness was low for the upper site during spring but not for the lower site. Three of the last four surveys have had relatively low taxa richness at the upper site. No obvious reason for the lower than normal taxa richness was evident at the time of sampling or for the previous monitoring year.

The time trend analysis showed the sites had significant positive trends over the full datasets indicating that macroinvertebrate communities have been getting healthier over time but that improvements have largely plateaued with little change over the most recent 10-year period.

3.2.8 Maketawa Stream

The Maketawa Stream is a ringplain stream with a source inside Egmont National Park that flows in an easterly direction into the Manganui River. Two sites, originally surveyed as components of the Maketawa catchment baseline investigation (Stark, 2003), were included in the 2002-03 SEM programme in recognition of the fisheries significance of this sub-catchment of the Manganui River catchment.

3.2.8.1 Derby Road site (MKW000200)

3.2.8.1.1 Taxa richness and MCI

Thirty-six surveys have been undertaken at this upper reach site in the Maketawa Stream between March 1998 and March 2018. These results are summarised in Table 23 together with the results from the current period, and illustrated in Figure 38.

Table 23 Results of previous surveys performed in the Maketawa Stream at Derby Road together with 2018-2019 results

Site code	SEM data (1998 to Mar 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MKW000200	36	8-33	23	100-142	129	25	133	30	126

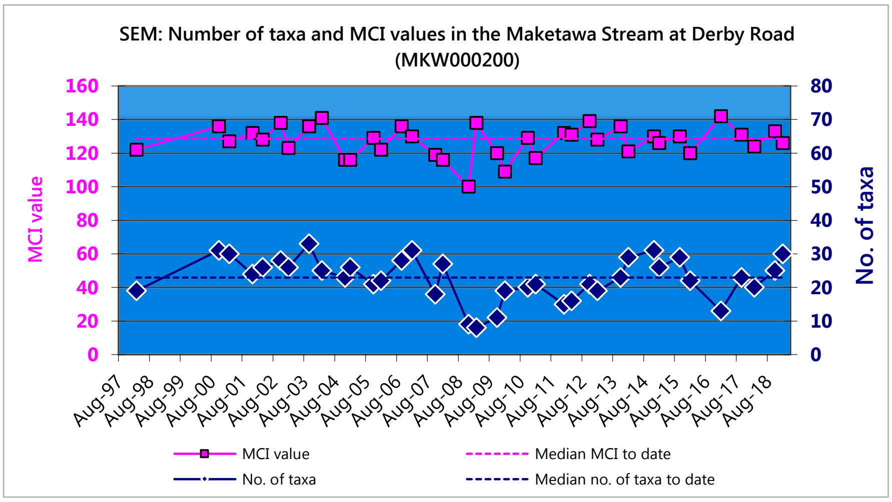


Figure 38 Number of taxa and MCI values in the Maketawa Stream at Derby Road

A very wide range of richness (8 to 33 taxa) has been found as a result of marked reductions in richness due to the impacts of previous headwater erosion events, with a median richness of 23 taxa (slightly lower than typical richness found in the upper reaches of ringplain streams and rivers). During the current period, spring (25 taxa) and summer (30 taxa) richness were slightly higher than the previously recorded median.

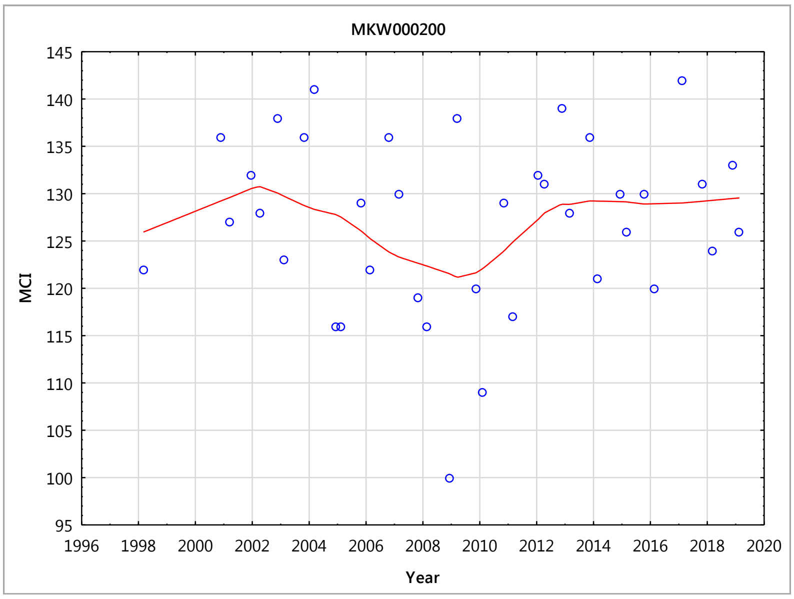
MCI values have had a very wide range (42 units) at this site, atypical of a site in the upper reaches of a ringplain stream mainly due to headwater erosion effects referenced above. The median value (129 units) however, has been more typical of upper reach sites elsewhere on the ringplain. The spring (133 units) and summer (126 units) scores were not significantly different (Stark, 1998) to the historical median. The scores categorised this site as having ‘very good’ generic health (Table 3) in spring and summer. The historical median score (129 units) placed this site in the ‘very good’ category for generic health.

3.2.8.1.2 Predicted stream 'health'

The Maketawa Stream site at Derby Road is 2.3 km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 121 for this site. The spring score was significantly higher than the distance predictive value while the summer score and historic median were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 130 units. The historical site median, spring and summer scores were not significantly different to this value.

3.2.8.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 39). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all SEM results (1998-2019) and the most recent ten-years of results (2009-2019) from the site in the Maketawa Stream at Derby Road.



N = 38
Kendall tau = 0.02
p level = 0.83
FDR p = 0.88

N = 19
Kendall tau = 0.17
p level = 0.30
FDR p = 0.57

Figure 39 LOWESS trend plot of MCI data at the Derby Road site, Maketawa Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

No significant trend in MCI scores has been found over the entire monitoring period at this relatively pristine site. Scores decreased following the headwater erosion events, prior to recovery over the more recent five-year period. The variability in the trendline (range 9 units) represented minor ecological importance during the period accentuated by the impact of headwater erosion events during 2008. Overall, the trendline remained indicative of 'very good' generic stream health for the majority of the period, dropping toward 'good' health briefly between 2008 and 2010.

There was a non-significant positive trend in MCI scores over the most recent ten-year period, congruent with the full dataset, even though there was a relatively large increase in the trendline from 2010 to 2013. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.8.2 Tarata Road site (MKW000300)

3.2.8.2.1 Taxa richness and MCI

Thirty-five surveys have been undertaken at this mid-reach site at Tarata Road in the Maketawa Stream between March 2000 and March 2018. These results are summarised in Table 24, together with the results from the current period, and illustrated in Figure 40.

Table 24 Results of previous surveys performed in the Maketawa Stream at Tarata Road together with 2018-2019 results

Site code	SEM data (2000 to Mar 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 18		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MKW000300	35	12-31	22	90-127	108	18	109	23	105

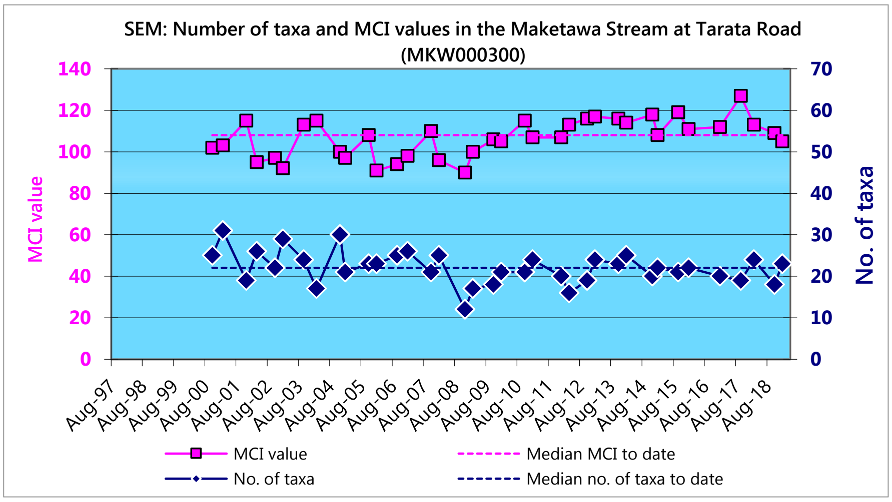


Figure 40 Number of taxa and MCI values in the Maketawa Stream at Tarata Road

A wide range of richness (12 to 31 taxa) has been found; wider than might be expected, with a median richness of 22 taxa which is more representative of typical richness in the mid-reaches of ringplain streams and rivers. During the current period, spring (18 taxa) and summer (23 taxa) richness was similar to the median taxa number. MCI scores have had a relatively wide range (37 units) at this site, more typical of sites in the mid to lower reaches of ringplain streams. The median value (108 units) has been relatively typical of mid-reach sites elsewhere on the ringplain. The spring (109 units) and summer (105 units) score was within the range typical for the site and not significantly different to the historical median (Stark, 1998). The scores categorized this site as having ‘good’ spring and summer health (Table 3). The historical median score (108 units) also placed this site in the ‘good’ category for generic health.

3.2.8.2.2 Predicted stream ‘health’

The Maketawa Stream site at Tarata Road is 15.5 km downstream of the National Park boundary at an altitude of 150 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 101 for this site. The historical site median, spring and summer scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 111 units. Again, the historical site median, spring and summer scores were not significantly different to the REC predictive value.

3.2.8.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 41). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (2000-2019) and the most recent ten-years of results (2009-2019) from the site in the Maketawa Stream at Tarata Road.

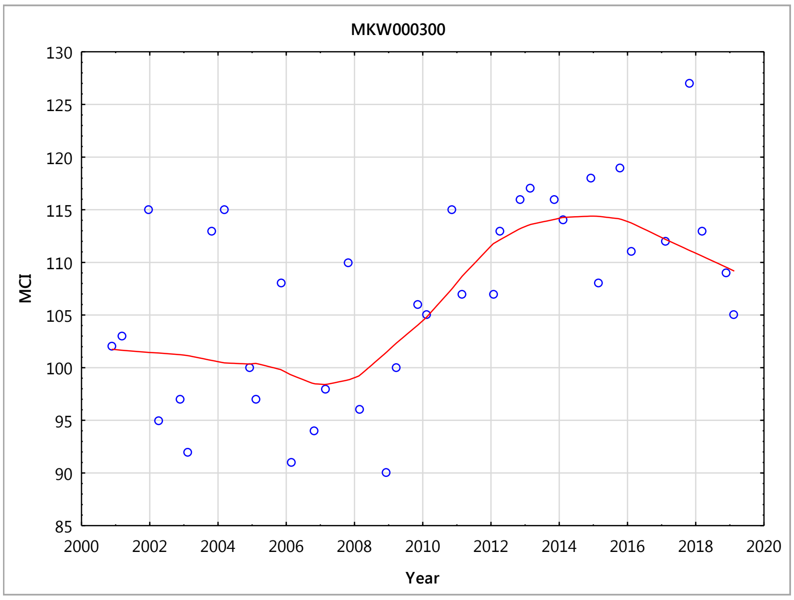


Figure 41 LOWESS trend plot of MCI data at the Tarata Road site for the full dataset with Mann-Kendall test for the full and ten-year dataset

The positive trend in MCI scores found over the entire monitoring period has been highly statistically significant (FDR $p < 0.01$). Ecological variability, which have ranged over 16 units, has been important ecologically with scores indicative of 'good' generic stream health (Table 3) trending downward to 'fair' stream health, between 2006 and 2008 before returning to 'good' health where it currently remains.

There was a positive, but non-significant trend in MCI scores over the most recent ten-year period, even though there was a relatively large increase in the trendline from 2009 to 2014. The trendline for the most recent ten-year period was indicative of 'good' health.

3.2.8.3 Discussion

Both sites had typical, moderate, taxa richness. MCI scores at the upper Maketawa Stream site indicated that the macroinvertebrate community was in 'very good' health. The lower Maketawa Stream site MCI scores indicated 'good' macroinvertebrate health. There was a significant decrease in MCI scores in a downstream direction for both spring and summer which was typical for the site. The general deterioration in macroinvertebrate health was likely due to cumulative inputs from point and diffuse sources in a catchment dominated by agriculture but which also has some industrial and urban influence.

The time trend analysis showed the upper site had no significant trends which would be expected from a site with few impacts that has not changed significantly over time. The lower site had a significant positive trend over the full dataset indicating that macroinvertebrate communities have been getting healthier over time. Long-term improvements in macroinvertebrate health at the site were likely in relation to higher levels of fencing and riparian planting in the catchment in combination with a reduction in point source inputs from farm oxidation ponds with effluent now being discharged to land. However, there were no significant trends over the most recent ten-year period suggesting little recent improvement.

3.2.9 Mangaehu River

The Mangaehu River is a large eastern hill country river and is a major tributary of the Patea River. There is one SEM site located on the Mangaehu River not far from its confluence with the Patea River.

3.2.9.1 Raupuha Road site (MGH000950)

3.2.9.1.1 Taxa richness and MCI

Forty-six surveys have been undertaken at this lower reach site in the Mangaehu River between October 1995 and February 2018. These results are summarised in Table 25, together with the results from the current period, and illustrated in Figure 42.

Table 25 Results of previous surveys performed in the Mangaehu River at Raupuha Road, together with 2018-2019 results

Site code	SEM data (1995 to Feb 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGH000950	46	12-26	20	77-104	92	17	99	20	96

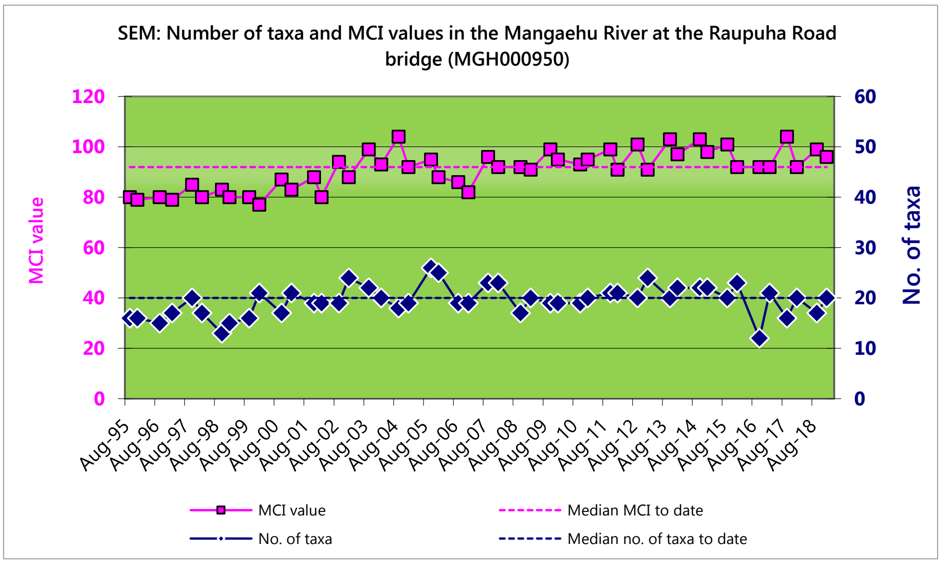


Figure 42 Numbers of taxa and MCI values in the Mangaehu River at Raupuha Road

A relatively wide range of richness (12 to 26 taxa) has been found with a moderate median richness similar to richness in the lower reaches of hill country rivers, although generally at lower altitudes. During the current period, spring (17 taxa) summer (20 taxa) taxa richness were similar to the historical median.

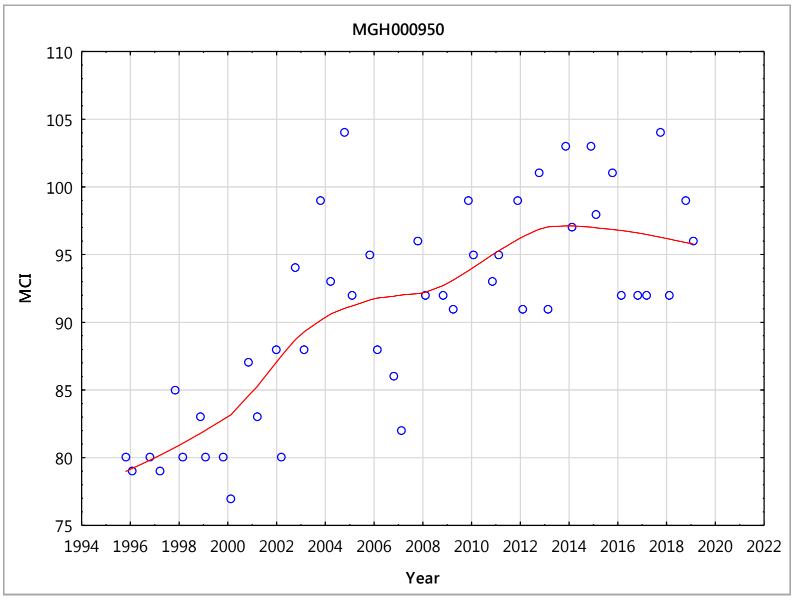
MCI values have had a relatively wide range (27 units) at this site typical of a site in the lower reaches of streams and rivers. The median value (92 units) has been typical of lower reach sites. The spring (99 units) and summer (96 units) scores were not significantly different to the historical median. These scores categorised this site as having ‘fair’ health in both spring and summer (Table 3). The historical median score (92 units) placed this site in the ‘fair’ category for the generic method of assessment.

3.2.9.1.2 Predicted stream 'health'

The Mangaehu River site at Raupuha Road, at an altitude of 120 m asl, is in the lower reaches of a river draining an eastern hill country catchment. The REC predicted MCI value (Leathwick, et al. 2009) was 117 units. The historical median, spring and summer scores were all significantly lower than this value.

3.2.9.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 43). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Mangaehu River at Raupuha Road.



N = 48
Kendall tau = 0.54
p value < 0.01
FDR p < 0.01

N = 20
Kendall tau = 0.03
p value = 0.87
FDR p = 0.95

Figure 43 LOWESS trend plot of MCI data for the Raupuha Road site, Mangaehu River for the full dataset with Mann-Kendall test for the full and ten-year dataset

A significant positive temporal trend in MCI scores (p < 0.01 after FDR) was found at this lower reach, hill country river site. The wide range of trendline scores (19 units) has also been ecologically important, particularly over the period since 2000. The trendline was originally bordering on 'poor/fair' generic river health but has now trended upward to 'fair' health.

There was a non-significant positive trend in MCI scores over the most recent ten-year period with a decline in the trendline from 2014 onwards. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.9.2 Discussion

The Mangaehu River had a typical taxa richness. MCI scores at the site indicated that the macroinvertebrate community was in 'fair' health. The time trend analysis showed a significant positive trend over the full dataset indicating that macroinvertebrate communities have been getting healthier over time. There was no significant trend for the ten-year dataset. Long term improvements in macroinvertebrate health at the site were likely in relation to an apparent reduction in river bed sedimentation possibly related to fewer severe flood events particularly since 2000 with scores tending to plateau between in 2004 and 2008 before improving steadily again since then. Work has also been undertaken encouraging farmers to stabilise erosion prone hill slopes by planting appropriate vegetation such as poplar. Recent scores show a decrease in the trend coincident with widespread periphyton mats on the streambed in conjunction at times with widespread filamentous periphyton, which provide favourable habitat and food for more tolerant taxa resulting in lower macroinvertebrate health scores.

3.2.10 Manganui River

The Manganui River is a ringplain river whose source is inside Egmont National Park and is a significant tributary of the Waitara River. There are two SEM sites located on the river, one at its mid reaches and another at its lower reaches.

3.2.10.1 State Highway 3 site (MGN000195)

3.2.10.1.1 Taxa richness and MCI

Forty-six surveys have been undertaken at this mid reach site in the Manganui River between September 1995 and March 2018. These results are summarised in Table 26 together with the results from the current period, and illustrated in Figure 65.

Table 26 Results of previous surveys performed in the Manganui River u/s of railway bridge (SH 3), together with 2018-2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGN000195	46	9-26	21	106-143	126	18	133	25	123

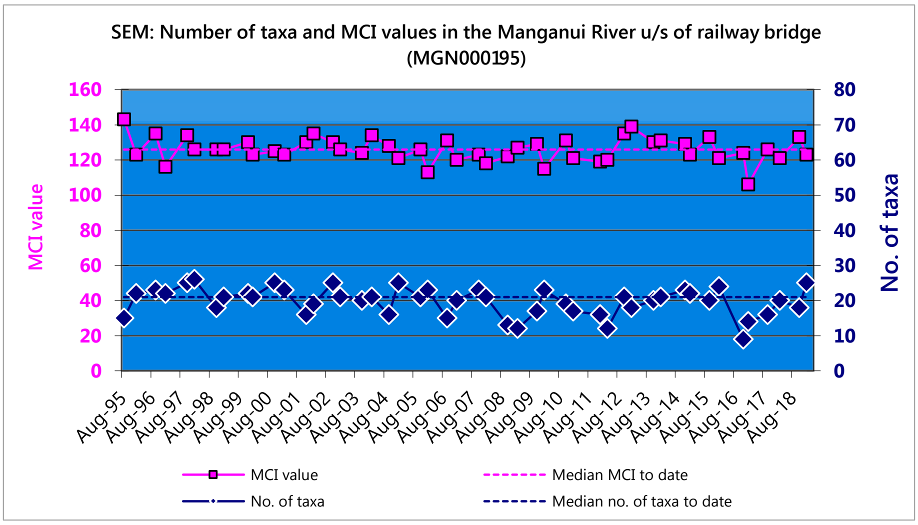


Figure 44 Numbers of taxa and MCI values in the Manganui River above the railway bridge (SH3)

A wide range of richness (9 to 26 taxa) has been found, with a median richness of 21 taxa which was slightly lower than typical richness in the mid-reaches of ringplain streams and rivers. During the current period spring (18 taxa) and summer (25 taxa) richness were both similar to the historical median though summer richness was noticeably higher than spring richness.

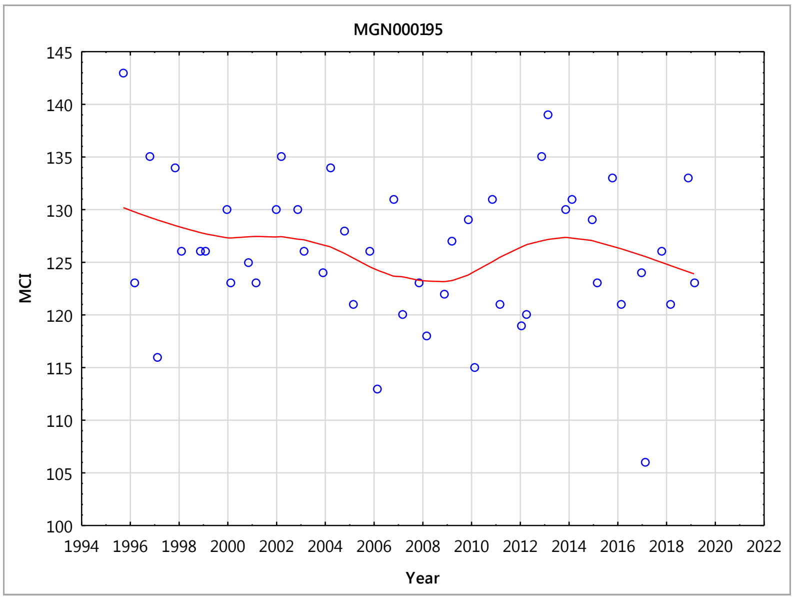
MCI values have had a relatively wide range (37 units) at this site, slightly wider than typical for a site in the mid reaches of a ringplain stream. The median value (126 units) was higher than has been typical of similar mid-reach sites elsewhere on the ringplain. The spring (133 units) and summer (123 units) scores were not significantly different to the historical median. These scores categorised this site as having 'very good' health (Table 3) in spring and summer. The historical median score (126 units) placed this site in the 'very good' generic health.

3.2.10.1.2 Predicted stream 'health'

The Manganui River site at SH3 is 8.7 km downstream of the National Park boundary at an altitude of 330 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 107 for this site. The historical site median, spring and summer scores were significantly above the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 124 units. The historical site median, spring and summer scores were not significantly different to this value.

3.2.10.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 45). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all of the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Manganui River at SH3.



N = 48
Kendall tau = -0.11
p level = 0.26
FDR p = 0.36

N = 20
Kendall tau = -0.01
p level = 0.97
FDR p = 0.97

Figure 45 LOWESS trend plot of MCI data at the SH3 site, Manganui River

A very slight overall decrease in MCI scores was identified (more accentuated over the first 12 years) which was not statistically significant for the 24-year period. The scores (range of nine units) represented no ecological importance in terms of variability. These trendline consistently indicated 'very good' generic river health over the entire period.

There was a minor non-significant negative trend in MCI scores over the most recent ten-year period, congruent with the full dataset. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.10.2 Bristol Road site (MGN000427)

3.2.10.2.1 Taxa richness and MCI

Forty-six surveys have been undertaken at this lower reach site at Bristol Road in the Manganui River between October 1995 and March 2018. These results are summarised in Table 27 together with the results from the current period, and illustrated in Figure 46.

Table 27 Results of previous surveys performed in the Manganui River at Bristol Road together with 2018-2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Mar 2019	
		Range	Taxa no	Taxa no	Median	Taxa no	MCI	Taxa no	MCI
MGN000427	46	14-26	20	77-117	98	20	89	20	93

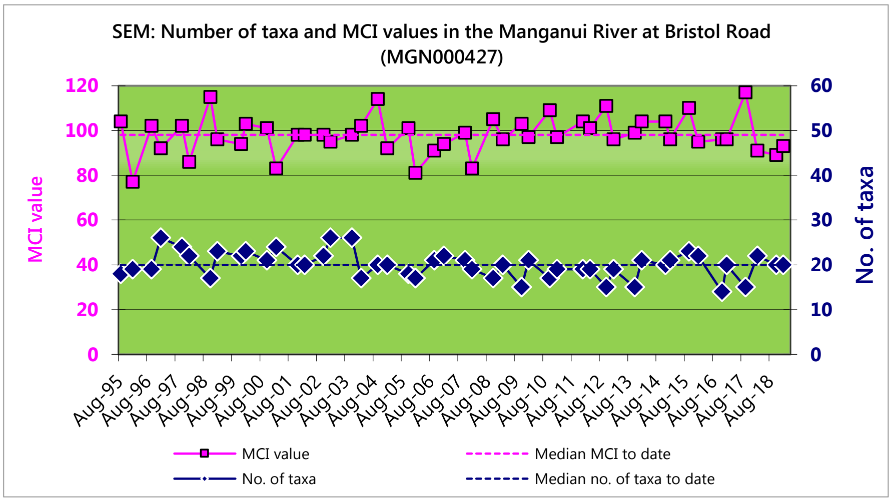


Figure 46 Numbers of taxa and MCI values in the Manganui River at Bristol Road

A moderate range of richness (14 to 26 taxa) has been found with a median richness of 20 taxa which is representative of typical richness in ringplain streams and rivers in the lower reaches. During the current period, the spring (20 taxa) and summer (20 taxa) richness the same as the historical median.

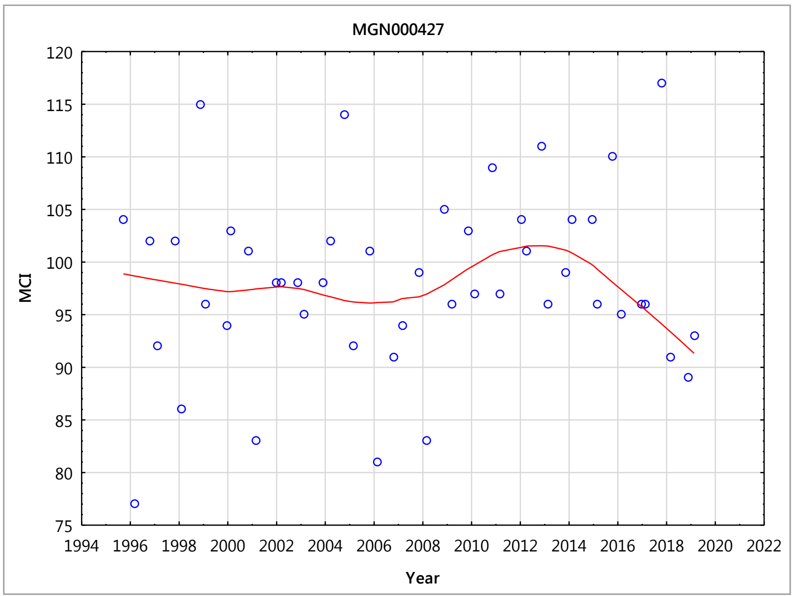
MCI scores have had a very wide range (40 units) at this site, typical of sites in the lower reaches of streams elsewhere on the ringplain although this site was located at an atypically higher altitude of 140 m asl for a lower reach site more than 37 km downstream from the National Park boundary. The median value (98 units) has been higher than typical of lower reach ringplain sites. The spring (89 units) and summer (93 units) scores were both lower than the historical median. These scores categorised this site as having 'fair' spring and summer health (Table 3). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.10.2.2 Predicted stream 'health'

The Manganui River site at Bristol Road is 37.9 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National park boundary (Stark and Fowles, 2009) predict a MCI value of 91 for this site. The historical site median, spring and summer scores were not significantly different to the predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 103 units. The historical site median and summer score was not significantly different to the REC predictive value, while the spring score was significantly lower.

3.2.10.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 47). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all of the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Manganui River at Bristol Road.



N = 48
Kendall tau = 0.02
p level = 0.87
FDR p = 0.90

N = 20
Kendall tau = -0.34
p level = 0.04
FDR p = 0.22

Figure 47 LOWESS trend plot of MCI data at the Bristol Road site, Manganui River

The slight overall positive trend in MCI scores was not statistically significant and though there has been some variability in the trendline of 10 units been of minor ecological importance. The trendline was indicative of 'fair' generic river health at this site throughout the majority of 23-year period.

There was a negative trend in MCI scores over the most recent ten-year period, in contrast with the full dataset, with a decline in the trendline from 2013 onwards. This trend was not statistically significant after FDR application (FDR p = 0.22), although continued deterioration in the future will likely cause a statistically significant result. The trendline for the most recent ten-year period was indicative of 'fair' health with a brief period of 'good' health between 2010 and 2015.

3.2.10.3 Discussion

The Manganui River had typical taxa richness. MCI scores were also typical at the upper site and slightly lower than the historic median at the lower site. MCI scores indicated that the upper site was in 'very good' health while the lower site was in 'fair' health. MCI score typically fell in a downstream direction in both spring and summer, over a stream distance of 29.2 km downstream from the National Park boundary. Based on the long-term median, SEM MCI scores fell in a downstream direction by 28 units. The deterioration in macroinvertebrate health was likely due to cumulative inputs from point and diffuse sources in a catchment that was dominated by agriculture.

The time trend analysis showed no significant trends for either site for both the full and ten-year dataset indicting no significant changes in macroinvertebrate health over time at the two monitored sites though the lower site had a non-significant negative trend which may become significant if the trend continues its current trajectory.

3.2.11 Mangaoraka Stream

The Mangaoraka Stream is a ringplain stream whose source is outside Egmont National Park. The stream flows in a northerly direction and is a tributary of the Waiongana Stream where it joins close to the coast. A single site is surveyed.

3.2.11.1 Corbett Road site (MRK000420)

3.2.11.1.1 Taxa richness and MCI

Forty-five surveys have been undertaken at this lower reach site in the Mangaoraka Stream between October 1995 and February 2018. These results are summarised in Table 28, together with the results from the current period, and illustrated in Figure 48.

Table 28 Results of previous surveys performed in Mangaoraka Stream at Corbett Road, together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Taxa no	Taxa no	Median	Taxa no	MCI	Taxa no	MCI
MRK000420	45	11-30	25	75-105	90	18	94	28	81

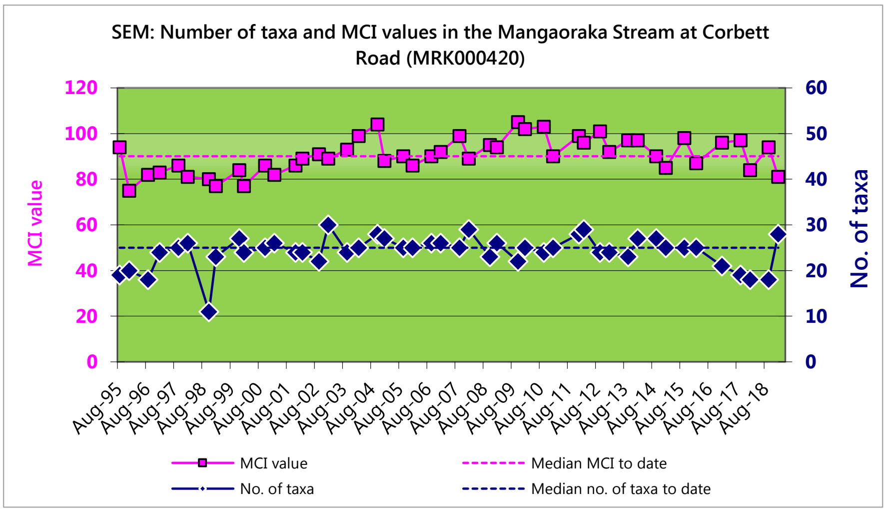


Figure 48 Numbers of taxa and MCI values in the Mangaoraka Stream at Corbett Road

A wide range of richness (11 to 30 taxa) has been found, with a median richness of 25 taxa (more representative of typical richness in the lower reaches of ringplain streams rising outside the National Park boundary). During the current period there was substantial variability displayed with spring (18 taxa) richness significantly lower than summer (28 taxa) richness and the historical median richness, by ten and seven taxa respectively.

MCI values have also had a relatively wide range (30 units) at this site to date. The median value (90 units) has been typical of lower reach sites elsewhere on the ringplain. The spring (94 units) and summer (81 units) scores were not significantly different to the historical median but the summer score was significantly lower than the spring score. The MCI scores categorised this site as having 'fair' health generically (Table 3). The historical median score (90 units) placed this site in the 'fair' generic health.

3.2.11.1.2 Predicted stream 'health'

The Mangaoraka Stream rises below the National Park boundary and the site at Corbett Road is in the lower reaches at an altitude of 60 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical site median and spring scores were also not significantly different to this value but the summer score was significantly lower.

3.2.11.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 49). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all of the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Mangaoraka Stream at Corbett Road.

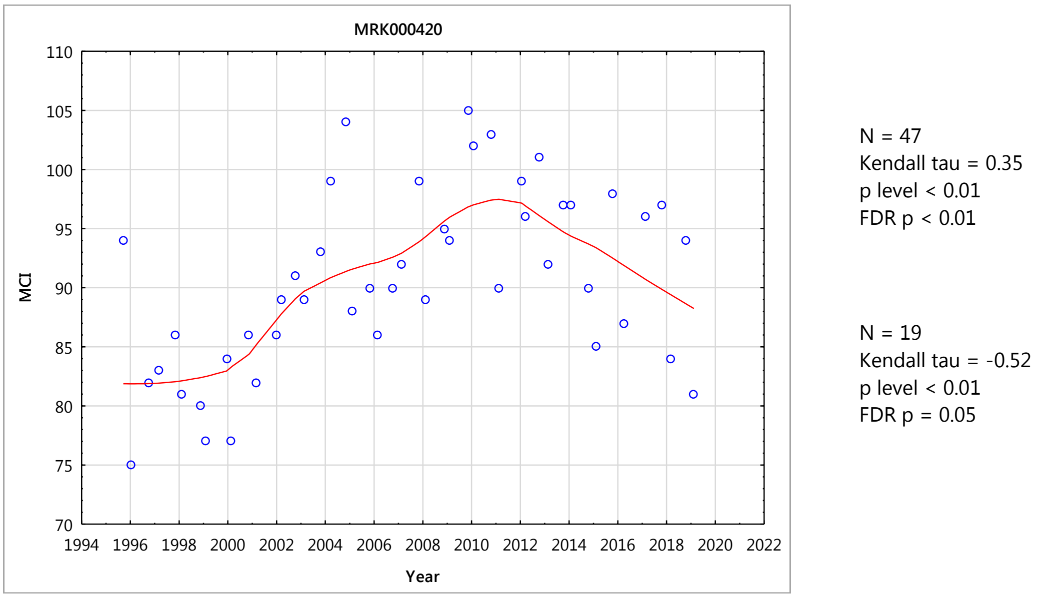


Figure 49 LOWESS trend plot of MCI data at the Corbett Road site, Mangaoraka Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

The MCI scores have shown a highly significant improvement ($p < 0.01$ after FDR). Scores improved from 1995 to 2011 but have since decreased from 2011 to 2019. The trendline has varied over an ecologically important range of 16 units during the period. SEM physicochemical monitoring at this site had illustrated significant improvements in aspects of organic loadings at this site in the lower reaches of the stream prior to mid-2008. This was coincident with more rigorous surveillance monitoring of nearby quarrying and waste disposal activities and good dairy shed wastewater disposal compliance performance during that period. The trendline was indicative of 'fair' generic stream health.

There was a non-significant negative trend in MCI scores over the most recent ten-year period after FDR ($p = 0.05$), in contrast with the significant positive trend of the full dataset, with a decline in the trendline from 2012 onwards.

3.2.11.2 Discussion

The site had a lower than usual taxa richness during spring, similar to what was found for the preceding monitoring year, but the summer result was slightly higher than the historical median indicating richness had returned to more typical levels. MCI scores were typical and indicated 'fair' health. MCI values significantly decreased between spring and summer at this lower reach site by 13 units (Appendix II) indicating significant seasonal variation.

The time trend analysis showed a significant positive trend for the full dataset indicting a significant improvement in macroinvertebrate health over the full duration of monitoring. However, there was a non-significant (but extremely close to being significant) negative trend for the ten-year dataset which will probably become significant for the next monitoring year if the current trend continues. Recently, deteriorating water quality (i.e. increased dissolved reactive phosphorus, total phosphorus, faecal coliforms, enterococci and decreased visual clarity as a measure by black disc) has been recorded at the site (TRC, 2018). The decline in water quality was due to a large increase in land use activity, namely new poultry farms and a deterioration in stock control, resulting in an overall increase in pollution loads on the catchment. The declining water quality was probably the main driver negatively impacting the macroinvertebrate community present at the site.

3.2.12 Mangati Stream

The Mangati Stream is a small coastal stream, and flows in a northerly direction through a mix of agriculture, industrial and urban areas. Two sites, located above and below an industrial area, are sampled for SEM purposes.

3.2.12.1 Site downstream of railbridge (MGT000488)

3.2.12.1.1 Taxa richness and MCI

Between September 1995 and February 2018, forty-five surveys have been undertaken at this site, which lies in the mid reaches of the stream and drains an industrial catchment. Historical results are summarised in Table 29, together with the results from the current period, and illustrated in Figure 50.

Table 29 Results of previous surveys performed in the Mangati Stream at the site downstream of the railbridge, together with 2018-2019 results

Site code	SEM data (1995 to Feb 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGT000488	45	9-29	16	56-91	78	20	79	16	74

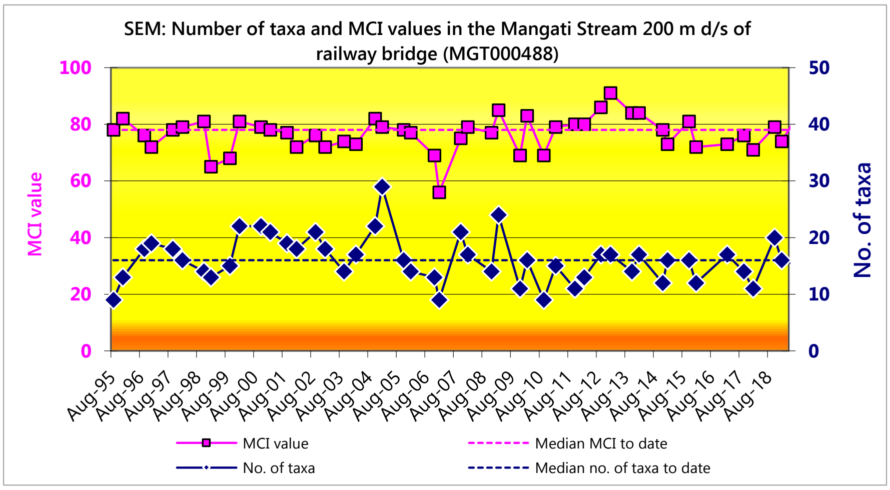


Figure 50 Numbers of taxa and MCI values in the Mangati Stream downstream of the railbridge

A very wide range of richness (9 to 29 taxa) has been found; with a median richness of 16 taxa which was a typical richness in Taranaki lowland coastal streams. During the current period, the spring survey (20 taxa) had a slightly higher taxa richness than the historic median while the summer survey (16 taxa) had a richness exactly the same as the historic median.

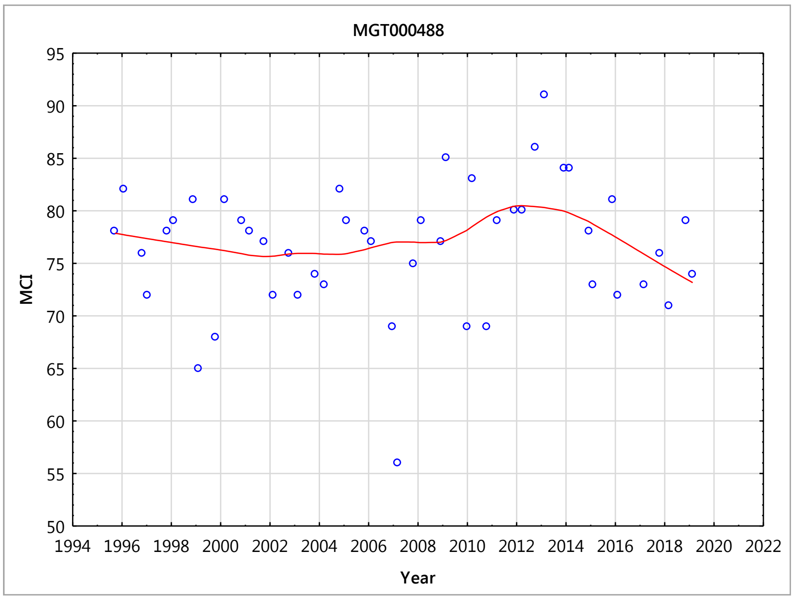
MCI values have had a wide range (35 units) at this site, relatively typical of a site in a small coastal stream. The median historical value (78 units) has also been typical of such streams and the spring (79 units) and summer (74 units) score was not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'poor' health in spring and summer (Table 3). The historical median score (78 units) also placed this site in the 'poor' health category for the generic method of assessment.

3.2.12.1.2 Predicted stream 'health'

The Mangati Stream site downstream of the railbridge is in the middle reaches of a small lowland, coastal stream at an altitude of 30 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 80 units. The historical site median, spring and summer scores were not significantly different to this value.

3.2.12.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 51). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all of the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Mangati Stream at the site downstream of the railbridge.



N = 47
Kendall tau = 0.06
p level = 0.58
FDR p = 0.65

N = 19
Kendall tau = -0.14
p level = 0.39
FDR p = 0.67

Figure 51 LOWESS trend plot of MCI data at the Mangati Stream site downstream of the railbridge for the full dataset with Mann-Kendall test for the full and ten-year dataset

There was a non-significant positive overall trend identified in the MCI scores over the full time range. The trendline had a range of eight units indicative of marginal ecological importance over the period. Overall, the trendline was indicative of 'poor' generic stream health throughout most of the period.

There was a non-significant negative trend in MCI scores over the most recent ten-year period after FDR, in contrast with the full dataset, with a decline in the trendline from 2012 onwards, probably as a result of increased earthworks upstream of the site. The trendline for the most recent ten-year period was indicative of 'poor' health.

3.2.12.2 Te Rima Place, Bell Block site (MGT000520)

3.2.12.2.1 Taxa richness and MCI

Forty-five surveys have been undertaken at this lower reach site at SH45 in the Mangati Stream between October 1995 and February 2018. These results are summarised in Table 30, together with the results from the current period, and illustrated in Figure 52.

Table 30 Results of previous surveys performed in the Mangati Stream at Te Rima Place, Bell Block together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGT000520	45	3-22	10	44-79	67	13	74	12	73

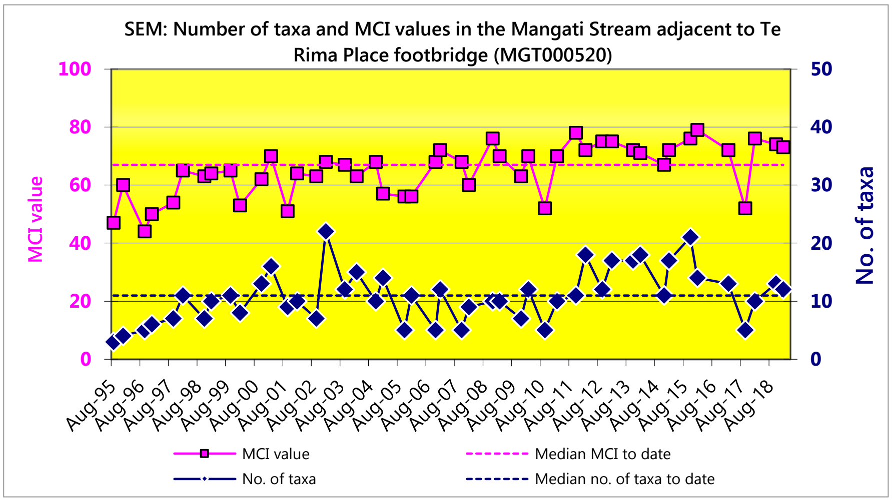


Figure 52 Numbers of taxa and MCI values in the Mangati Stream at Te Rima Place footbridge

A wide range of richness (3 to 22 taxa) has been found; wider than might be expected with a median richness of 10 taxa, lower than typical richness in the lower reaches of small lowland, coastal streams in Taranaki. During the current period, spring (13 taxa) and summer (12 taxa) richness was similar to the historical median richness.

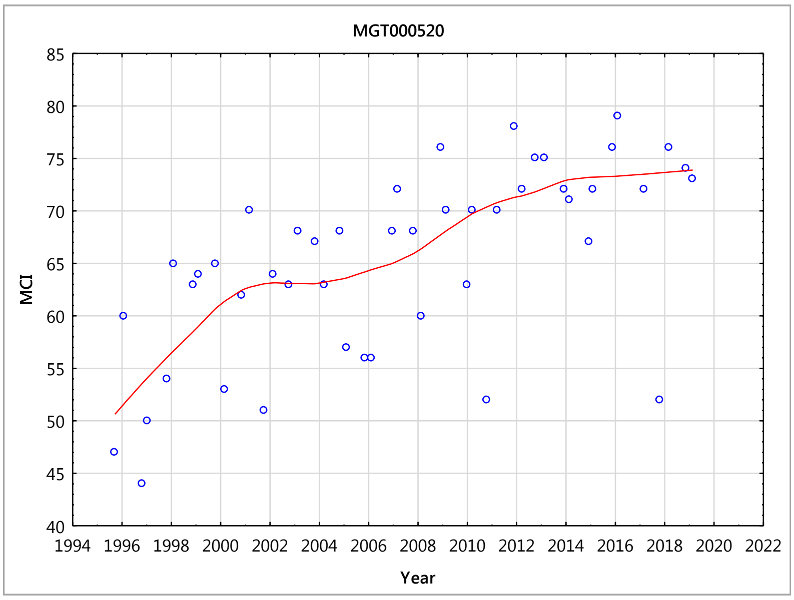
MCI scores have had a relatively wide range (35 units) at this site, typical of sites in the lower reaches of small lowland, coastal streams. The spring (74 units) and summer (73 units) scores were non-significantly higher than the historic median. The scores categorised this site as having 'poor' health in both spring and summer (Table 3). The historical median score (67 units) also placed this site in the 'poor' category for the generic method of assessment.

3.2.12.2.2 Predicted stream 'health'

The Mangati Stream at Te Rima Place, Bell Block is in the lower, more gravel-bottomed reaches of a small lowland, coastal stream at an altitude of 20 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 88 units. The historical site median, spring and summer scores were significantly lower than this value.

3.2.12.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 53). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on 24 years of SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Mangati Stream at Te Rima Place.



N = 47
Kendall tau = 0.52
p level < 0.01
FDR p < 0.01

N = 19
Kendall tau = 0.12
p level = 0.12
FDR p = 0.40

Figure 53 LOWESS trend plot of MCI data at the Mangati stream site at Te Rima Place, Bell Block for the full dataset with Mann-Kendall test for the full and ten-year dataset

A positive significant trend in MCI scores has indicated continued improvement coincident with better control and treatment of industrial point source discharges in the catchment and wetland installation (stormwater interception) in the mid catchment with this improvement continuing in recent years. The trendline had a range of scores (23 units) that has been ecologically important with MCI scores indicative of a shift from 'very poor' over the first four years to 'poor' generic stream health during the remaining period.

There was a non-significant positive trend in MCI scores over the most recent ten-year period with the trendline slope starting to flatten out after 2014. The trendline for the most recent ten-year period was indicative of 'poor' health.

3.2.12.3 Discussion

Taxa richness at both sites were similar to historic medians indicating no recent effects of illegal discharges, that unfortunately sometimes occur in the stream. MCI scores were congruent with taxa richness, with both sites having typical scores compared with historic medians.

The time trend analysis showed no significant trends for the upper site but there was a significant, positive trend at the lower site for the full dataset. This indicates that macroinvertebrate health has been improving at the lower site and suggests that improvements in water quality have largely occurred between the two sites. The lack of a significant trend for the ten-year dataset indicates that improvements have been recently levelling off.

3.2.1 Mangawhero Stream

The Mangawhero Stream is a small stream that arises as a seepage stream draining the Ngaere swamp with a lower sub-catchment (Mangawharawhara Stream) rising on the ringplain but outside of Egmont National Park. Two sites are located on the stream, one above the discharge point of the Eltham WWTP and another close to the where it joins the Waingongoro River.

3.2.1.1 Site upstream of the Eltham Municipal WWTP discharge (MWH000380)

3.2.1.1.1 Taxa richness and MCI

Forty-six surveys have been undertaken in this mid-reach site in the Mangawhero Stream within about 3 km of the Ngaere swamp between October 1995 and March 2018. These results are summarised in Table 31, together with the results from the current period, and illustrated in Figure 54.

Table 31 Results of previous surveys performed in Mangawhero Stream upstream of Eltham WWTP, together with 2018-2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000380	46	10-24	15	58-85	74	13	88	15	83

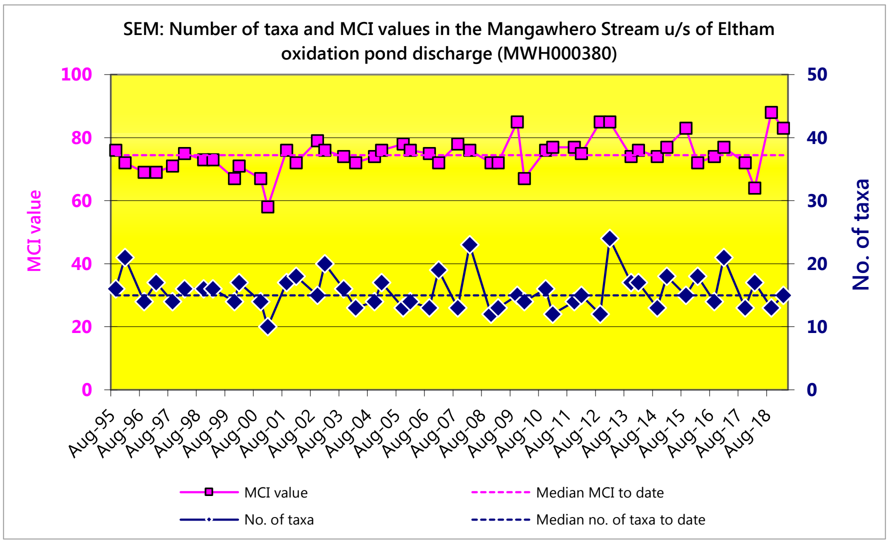


Figure 54 Numbers of taxa and MCI values in the Mangawhero Stream upstream of Eltham WWTP

A moderately wide range of richness (10 to 24 taxa) has been found, with a median richness of 15 taxa (more representative of typical richness in small swamp drainage streams where a median richness of 18 taxa has been found at similar altitudes. During the current period spring (13 taxa) and summer (15 taxa) richness were relatively similar to each other and to the historical median.

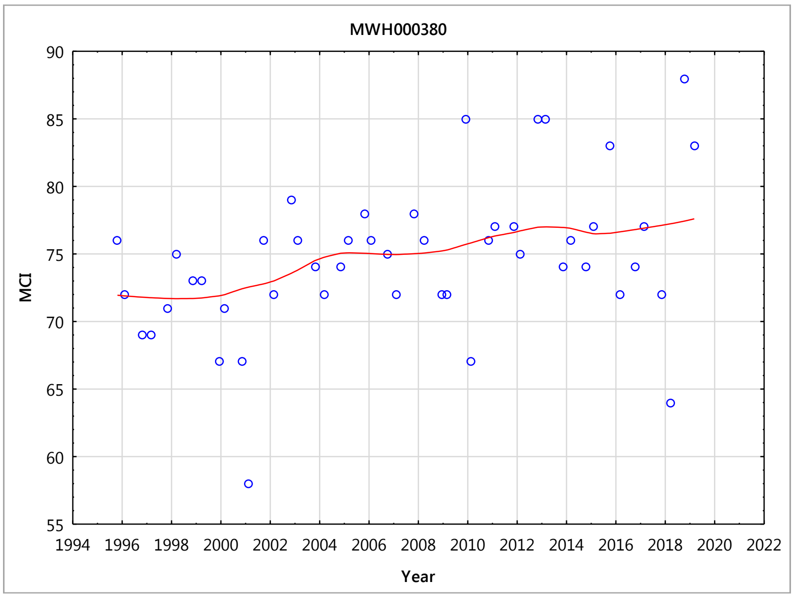
MCI values have had a moderate range (27 units) at this site. The median value (74 units) has been typical of similar non-ringplain sites elsewhere in the region. The spring (88 units) score was significantly higher than the historical median, while the summer (83 units) score was not significantly higher than the historical median (Stark, 1998). These scores categorised this site as having 'fair' (spring and summer) health generically (Table 2). The historical median score (74 units) placed this site in the 'poor' category for generic health.

3.2.1.1.2 Predicted stream 'health'

The Mangawhero Stream rises as seepage from the Ngaere swamp and is not a ringplain stream at the site upstream of the Eltham WWTP. This site is at an altitude of 200 m asl and toward its upper reaches. The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical median was significantly lower than the REC predictive value while the spring and summer scores were not significantly different.

3.2.1.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 55). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all of the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Mangawhero Stream upstream of the Eltham WWTP discharge.



N = 48
Kendall tau = 0.29
p value < 0.01
FDR p = 0.01

N = 20
Kendall tau = -0.08
p value = 0.61
FDR p = 0.83

Figure 55 LOWESS trend plot of MCI data at site upstream of the Eltham WWTP discharge, Mangawhero Stream for the full dataset with Mann-Kendall test for the full and ten- year dataset

A highly significant ($p < 0.01$, after FDR) trend in MCI scores has been found over the full monitoring period at this site. However, the narrow range of trendline scores (six units) has been of only minor ecological importance. The trendline has consistently have been indicative of 'poor' generic stream health (Table 2) throughout the period.

In contrast to the full dataset the there was a negative, but non-significant, trend in MCI scores over the most recent ten-year. The trendline for the most recent ten-year period was indicative of 'poor' health.

3.2.1.2 Site downstream of the Mangawharawhara Stream confluence (MWH000490)

3.2.1.2.1 Taxa richness and MCI

Forty-six surveys have been undertaken at this lower mid-reach site in the Mangawhero Stream between October 1995 and March 2018. These results are summarised in Table 32, together with the results from the current period, and illustrated in Figure 56.

Table 32 Results of previous surveys performed in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence, together with 2018-2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MWH000490	46	13-30	20	63-102	80	16	96	20	88

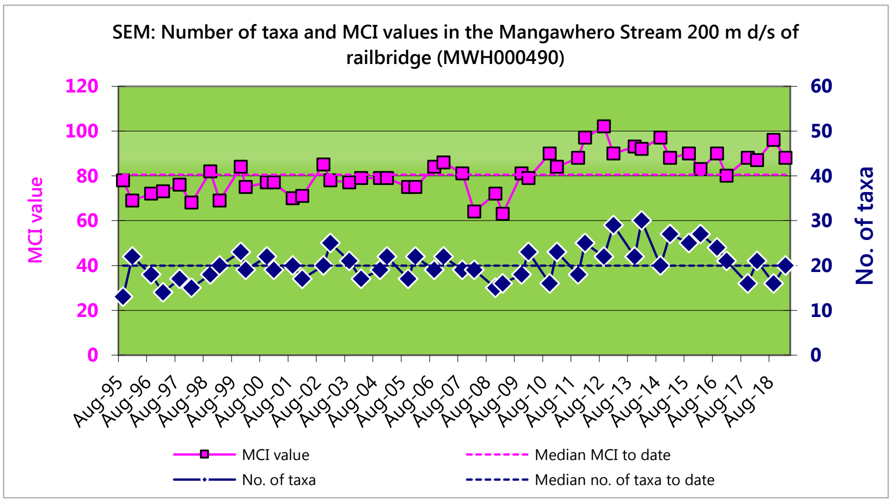


Figure 56 Numbers of taxa and MCI values in the Mangawhero Stream downstream of the railbridge and Mangawharawhara Stream confluence

A relatively wide range of richness (13 to 30 taxa) has been found with a moderate median richness of 20 taxa (more representative of typical richness in the lower-mid reaches of streams and rivers). During the current period spring (16 taxa) and summer (20 taxa) richness were similar to the historical median richness.

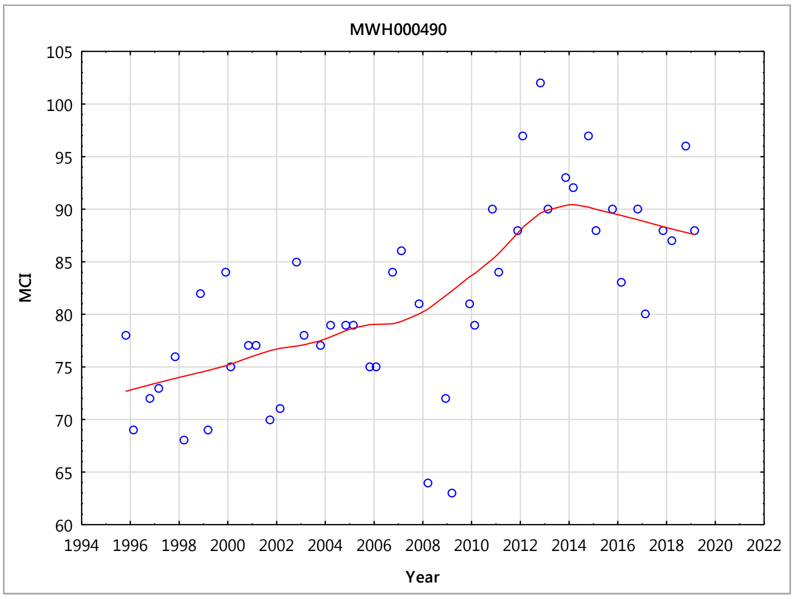
MCI values have had a wide range (39 units) at this site, more typical of a site in the middle to lower reaches of ringplain streams. However, the median value (80 units) has been lower than typical of lower mid-reach sites elsewhere. The spring (96 units) score was significantly higher than the historic median while the summer (88 units) score was not significantly different to the historical median (Stark, 1998). The MCI scores categorised the site as having 'fair' health generically (Table 2) in both spring and summer. The historical median score (80 units) placed this site in the 'fair' category for generic health.

3.2.1.2.2 Predicted stream 'health'

The Mangawhero Stream site below the Mangawharawhara Stream confluence, at an altitude of 190 m asl, is in the lower reaches of a stream draining a catchment comprised of the Ngaere Swamp drainage system and a mid-reach ringplain sub-catchment with its headwaters outside the National Park. The REC predicted MCI value (Leathwick, et al. 2009) was 93 units. The historic median was significantly lower than this value while the spring and summer scores were not significantly different to the REC predictive value.

3.2.1.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 57). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Mangawhero Stream downstream of the Mangawharawhara Stream confluence.



N = 48
Kendall tau = 0.50
p value < 0.01
FDR p < 0.01

N = 20
Kendall tau = 0.02
p value = 0.92
FDR p = 0.96

Figure 57 LOWESS trend plot of MCI data at the Mangawhero Stream site downstream of the Mangawharawhara Stream confluence for the full dataset with Mann-Kendall test for the full and ten-year dataset

A significant (p < 0.01, after FDR) improvement in MCI scores has been illustrated at this more ringplain-like site in the lower reaches of the stream near its confluence with Waingongoro River. The wide range in trendline scores (17 units) was of major ecologically importance. Scores rose steadily from 1995 to 2010 and then rapidly improved following the diversion of the Eltham WWTP wastes discharge out of the stream in July 2010. However, more recently from 2014 onwards a decline in the trendline was evident.

There was a non-significant trend in MCI scores over the most recent ten-year period. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.1.3 Discussion

The Mangawhero Stream generally had moderate taxa richness with the upper site typically having slightly lower richness than the lower site due to poorer habitat quality and the current survey results were largely congruent with previous surveys. MCI scores indicated 'fair' health at the upper site and lower site. The scores continue to reflect the lowland, swampy, nature of the headwaters of the Mangawhero Stream. MCI scores typically improved in a downstream direction in both spring and summer over a stream distance of 16.5 km between the upper and lower sites of this stream. This was principally a result of improvement in physical habitat between the two sites.

The time trend analysis showed a significant positive trend for both sites for the full dataset. This indicates that macroinvertebrate health has been improving over the long term. The upper site has probably improved due to riparian plantings that now provide significant shade at the site. Improvement at the lower site was consistent with the diversion of the major point source Eltham municipal wastewater discharge out of the Mangawhero Stream which was completed in June 2010. The ten-year trends for both sites were close to being flat with very small Kendall tau and p-values recorded indicating no recent changes in macroinvertebrate community health in the Mangawhero Stream.

3.2.2 Mangorei Stream

The Mangorei Stream is a ringplain stream and tributary of the Waiwhakaiho River. A site was established in the lower reaches of the Mangorei Stream, near the confluence with the Waiwhakaiho River, for the SEM programme in 2002-2003, in recognition of the importance of this catchment as the only major inflow to the lower reaches of the river below a significant hydroelectric power scheme and New Plymouth District Council water supply abstractions.

3.2.2.1 SH3 site (MGE000970)

3.2.2.1.1 Taxa richness and MCI

Thirty-one surveys have been undertaken at this lower reach site in the Mangorei Stream between November 2002 and March 2018. These results are summarised in Table 62, together with the results from the current period, and illustrated in Figure 58.

Table 33 Results of previous surveys performed in the Mangorei Stream at SH 3 together with the 2018-2019 results

Site code	SEM data (2002 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
MGE000970	31	22-33	27	86-113	102	22	107	22	84

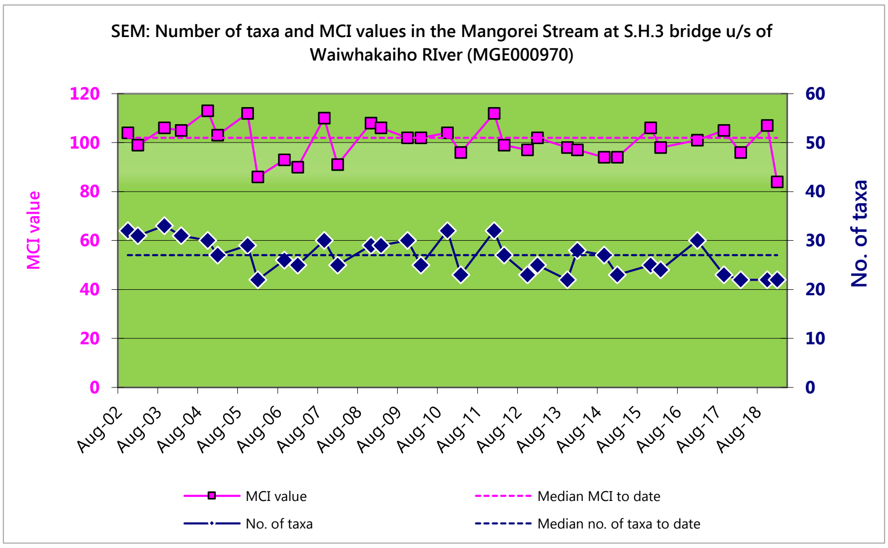


Figure 58 Numbers of taxa and MCI values in the Mangorei Stream at SH3

A moderate range of richness (22 to 33 taxa) has been found with a relatively high median richness of 27 taxa which was more representative of typical richness in upper and middle reaches of ringplain streams and rivers. During the current period, spring (22 taxa) and summer (22 taxa) richness was lower than the historical median richness and were the equal lowest recorded taxa richness to date.

MCI values have had a relatively wide range (27 units) at this site, typical of a site in the lower reaches of a ringplain stream. However, the median value (102 units) has been more typical of mid-reach sites elsewhere on the ringplain. The spring (107 units) score was similar to the historic median but the summer score (84 units) was significantly lower than both the spring score and historic median and was the lowest score recorded to date for this site. The scores categorised this site as having ‘good’ (spring) and ‘fair’ (summer) health generically (Table 3). The historical median score (102 units) placed this site in the 'good' health category.

3.2.2.1.2 Predicted stream 'health

The Mangorei Stream site at SH3 is 15.6 km downstream of the National Park boundary at an altitude of 90 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 101 for this site. The historical site median and spring score were not significantly different to the distance predictive value but the summer score was significantly lower.

The REC predicted MCI value (Leathwick, et al. 2009) was 101 units. The historical site median and spring score were not significantly different to the REC predictive value but the summer score was significantly lower.

3.2.2.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 59). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (2002-2019) and the most recent ten-years of results (2009-2019) from the site in the Mangorei Stream at SH3.

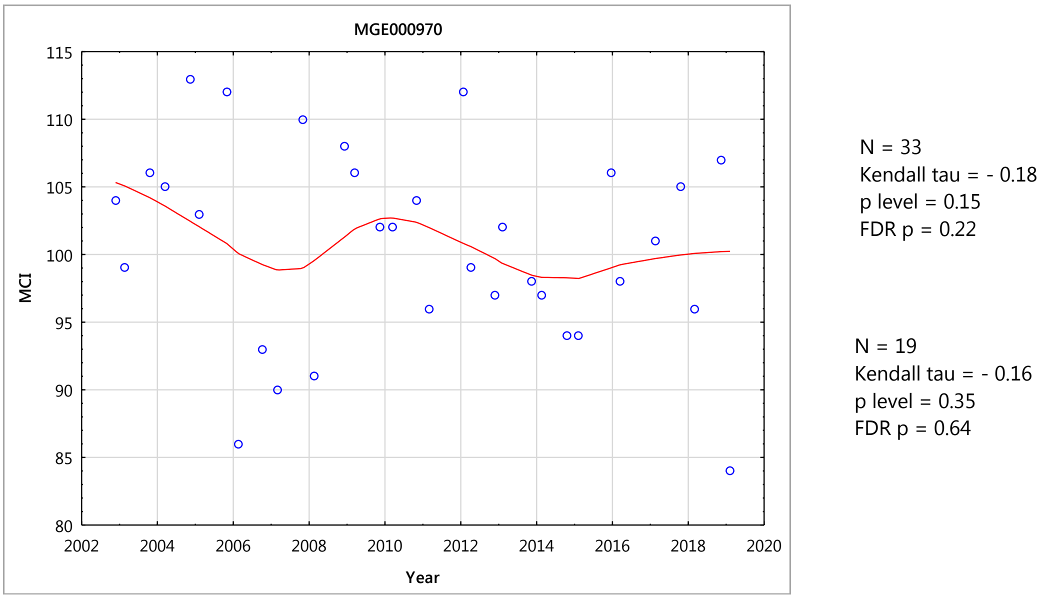


Figure 59 LOWESS trend plot of MCI data at the SH3 site, Mangorei Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

The slightly negative decline over the 16-year period has not been statistically significant at this site. The trendline range of scores (7 units) has been indicative of marginal ecological importance. During the monitoring period, the trendline has alternated between 'fair' and 'good' generic stream health.

There was also a non-significant negative trend in MCI scores over the most recent ten-year period, congruent with the full dataset. The trendline for the most recent ten-year period has alternated between 'fair' and 'good' generic stream health.

3.2.2.2 Discussion

The Mangorei Stream had moderate taxa richness but both spring and summer results were the equal lowest recorded at the site. MCI scores were widely divergent between spring and summer with the summer result significantly lower than what was typically found for the site and was a new record low for the site. These results suggest a likely deterioration in either habitat and/or water quality at the site.

The time trend analysis showed a negative, but non-significant trend for both the full and ten-year datasets. This indicates that there has been little change in macroinvertebrate health.

3.2.3 Patea River

The Patea River is a large, ringplain river that originates within Egmont National Park and flows in a south-easterly direction. Three SEM sites are located in the upper and middle reaches of the river.

3.2.3.1 Barclay Road site (PAT000200)

3.2.3.1.1 Taxa richness and MCI

Forty-six surveys have been undertaken at this upper reach, shaded site adjacent to the National Park boundary in the Patea River between October 1995 and April 2018. These results are summarised in Table 34, together with the results from the current period, and illustrated in Figure 60.

Table 34 Results of previous surveys performed in the Patea River at Barclay Road, together with 2018-2019 results

Site code	SEM data (1995 to April 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000200	46	23-35	30	127-150	138	25	135	23	148

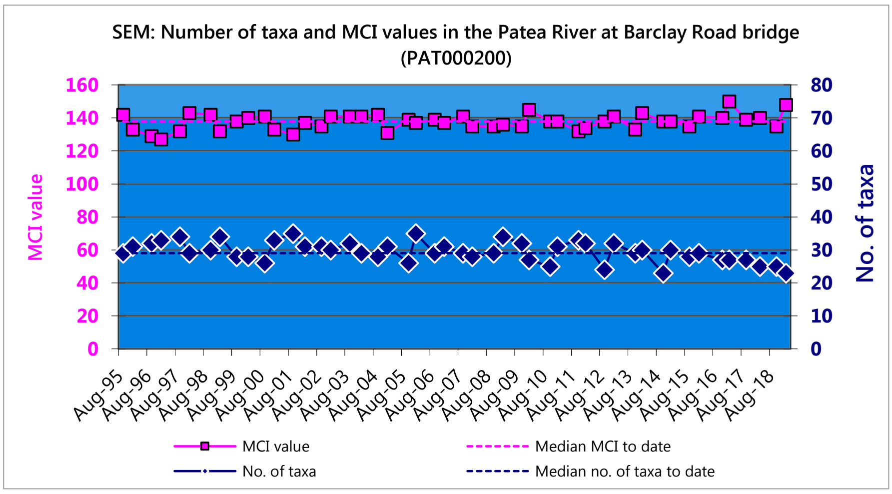


Figure 60 Numbers of taxa and MCI values in the Patea River at Barclay Road

A moderate range of richness (23 to 35 taxa) has been found with a relatively high median richness of 30 taxa, typical of richness in ringplain streams and rivers near the National Park boundary. During the current period spring (25 taxa) and summer (23 taxa) richness were lower than the historical median.

MCI values have had a moderate range (23 units) at this site, typical of a National Park boundary site. The high median value (138 units) has been typical of upper reach sites elsewhere on the ringplain. The spring

(135 units) and summer (148 units) scores were not significantly different to the historic median and categorised this site as having 'very good' (spring) and 'excellent' (summer) health generically. (Table 3). The historical median score (138 units) placed this site in the 'very good' category for generic health.

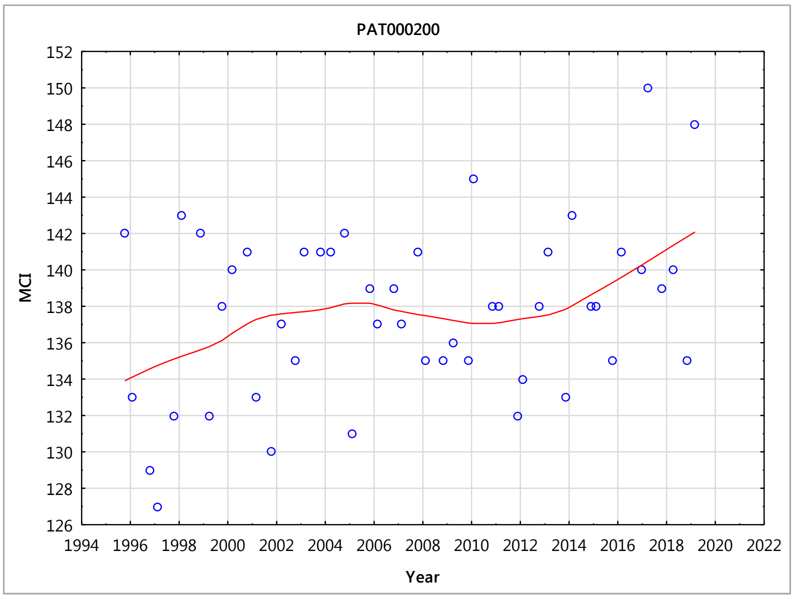
3.2.3.1.2 Predicted stream 'health'

The Patea River site at Barclay Road is 1.9 km downstream of the National Park boundary at an altitude of 500 m asl. Some bush cover extends from the National Park adjacent to most of the reach upstream of this site which is situated in farmland. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value 125 distance for this site. The historical site median (138 units) and summer score were significantly higher than the distance predictive value while the spring score was not significantly different.

The REC predicted MCI value (Leathwick, et al. 2009) was 129 units. The historical median and spring score were not significantly different to this value while the summer score was significantly higher.

3.2.3.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 90). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Patea River at Barclay Road.



N = 48
Kendall tau = 0.16
p value = 0.12
FDR p = 0.18

N = 20
Kendall tau = 0.25
p value = 0.13
FDR p = 0.40

Figure 61 LOWESS trend plot of MCI data at the Barclay Road site, Patea River for the full dataset with Mann-Kendall test for the full and ten-year dataset

No statistically significant temporal trend in MCI scores has been found at this upper catchment site over the full monitoring period during which there has been an overall trend of slight improvement. The trendline range (8 units) did show minor ecological importance. The trendline has indicated 'very good' generic river health until 2017 when it improved to 'excellent' (Table 3) at this relatively pristine site just outside the National Park boundary. Interestingly, physiochemical data has been collected at this site, which shows significantly improving total nitrogen, and nitrate, suggesting water quality in the past has been impacted by farming.

The ten-year trend also showed a non-significant improving trend consistent with the trend for the full period.

3.2.3.2 Swansea Road site (PAT000315)

3.2.3.2.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Patea River at this mid-reach site at Swansea Road, Stratford between October 1995 and April 2018. These results are summarised in Table 35, together with the results from the current period, and illustrated in Figure 62.

Table 35 Results of previous surveys performed in the Patea River at Swansea Road, together with 2018-2019 results

Site code	SEM data (1995 to April 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000315	46	20-32	26	99-130	111	25	110	26	113

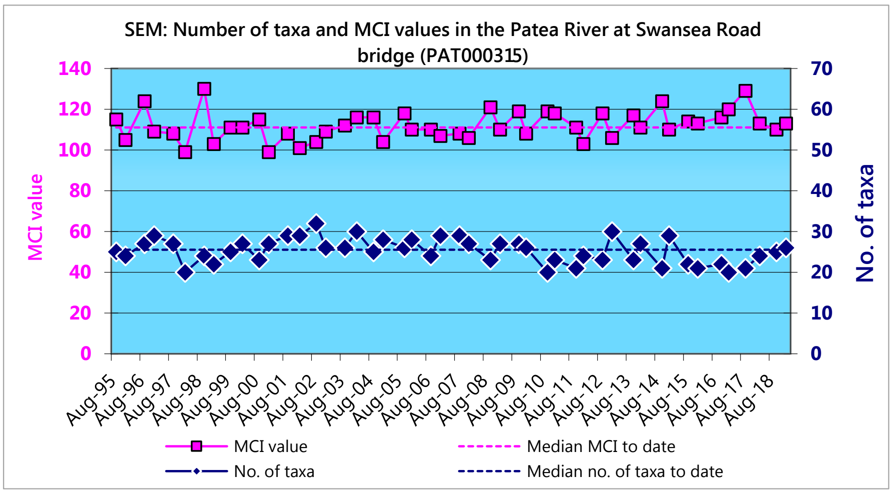


Figure 62 Numbers of taxa and MCI values in the Patea River at Swansea Road

A moderate range of richness (20 to 32 taxa) has been found, with a median richness of 26 taxa, typical of richness in the mid reaches of ringplain streams and rivers. During the current period, spring (25 taxa) and summer (26 taxa) richness were very similar to the median taxa number.

MCI values have had a relatively wide range (31 units) at this site, more so than typical of many sites in the mid reaches of ringplain rivers. The median value (111 units) has been relatively typical of scores in mid-reach sites elsewhere on the ringplain. The spring (110 units) and summer (113 units) scores were very similar to each other and to the historical median. These scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (111 units) placed this site in the 'good' category for generic health.

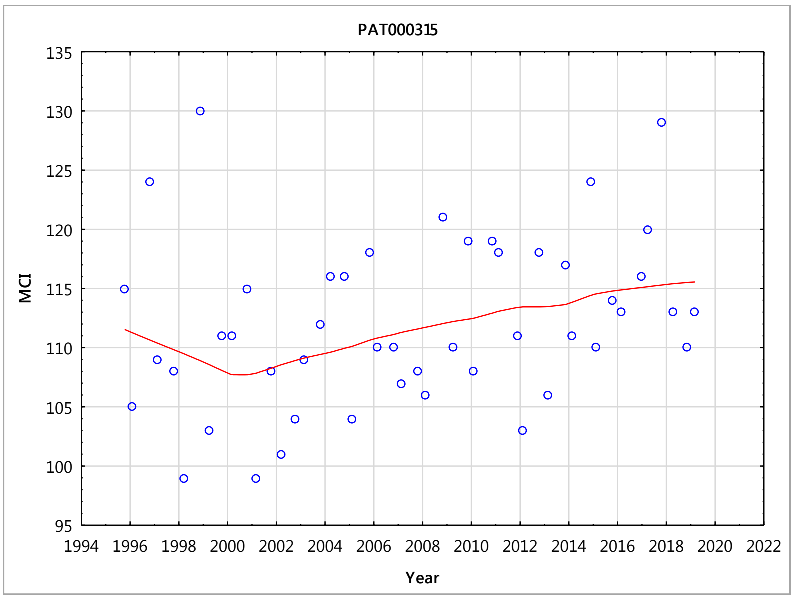
3.2.3.2.2 Predicted stream 'health'

The Patea River site at Swansea Road, Stratford is 12.4 km downstream of the National Park boundary at an altitude of 300 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 103 units for this site. The historical site median, spring summer scores were not significantly different to the distance predictive value (Stark, 1998).

The REC predicted MCI value (Leathwick, et al. 2009) was 112 units. The historical site median, spring and summer scores were not significantly different to the REC predictive value (Stark, 1998).

3.2.3.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 63). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all of the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Patea River at Swansea Road.



N = 48
Kendall tau = 0.22
p value = 0.03
FDR p = 0.05

N = 20
Kendall tau = 0.02
p value = 0.92
FDR p = 0.96

Figure 63 LOWESS trend plot of MCI data at the Swansea Road site, Patea River for the full dataset with Mann-Kendall test for the full and ten-year dataset

The small positive temporal trend in MCI scores was not statistically significant over the full monitoring period after FDR was applied to the p value (FDR p =0.05). The trendline range of scores (8 units) was of minor ecological importance. The trendline range of scores consistently indicated 'good' generic river health (Table 3) throughout the monitoring period.

The ten-year period had no statistical significant trend indicating that there was very little change in the last ten years at the site.

3.2.3.3 Skinner Road site (PAT000360)

3.2.3.3.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Patea River at this mid-reach site at Skinner Road (some 6 km downstream of the Swansea Road, Stratford site), between October 1995 and April 2018. These results are summarised in Table 36, together with the results from the current period, and illustrated in Figure 64.

Table 36 Results of previous surveys performed in the Patea River at Skinner Road, together with 2018-2019 results

Site code	SEM data (1995 to April 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PAT000360	46	15-33	23	86-112	98	19	98	21	90

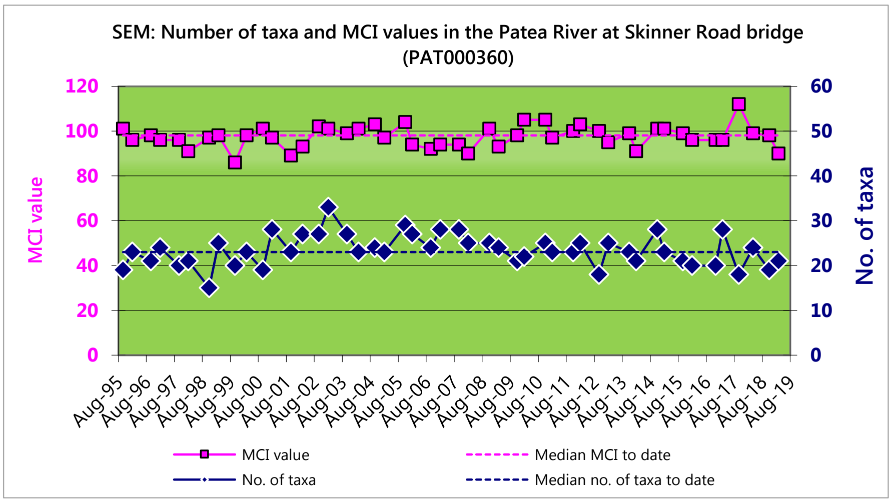


Figure 64 Numbers of taxa and MCI values in the Patea River at Skinner Road

A wide range of richness (15 to 33 taxa) has been found with a median richness of 23 taxa (more representative of typical richness in the mid-reaches of ringplain streams and rivers). During the current period spring (19 taxa) and summer (21 taxa) richness were slightly lower than the historical median.

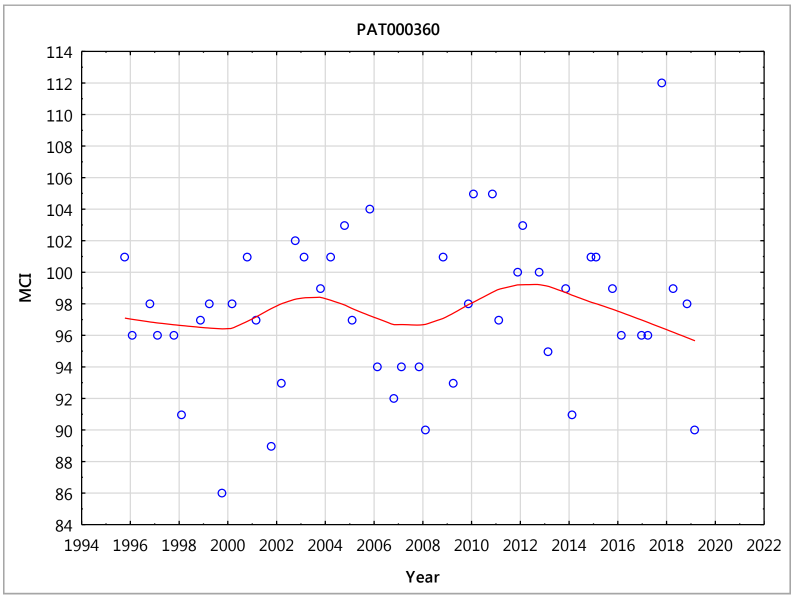
MCI values have had a moderately large range (26 units) at this site, typical of sites in the mid-reaches of ringplain streams and rivers. The median value (98 units) has been relatively typical of the scores at mid-reach sites elsewhere on the ringplain. The spring (98 units) was the same as the historical median and while the summer score (90 units) was not significantly lower than the historic median and spring score. They categorised this site as having 'fair' health (spring and summer) generically (Table 3). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.3.3.2 Predicted stream 'health'

The Patea River site at Skinner Road is 19.2 km downstream of the National Park boundary at an altitude of 240 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 99 for this site. The historical site median, spring and summer scores were not significantly different to this value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 109 units. The historical, spring and summer scores were all significantly lower than the REC predictive value.

3.2.3.3.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 65). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Patea River at Skinner Road.



N = 48
Kendall tau = 0.08
p value = 0.41
FDR p = 0.49

N = 20
Kendall tau = -0.27
p value = 0.10
FDR p = 0.40

Figure 65 LOWESS trend plot of MCI data at the Skinner Road site, Patea River for the full dataset with Mann-Kendall test for the full and ten-year dataset

The small positive temporal trend in MCI scores over the entire monitoring period has not been statistically significant. An apparent decline in scores between 2004 and 2008 has been followed by some improvement followed by a more recent decline in scores again. The very small range exhibited by the trendline (3 units) has been of no ecological importance over the period. The trendline consistently indicated 'fair' generic river health (Table 3).

In contrast to the full dataset, the ten-year trend shows a declining trend. However, this was neither ecologically important or statistically significant.

3.2.3.4 Discussion

The Patea River at the SEM sites was found to have moderate to moderately high taxa richness which was consistent with the results from past surveys.

The upper site had 'very good' and 'excellent' macroinvertebrate community health in spring and summer respectively. The middle site had generally 'good' health while the lower site was in the poorest condition with only 'fair' health.

Overall, MCI scores fell in a downstream direction between the upper site and the furthest downstream site by 37 units in spring and 58 units in summer, over a river distance of 17.3 km indicating a significant deterioration in macroinvertebrate community health between the upper and lower site. This was consistent with previous surveys with a median decrease of 40 units recorded over all surveys.

The time trend analysis showed no significant changes at any of the sites, though the middle site was close to showing a statistically significant improvement. Overall, the time trend analysis indicated that macroinvertebrate community health had not been significantly improving or deteriorating at sites in the upper/middle Patea River since monitoring began. Lack of improvement for the upper site was probably due to it already being in great condition; while the lower site has consistency had discharges from the Stratford WWTP during the monitoring period which has likely mitigated other effects in the catchment.

3.2.4 Punehu Stream

The Punehu Stream is a ringplain stream whose source is located within Egmont National Park and flows in a southerly direction with its mouth located east of the town of Opunake. There are two SEM sites, one located in its upper middle reaches and the other located in its lower reaches.

3.2.4.1 Wiremu Road site (PNH000200)

3.2.4.1.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Punehu Stream between October 1995 and February 2018 at this open, upper mid-reach site in farmland, 4 km downstream of the National Park These results are summarised in Table 37 together with the results from the current period, and illustrated in Figure 66.

Table 37 Results of previous surveys performed in the Punehu Stream at Wiremu Road together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000200	46	18-32	27	104-137	124	20	135	21	122

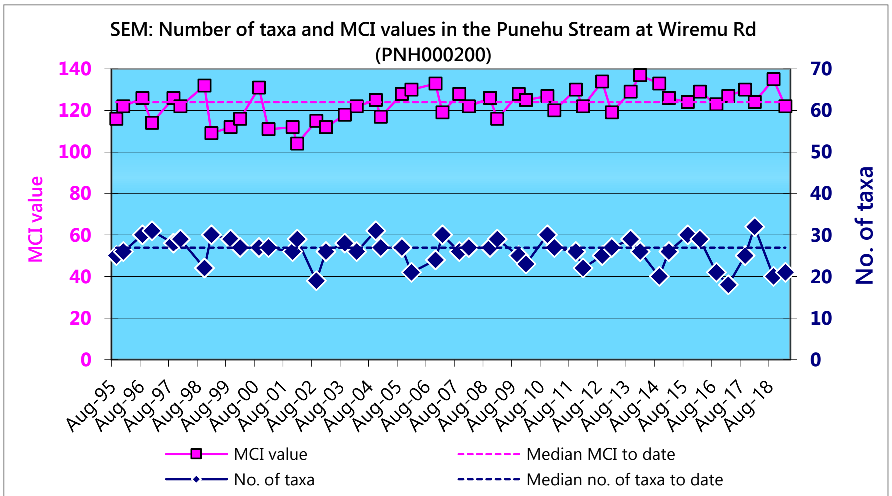


Figure 66 Numbers of taxa and MCI values in the Punehu Stream at Wiremu Road

A moderate range of richness (18 to 32 taxa) has been found at this site with a median richness of 27 taxa. During the current period, spring (20 taxa) and summer (21 taxa) richness were moderate and lower than the historic median richness.

MCI values have had a moderate range (33 units) at this site, typical of a site in the (upper) mid reaches of a ringplain stream in more open farmland. The median value (124 units) has been typical of mid reach sites elsewhere on the ringplain. The spring score (135 units) was significantly higher than the historic median while summer score (122 units) was not significantly different to the historical median but significantly lower than the spring score (Stark, 1998). These scores categorised this site as having ‘very good’ generic health (Table 3) in spring and summer. The historical median score (124 units) placed this site in the ‘very good’ category for the generic health.

3.2.4.1.2 Predicted stream 'health'

The Punehu Stream site at Wiremu Road is 4.4 km downstream of the National Park boundary at an altitude of 270 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 115 for this site. The historical site median and summer score were not significantly different to the distance predictive value while the spring score was significantly higher (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 121 units. Again, the historical site median and summer score were not significantly different to the predictive value while the spring score was significantly higher (Stark, 1998)

3.2.4.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 67). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Punehu Stream at Wiremu Road.

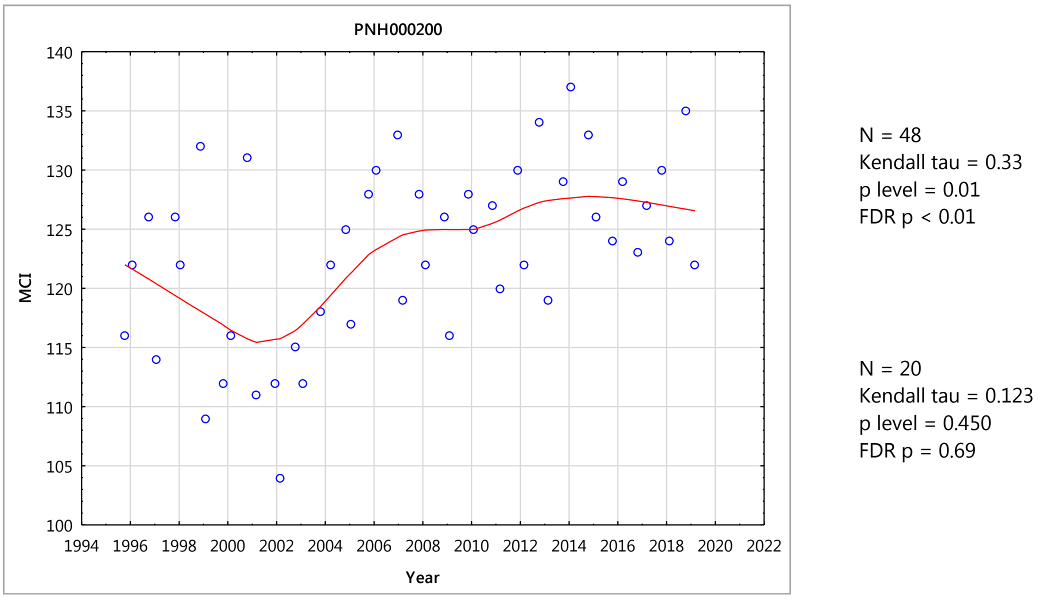


Figure 67 LOWESS trend plot of MCI data at the Wiremu Road site, Punehu Stream

A steady increase in MCI scores had been apparent between 2002 and 2007, and again since 2010, resulting in the positive trend in scores over the entire period which has been statistically highly significant (FDR $p < 0.01$ level). The trendline range (13 units) has been of ecological importance, particularly since 2002 (coincident with localised riparian fencing and planting of the true left-bank of the stream). Overall, the trendline range was indicative of 'very good' generic stream health (Table 3) apart from a short period of 'good' health from 1997 to 2005.

The ten-year trend showed a slight positive trend, however unlike the trend for the full dataset this was of no statistical or ecological significance.

3.2.4.2 SH 45 site (PNH000900)

3.2.4.2.1 Taxa richness and MCI

Forty-six surveys have been undertaken at this lower reach site at SH 45 in the Punehu Stream between October 1995 and February 2018. These results are summarised in Table 38, together with the results from the current period, and illustrated in Figure 68.

Table 38 Results of previous surveys performed in the Punehu Stream at SH 45 together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
PNH000900	46	10-26	21	70-114	90	22	98	18	88

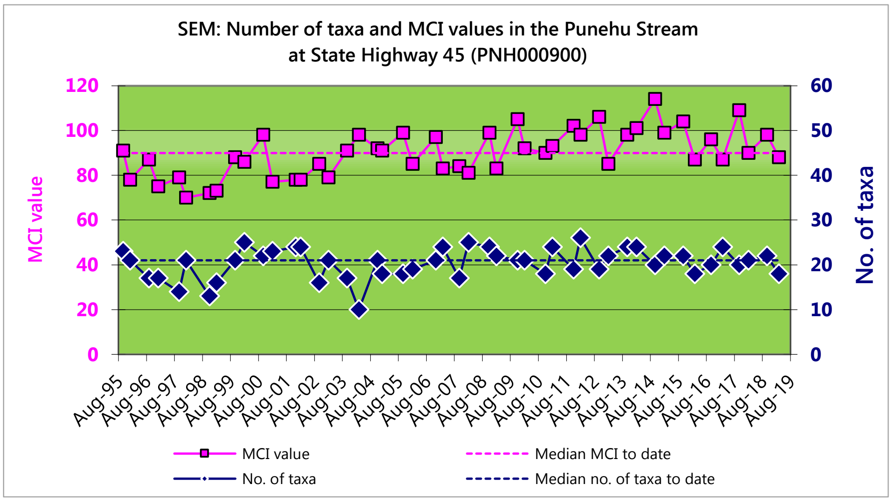


Figure 68 Numbers of taxa and MCI values in the Punehu Stream at SH 45

A wide of richness (10 to 26 taxa) has been found with a median richness of 21 taxa, relatively typical of richness in the lower reaches of ringplain streams and rivers. During the current period, spring (22 taxa) and summer (18 taxa) richness were moderate and similar to the historical median.

MCI scores have had a relatively wide range (44 units) at this site, typical of sites in the lower reaches of ringplain streams. The median value (90 units) also has been relatively typical of lower reach sites elsewhere on the ringplain. The spring (98 units) and summer (88 units) scores were not significantly different to the historical median (Stark, 1998). These scores categorised this site as having 'fair' health in spring and summer (Table 3). The historical median score (90 units) placed this site in the 'fair' category for generic health.

3.2.4.2.2 Predicted stream 'health'

The Punehu Stream site at SH 45 is 20.9 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 98 for this site. The historical site median, spring and summer score were not significantly different to the distance predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 100 units. The historical site median and spring score were not significantly different to this value while the summer score was significantly lower (Stark, 1998).

3.2.4.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 102). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on all the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Punehu Stream at SH 45.

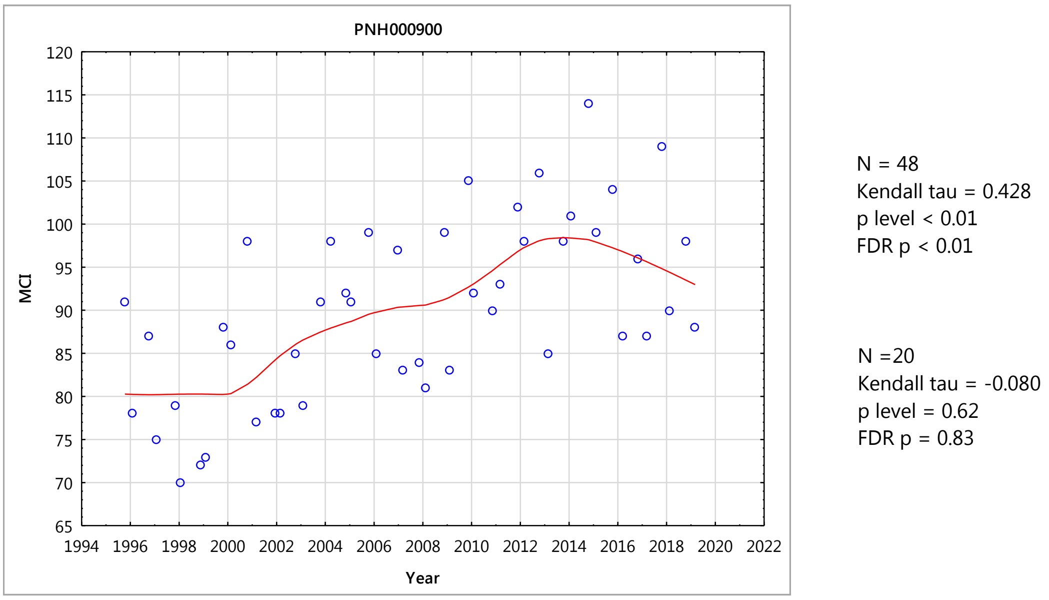


Figure 69 LOWESS trend plot of MCI data at the SH 45 site, Punehu Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

This site had a strong positive trend over the entire monitoring period, which was statistically significant ($p < 0.01$) after FDR application. The trendline range of scores (18 units) has been ecologically important over this period with scores mainly indicative of 'fair' generic stream health (Table 3).

In contrast to the full dataset, the ten-year trend was negative but this was not ecological or statistical significant.

3.2.4.3 Discussion

The Punehu Stream at the SEM sites was found to have moderate taxa richness which was consistent with the results from past surveys. The upper mid-reach (Wiremu Road) site had 'very good' macroinvertebrate community health while the lower reach (SH 45) site had 'fair' macroinvertebrate community health.

MCI scores typically significantly fell in a downstream direction by 34 units, over a stream distance of 16.5 km through the (upper) mid to lower reaches of this stream. Issues have occurred on occasions with consented dairy shed discharge compliance and cumulative impacts of such discharges in the Mangatawa Stream sub-catchment in the local vicinity of the lower site (TRC, 2011 and Fowles, 2014). Changes in macroinvertebrate community structure at the lower site, especially when compared with the upper mid-reach site, reflect ongoing issues with nutrient enrichment.

The time trend analysis showed significant positive trends for both sites for the full dataset indicating that over time macroinvertebrate community health has been significantly improving at both sites. However, while the ten-year trend for the upper site was positive, but non-significant, the lower site had a negative non-significant trend. Further declines in macroinvertebrate health at the lower site would indicate that previous improvements made in the lower catchment have been eroded with agricultural impacts the likely cause of any decline.

3.2.5 Tangahoe River

The Tangahoe River is an eastern hill country river flowing in a southerly direction with a river mouth located east of Hawera. Three sites were included in the SEM programme in 2007 for the purpose of monitoring long-term land use changes (afforestation) particularly in the upper-mid catchment. The Fonterra, Hawera dairy factory abstracts water from the river in the lower catchment for processing purposes. Two of the three sites are in the upper to mid, shallow gradient, reaches of the river (the upstream site within 4 km of the headwaters) with the third site in the lower reaches, some 4 km from the coast.

3.2.5.1 Upper Tangahoe Valley Road site (TNH000090)

3.2.5.1.1 Taxa richness and MCI

Twenty-two surveys have been undertaken at this upper reach site in the Tangahoe River between December 2007 and February 2018. These results are summarised in Table 39, together with the results from the current period, and illustrated in Figure 70.

Table 39 Results of previous surveys performed in the Tangahoe River at upper Tangahoe Valley Road, together with 2018-2019 results

Site code	SEM data (2007 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000090	22	14-31	23	90-107	100	15	96	29	93

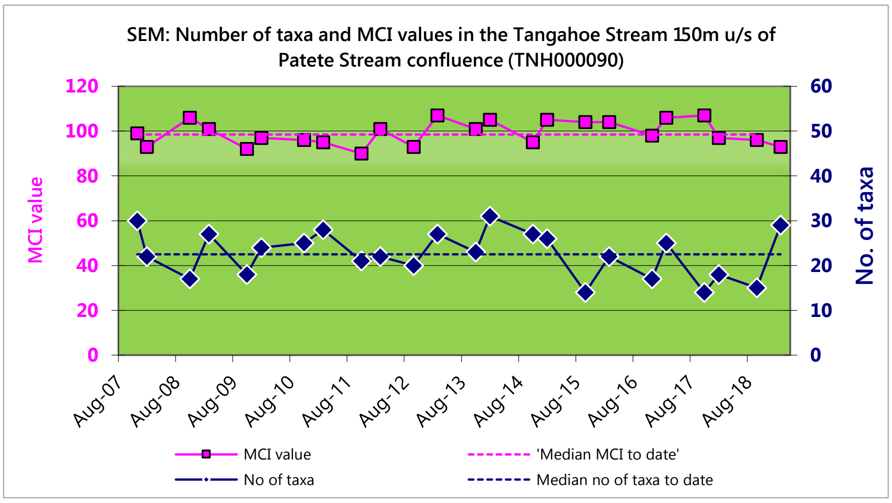


Figure 70 Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

A relatively wide range of richness (14 to 31 taxa) has been found with a moderate median richness of 23 taxa. During the current period, spring (15 taxa) and summer (29 taxa) taxa richness differed substantially from the median and from each other.

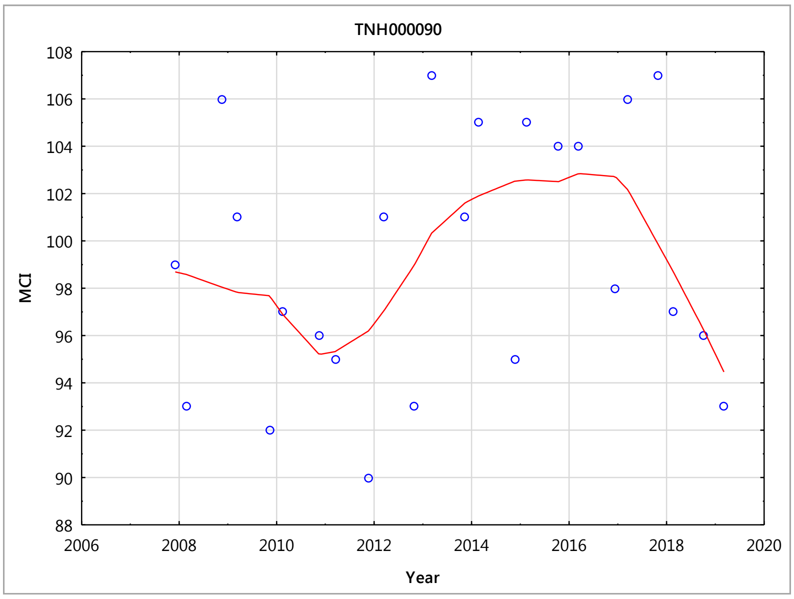
MCI values have had a relatively narrow range (17 units) at this site, typical of scores at sites toward the upper reaches of streams and rivers. The spring (96) units) and summer (93 units) scores were not significantly different to the historical median score, although the summer MCI score was towards the lower end of the recorded range. These scores categorised this site as having 'fair' (spring and summer) health generically (Table 3). The historical median score (100 units) placed this site in the 'good' category for the generic method of assessment.

3.2.5.1.2 Predicted stream 'health'

The Tangahoe River site at upper Tangahoe Valley Road, at an altitude of 85 m asl, is toward the upper reaches of this low gradient river draining an eastern hill country catchment. The REC predicted MCI value (Leathwick, et al. 2009) was 110 units and therefore the historical median was not significantly different but the spring and summer scores were significantly lower than the predictive value.

3.2.5.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 71). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the full SEM results (2007-2019) and the most recent ten-years of results (2009-2019) from the site in the Tangahoe River at upper Tangahoe Valley Road.



N = 24
Kendall tau = 0.122
p level = 0.4
FDR p = 0.49

N = 20
Kendall tau = 0.204
p level = 0.21
FDR p = 0.48

Figure 71 LOWESS trend plot of MCI data in the Tangahoe River for the upper Tangahoe Valley site for the full dataset with Mann-Kendall test for full and ten-year dataset

There was a small, positive, but non-significant trend for this hill country catchment site toward the upper reaches. The trendline range (8 units) was of limited ecological importance to date. The trendline range indicated 'fair' health from 2007-2013 before improving to 'good' health from 2014 to 2017, and decreasing to 'fair' health in recent years coincident with forestry operations in the catchment taking place in 2017.

There was a non-significant positive trend in MCI scores over the most recent ten-year period, congruent with the only slightly larger full dataset. The trendline range indicated 'fair' health from 2009-2013 before improving to 'good' health from 2014 to 2017, and decreasing to 'fair' health in recent years.

3.2.5.2 Tangahoe Valley Road bridge site (TNH000200)

3.2.5.2.1 Taxa richness and MCI

Twenty-two surveys have been undertaken at this mid reach site in the Tangahoe River between December 2007 and February 2018. These results are summarised in Table 40, together with the results from the current period, and illustrated in Figure 72.

Table 40 Results of previous surveys performed in the Tangahoe River at Tangahoe Valley Road Bridge, together with 2018-2019 results

Site code	SEM data (2007 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000200	22	17-35	25	92-111	103	26	101	29	99

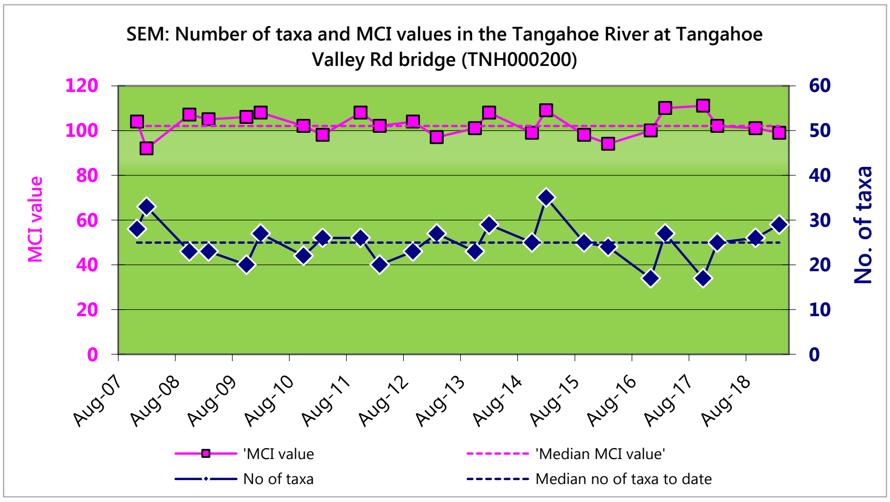


Figure 72 Numbers of taxa and MCI values in the Tangahoe River at Tangahoe Valley Road Bridge

A moderate range of richness (17 to 33 taxa) has been found with a relatively good median richness of 25 taxa (typical of richness in the mid-reaches of hill country rivers). During the current period, spring richness (26 taxa) and summer richness (29 taxa) were similar to the historical median.

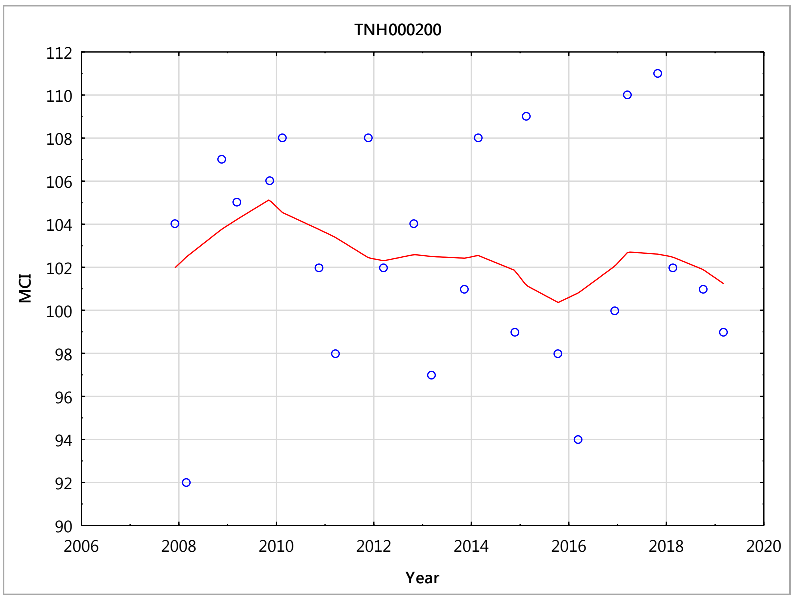
MCI values have had a moderate range (19 units) at this site, typical of a site in the mid-reaches of hill country streams and rivers. The spring (101 units) and summer (99 units) scores were not significantly different to the historical median (103 units). These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (103 units) placed this site in the 'good' category for the generic assessment of health.

3.2.5.2.2 Predicted stream 'health'

The Tangahoe River site at Tangahoe Valley Road Bridge, at an altitude of 65 m asl, is in the mid reaches of a river draining a hill country catchment. The REC predicted MCI value (Leathwick, et al. 2009) was 108 units. The historical, spring and summer scores were not significantly different to this predictive value either (Stark, 1998).

3.2.5.2.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 73). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the full SEM results (2007-2019) and the most recent ten-years of results (2009-2019) from the site in the Tangahoe River at the Tangahoe Valley Road Bridge.



N = 24
Kendall tau = -0.037
p level = 0.80
FDR p = 0.88

N = 20
Kendall tau = -0.070
p level = 0.67
FDR p = 0.85

Figure 73 LOWESS trend plot of MCI data in the Tangahoe River for the Tangahoe Valley Road bridge site for the full dataset with Mann-Kendall test for the full and ten-year dataset

There was a very small, negative, non-significant trend for this mid river reach, hill country catchment site. The trendline range (5 units) over the period has been of limited ecological importance. The trendline range has indicated 'good' generic river health.

There was also a very small, negative, non-significant trend in MCI scores over the most recent ten-year period, congruent to the full dataset. The trendline for the most recent ten-year period was indicative of 'good' health.

3.2.5.3 Site downstream of railbridge (TNH000515)

3.2.5.3.1 Taxa richness and MCI

Twenty-two surveys have been undertaken at this lower reach site in the Tangahoe River between December 2007 and February 2018. These results are summarised in Table 41, together with the results from the current period, and illustrated in Figure 74.

Table 41 Results of previous surveys performed in the Tangahoe River d/s of railbridge, together with 2018-2019 results

Site code	SEM data (2007 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TNH000515	22	14-26	20	78-104	94	21	94	17	79

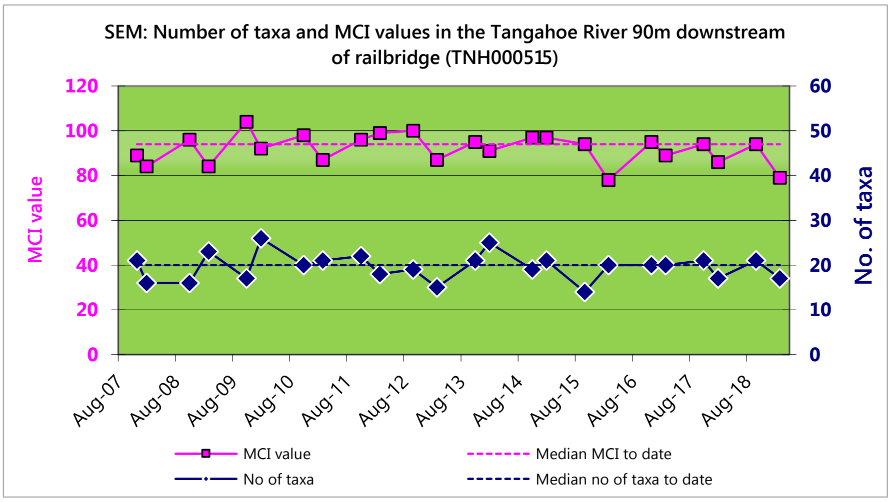


Figure 74 Numbers of taxa and MCI values in the Tangahoe River downstream of the railbridge

A moderate range of richness (14 to 26 taxa) have been found with a slightly higher than typical median richness of 20 taxa for a site in the lower reaches of a hill country river. During the current period, spring (21 taxa) and summer (17 taxa) richness were similar to the median richness.

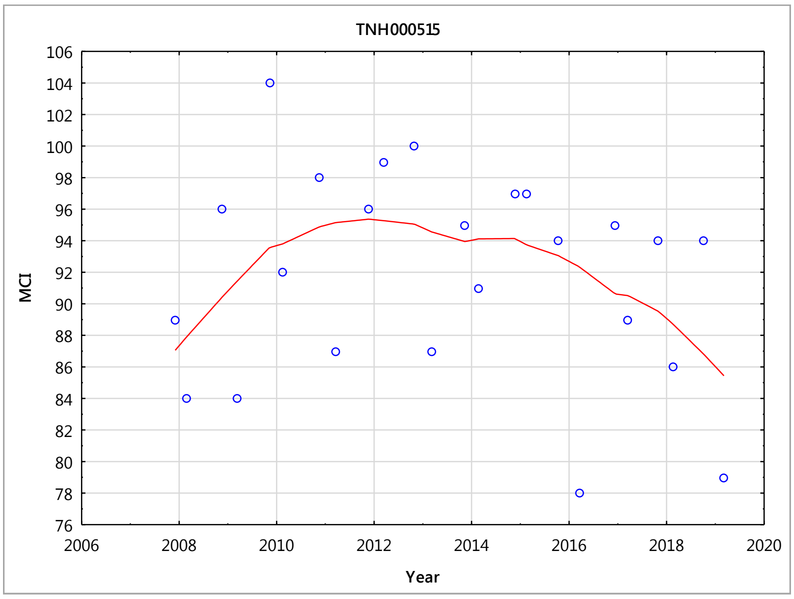
MCI values also have had a moderate range (26 units) at this site, narrower than typical of sites in the lower reaches of hill country streams and rivers. The spring score (94 units) was very similar to the historical median while the summer (79 units) score was significantly lower and was only one unit higher than the lowest score recorded to date at the site. These scores categorised this site as having 'fair' health in spring and 'poor' health in summer (Table 3). The historical median score (94 units) placed this site in the 'fair' category for the generic health.

3.2.5.3.2 Predicted stream 'health'

The Tangahoe River site downstream of the railbridge, at an altitude of 15 m asl, is in the lower reaches of a river draining a hill country catchment. The REC predicted MCI value (Leathwick, et al. 2009) was 95 units and therefore the historical median and spring score were not significantly different to the predictive value but the summer score was significantly lower (Stark, 1998).

3.2.5.3.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 75). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the full SEM results (2007-2019) and the most recent ten-years of results (2009-2019) from the site in the Tangahoe River downstream of the railbridge.



N = 24
Kendall tau = -0.136
p level = 0.35
FDR p = 0.46

N = 20
Kendall tau = -0.374
p level = 0.02
FDR p = 0.15

Figure 75 LOWESS trend plot of MCI data for the Tangahoe River site downstream of the railbridge for the full dataset with Mann-Kendall test for the full and ten-year dataset

There was a non-significant negative trend for this lower river reach, hill country catchment site. The trendline range (10 units) has bordered on ecologically important but overall there has been no real overall change over the monitored period. However, the trendline indicates there has been changes over time, with improvement at the site followed by decline. The trendline range have indicated 'fair' generic river health over the period to date.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, congruent with the full dataset, with a decline in the trendline from 2012 onwards, this trend was statistically significant before FDR. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.5.4 Discussion

The Tangahoe River at the SEM sites was found to have moderate to moderately low taxa richness. The upper site had lower than usual taxa richness for spring, probably due to a logging operation which may have reduced taxa richness. Both the middle and lowers sites had typical taxa richness.

The upper reach (upper Tangahoe Valley Road) site had 'fair' macroinvertebrate community health during spring and summer. The middle site at the Tangahoe Valley Road Bridge had 'good' to 'fair' macroinvertebrate community health with results slightly higher than the upper site which was a typical result. The lower reach site at the railbridge had 'fair' to 'poor' macroinvertebrate community health with the summer score quite low for the site.

MCI scores fell in a downstream direction in both spring (by two units) and in summer (by 14 units), over a distance of 30.2 km (and decrease in elevation of 70 m) though MCI scores actually improved from the upper to middle site. The improvement in macroinvertebrate health would be related to better quality habitat present at the middle site which has a riffle with a cobbles/ boulder substrate as opposed to the upper site with a clay dirt substrate. Using the long-term median SEM MCI scores for each site (Appendix II), there is normally an improvement in MCI scores between the upper reach (Upper Tangahoe Valley Road) and the mid-reach (Tangahoe Valley Road bridge) sites by six units. The decline between the mid-reach site and lower reach (railbridge) site has historically been nine units.

The time trend analyses showed no significant trends for any site indicating that macroinvertebrate health was not significantly improving or deteriorating though a relatively small time range of twelve years may be contributing to the lack of significance. However, the lower site for the most recent ten years was significant before FDR application, though after FDR the p-value was not that close to being p < 0.05. It was suggestive that if the site has low MCI scores in the future that the trend will become significant indicating deterioration at the site.

3.2.6 Timaru Stream

Timaru Stream is a ringplain stream arising within Egmont National Park and flows in a westerly direction. There are two SEM sites situated on the stream. In the 2008-2009 period severe headwater erosion events had impacted upon the macroinvertebrate communities of the upper reaches of this stream in particular (TRC, 2009).

3.2.6.1 Carrington Road site (TMR000150)

3.2.6.1.1 Taxa richness and MCI

Forty-five surveys have been undertaken at this upper reach site in the Timaru Stream inside the National Park boundary at Carrington Road between October 1995 and February 2018. These results are summarised in Table 42, together with the result from the current period, and illustrated in Figure 76.

Table 42 Results of previous surveys performed in the Timaru Stream at Carrington Road, together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TMR000150	45	8-34	26	119-152	138	24	131	27	130

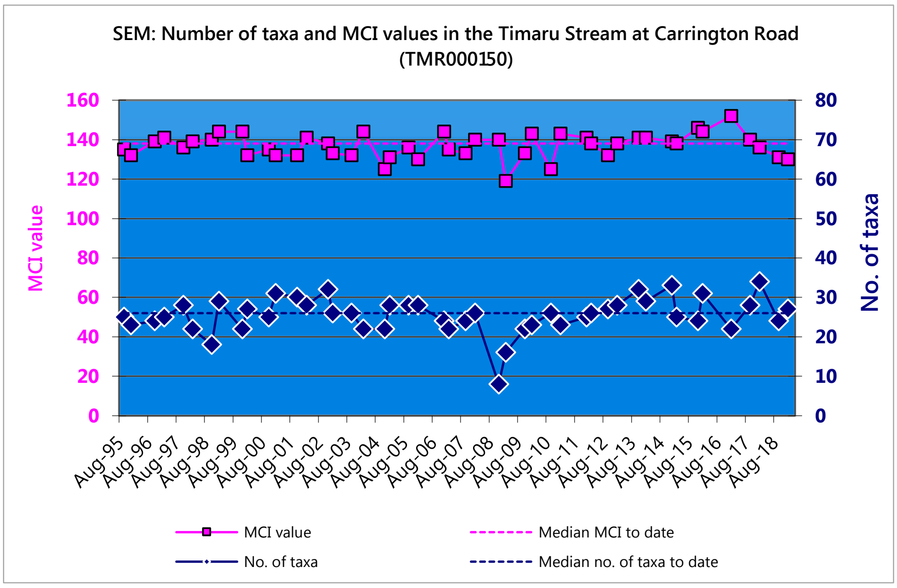


Figure 76 Numbers of taxa and MCI values in the Timaru Stream at Carrington Road

Taxa richness was typically moderately high for the site (median richness of 26 taxa) with only one low result in December 2008 (eight taxa) due to headwater erosion effects over the 2008-2009 period which markedly reduced richness. The median richness was similar to the typical richness (28 taxa) in ringplain streams and rivers near the National Park boundary at similar altitudes. During the current period, spring (24 taxa) and summer (27 taxa) richness were both similar to the historical median.

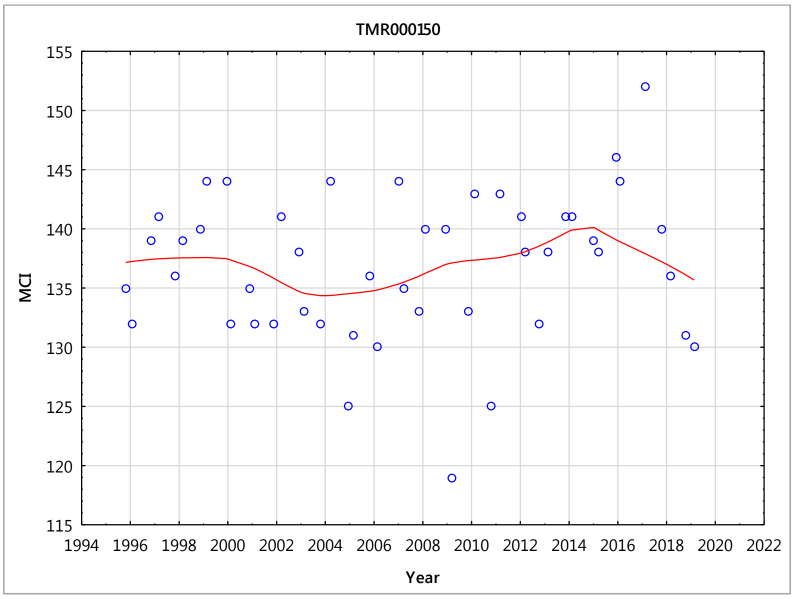
MCI values have had a wider range (33 units) at this site than typical of a site near the National Park boundary due to the low value (119 units) after the 2008-2009 headwater erosion period. However, the median value (138 units) is slightly higher than typical upper reach sites elsewhere on the ringplain. The spring (131 units) and summer (130 units) scores were slightly lower but not significantly different from the historical median. The scores categorised this site as having 'very good' (spring and summer) health generically (Table 3). The historical median score (138 units) placed this site in the 'very good' category for the generic health.

3.2.6.1.2 Predicted stream 'health'

The Timaru Stream at Carrington Road is within the National Park boundary at an altitude of 420 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median (138 units) and spring and summer scores were not significantly different to the predictive value (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 141 units. The historical site median and spring score were not significantly different to this value but the summer score was significantly lower at this pristine site.

3.2.6.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 77). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on all the SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Timaru Stream at Carrington Road.



N = 47
Kendall tau = 0.061
p level = 0.55
FDR p = 0.64

N = 19
Kendall tau = -0.036
p level = 0.83
FDR p = 0.95

Figure 77 LOWESS trend plot of MCI data at the Carrington Road site for the full dataset with Mann-Kendall test for the full and ten-year dataset

There was a small, positive, non-significant trendover the full data set. The trendline had a range over six units which was not ecologically important. The trendline scores have been indicative of 'very good' generic stream health from the data available (Table 3).

The ten-year period also showed a minor negative trend of neither ecological or statistical significance.

3.2.6.2 SH45 site (TMR000375)

3.2.6.2.1 Taxa richness and MCI

Forty-five surveys have been undertaken in the Timaru Stream at this lower, mid-reach site at SH45 between October 1995 and February 2018. These results are summarised in Table 43, together with the results from the current period, and illustrated in Figure 78.

Table 43 Results of previous surveys performed in the Timaru Stream at SH45, together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2017		Feb 2018	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
TMR000375	45	13-35	27	89-120	103	25	110	22	88

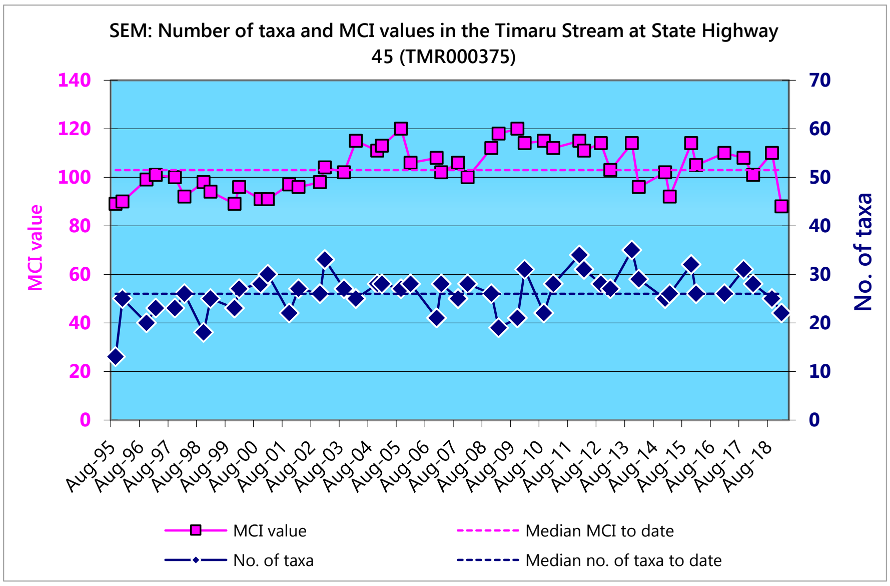


Figure 78 Numbers of taxa and MCI values in the Timaru Stream at State Highway 45

An unusually wide range of richness (13 to 35 taxa) has been found with a median richness of 27 taxa which was higher than typical richness in the mid reaches of ringplain streams and rivers. During the current period spring (25 taxa) and summer (22 taxa) richness were similar to the historical median.

MCI values have had a slightly wider range (31 units) at this site than typical of sites in the mid reaches of ringplain streams. The median value (103 units) was very similar to the median calculated from mid reach sites on the ringplain. The spring (110 units) were not significantly different to the historical median but the summer score (88 units) was significantly lower than both the historic median and spring score (Stark, 1998). The scores categorised this site as having 'good' health in spring and 'fair' health in summer (Table 3). The historical median score (103 units) placed this site in the 'good' category for the generic health.

3.2.6.2.2 Predicted stream 'health'

The Timaru Stream at SH45 is 10.9 km downstream of the National Park boundary at an altitude of 100 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 105 for this site. The historical site median and spring score were not significantly different to the predictive value but the summer score was significantly lower. The REC predicted MCI value (Leathwick, et al. 2009) was 117 units. The historical site median and summer score were significantly lower than this value, while the spring score was not significantly different to this value.

3.2.6.2.3 Temporal trends in data

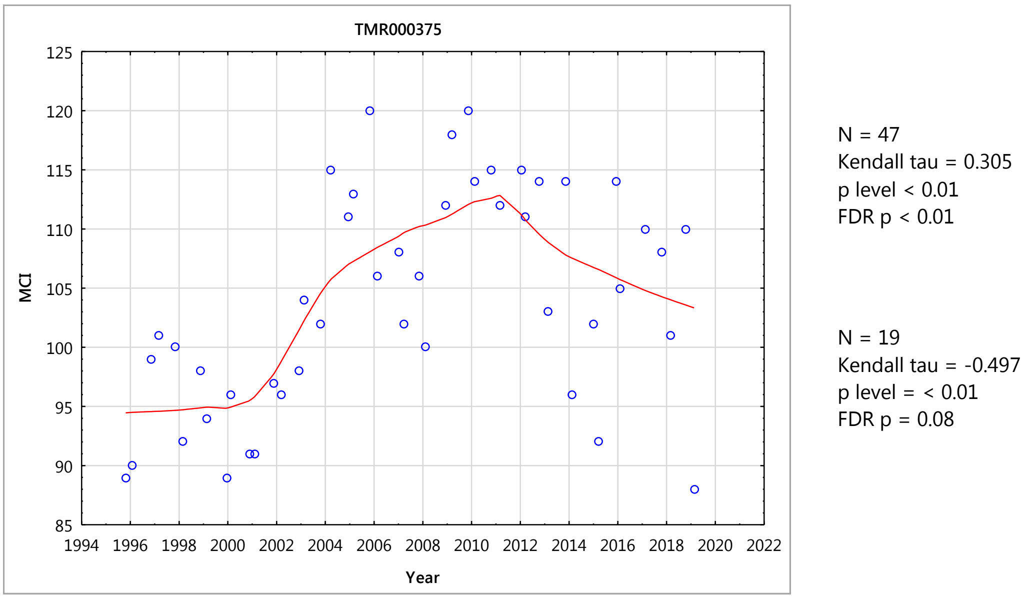


Figure 79 LOWESS trend plot of MCI data at the SH45 site for the full dataset with Mann-Kendall test for the full and ten-year dataset

The trendline had a highly significant improvement over time though since 2012 there has been a decrease in MCI scores. The trendline had a range of 18 units, an ecologically important range. The trendline indicated an improvement in generic stream 'health' (Table 3) from 'fair' to 'good'.

In contrast to the full dataset, the ten-year period showed a strong declining trend. This trend was statistically significant before FDR adjustment but not after FDR adjustment. If the present trend continues then it will likely become significant after FDR adjustment, indicating a significant decline at the site.

3.2.6.3 Discussion

The spring and summer surveys indicated that the upper site had 'very good' health while the lower site had 'good' to 'fair' health.

The MCI scores fell in a downstream direction by 21 units in spring and by 42 units in summer, over a stream distance of 10.9 km downstream from the National Park boundary. This was typical for Timaru Stream and was likely due to cumulative impacts throughout the middle catchment affecting the bottom site.

Time trend analysis indicated no change in macroinvertebrate community health over the full or ten-year dataset for the upper site, which was expected given that the site was unlikely to change as it was in a national park. The lower site showed a significant positive improvement over the full time period, which contrasted with the nearly significantly, negative, trend for the ten-year period. The site had mature riparian native vegetation and the site itself appears to have had minimal change over the entire monitoring period.

Therefore, improvements and declines in macroinvertebrate health at the site were likely due to changes in water quality, driven most likely by inputs from the agricultural dominated middle catchment.

3.2.7 Waiau Stream

The Waiau Stream is a small, lowland stream flowing in a northerly direction with a mouth situated east of Waitara. One SEM site is located in the mid reach of the stream.

3.2.7.1 Inland North site (WAI000110)

3.2.7.1.1 Taxa richness and MCI

Thirty-eight surveys have been undertaken in this mid-reach site in the Waiau Stream between February 1998 and February 2018. These results are summarised in Table 44, together with the results from the current period, and illustrated in Figure 80.

Table 44 Results of previous surveys performed in Waiau Stream at Inland North Road, together with the 2018-2019 results

Site code	SEM data (1998 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WAI000110	38	17-30	21	79-101	91	24	94	19	84

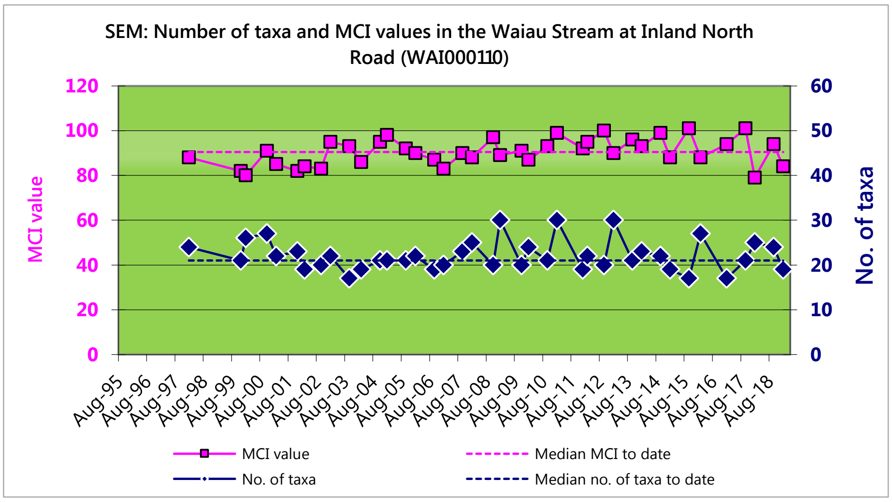


Figure 80 Numbers of taxa and MCI values in the Waiau Stream at the Inland North Road site

A moderate range of richness (17 to 30 taxa) has been found, with a median richness of 21 taxa, a typical richness in small lowland coastal streams. During the current period, the spring (24 taxa) and summer (19 taxa) richness were similar to the historic median richness.

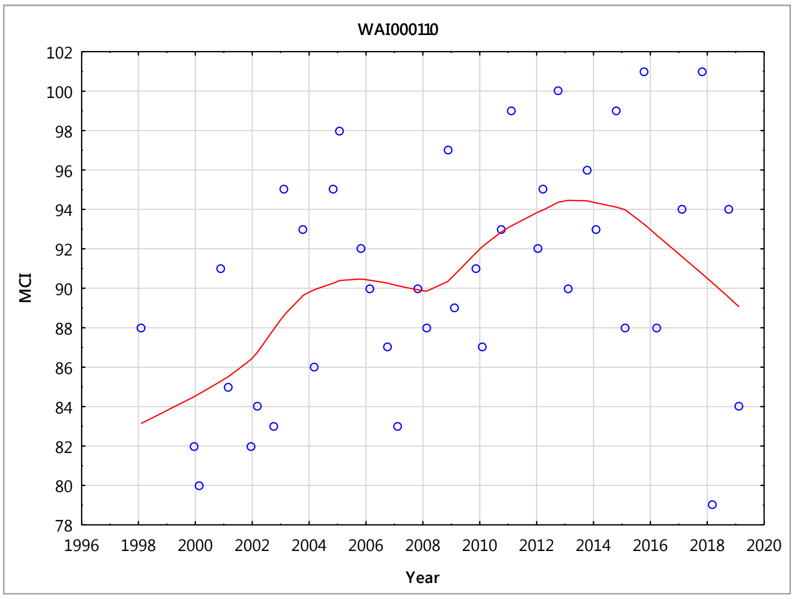
MCI values have had a moderate range (22 units) to date at this site. The median value (91 units) is more typical of scores at sites in the lower reaches of small lowland streams and rivers. The spring (94 units) and summer (84 units) scores were not significantly different to the historic median and each other through the summer score was the second lowest score recorded at the site since 2007, the lowest being the previous summer score. The score categorised this site as having ‘fair’ health in spring and summer (Table 3). The historical median score (91 units) placed this site in the 'fair' category for the generic method of assessment.

3.2.7.1.2 Predicted stream 'health'

The Waiau Stream rises at an elevation of less than 100 m asl as seepage beyond the ringplain and the site at Inland North Road is in the mid reaches at an altitude of 50 m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 91 units. The historical site median, spring and summer scores were not significantly different from the REC predicted value.

3.2.7.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 81). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1998-2019) and the most recent ten-years of results (2009-2019) from the site in the Waiau Stream at Inland North Road.



N = 40
Kendall tau = 0.297
p level = 0.01
FDR p = 0.02

N = 19
Kendall tau = -0.012
p level = 0.94
FDR p = 0.96

Figure 81 LOWESS trend plot of MCI data at the Inland North Road site, Waiau Stream for the full dataset with the full and ten-year dataset

A significant positive temporal trend in MCI scores has been found (FDR p = 0.02) over the monitoring term at this site. The trend had two dips where scores declined and the current period is in the second of the two dips. The trendline range of scores (11 units) has been of significant ecological importance. Trendline scores have been indicative of 'fair' generic stream health (Table 3) throughout the period.

The ten-year period, shows a minor negative trend, which is neither statistically or ecologically significant.

3.2.7.2 Discussion

Taxa richness was moderate and typical for this site. Both surveys indicated that the macroinvertebrate community was in 'fair' health though the summer survey was towards the lower end of the range recorded at this site. There was usually some seasonal variation with summer scores five units lower than spring scores, probably due to low, stable, flows in combination with higher temperatures and more sunlight contributing towards macrophyte and periphyton growth at the site.

3.2.8 Waimoku Stream

The Waimoku Stream is a small ringplain stream with a source inside Egmont National Park in the Kaitake Ranges and flows in an easterly direction. There are two SEM sites situated on the stream in the upper and lower reaches.

3.2.8.1 Lucy's Gully site (WMK000100)

3.2.8.1.1 Taxa richness and MCI

Thirty-seven surveys have been undertaken at this upper reach site in the Kaitake Ranges between December 1999 and February 2018. These results are summarised in Table 45, together with the results from the current period, and illustrated in Figure 82.

Table 45 Results of previous surveys performed in the Waimoku Stream at Lucy's Gully, together with the 2018-2019 results

Site code	SEM data (1999 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WMK000100	37	22-38	31	121-141	131	21	127	18	119

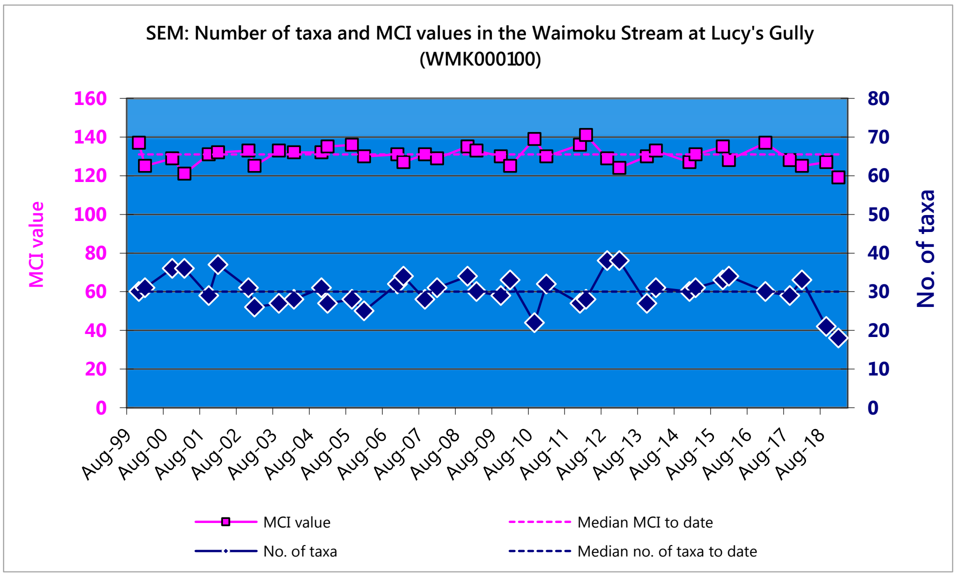


Figure 82 Numbers of taxa and MCI values in the Waimoku Stream at Lucy's Gully

A moderate range of richness (22 to 38 taxa) has been found, with a median richness of 31 taxa which is more representative of typical richness in the upper reaches of ringplain streams and rivers. During the current period the spring (21 taxa) and summer (18 taxa) richness were very substantially lower than the historic median richness by 10 to 13 taxa respectively. Furthermore, both spring and summer richness were the lowest recorded to date at the site.

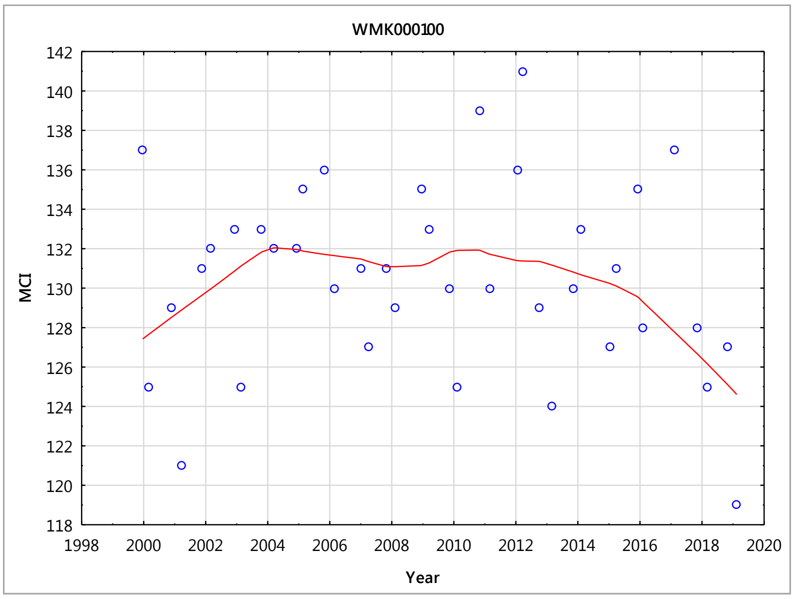
MCI values also have had a moderate range (20 units) at this site, slightly wider than typical of a site in the upper reaches of a ringplain stream. The median value (131 units) however, has been typical of upper reach sites elsewhere on the ringplain. The spring (127 units) score was not significantly different from the historical median but the summer score (119 units) was significantly lower and also the lowest recorded score to date for this site (Stark, 1998). This score categorised this site as having 'very good' health in spring and 'good' health in summer (Table 3). The historical median score (131 units) placed this site in the 'very good' health category.

3.2.8.1.2 Predicted stream 'health'

The Waimoku Stream site at Lucy's Gully is within the Kaitake Ranges of the National Park boundary but at an altitude of 160 m asl and only 4 km from the coast. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median and spring score were not significantly different to this value while the summer score was significantly lower. The REC predicted MCI value (Leathwick, et al. 2009) was 128 units. The historical site median, spring and summer scores were not significantly different to the REC predictive score.

3.2.8.1.3 Temporal trends in data

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 83). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1999-2019) and the most recent ten-years of results (2009-2019) from the site in the Waimoku Stream at Lucy's Gully.



N = 39
Kendall tau = -0.103
p level = 0.36
FDR p = 0.46

N = 19
Kendall tau = -0.256
p level = 0.13
FDR p = 0.4

Figure 83 LOWESS trend plot of MCI data at the Lucy's Gully site, Waimoku Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

There was a weak, negative, non-significant trend in MCI scores over the entire monitoring period at this pristine site within the National Park. The trendline range (seven units) has been of minor ecological importance and has continuously indicated 'very good' generic stream health (Table 3).

The ten-year period also shows a negative trend that was not statistically or ecologically significant.

3.2.8.2 Oakura Beach site (WMK000298)

3.2.8.2.1 Taxa richness and MCI

Thirty-seven surveys have been undertaken at this lower reach site just upstream of Oakura Beach in the Waimoku Stream between December 1999 and February 2018. These results are summarised in Table 46, together with the results from the current period, and illustrated in Figure 84.

Table 46 Results of previous surveys performed in the Waimoku Stream at Oakura Beach together with 2018-2019 results

Site code	SEM data (1999 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WMK000298	37	10-29	21	75-105	92	19	98	20	97

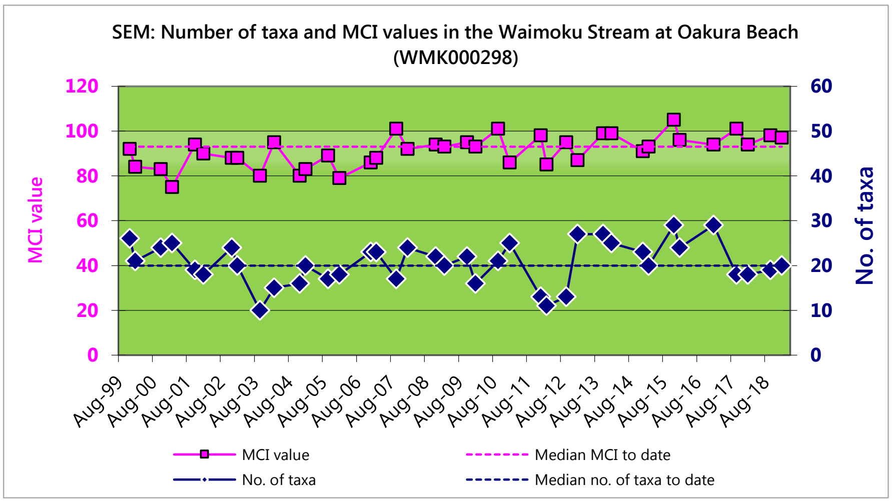


Figure 84 Numbers of taxa and MCI values in the Waimoku Stream at Oakura Beach

A wide range of richness (10 to 29 taxa) has been found; wider than might be expected, with a median richness of 21 taxa, which was more representative of typical richness in ringplain streams and rivers in the lower reaches. During the current period, spring (19 taxa) and summer (20 taxa) richness were similar to the historic median taxa richness.

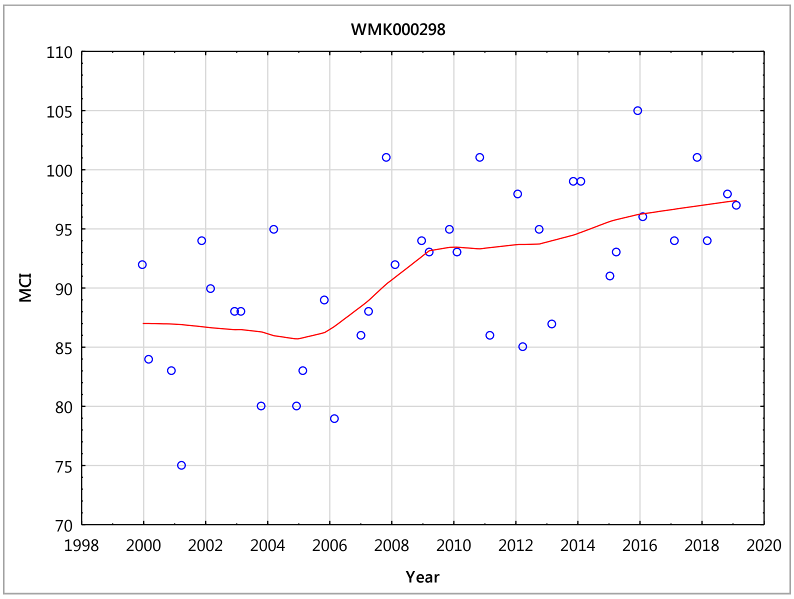
MCI scores have had a relatively wide range (30 units) at this site, typical of sites in the lower reaches of ringplain streams. The spring (98 units) and summer (97 units) scores were slightly higher but not significantly different to the historical median. The scores categorised this site as having 'fair' health (Table 3). The historical median score also categorised the site as having 'fair' health generically.

3.2.8.2.2 Predicted stream 'health'

The Waimoku Stream Oakura Beach site is at an altitude of only 1 m asl and is also only 4 km downstream of the National Park boundary. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 116 for this site. The historical site median (92 units) is a significant 24 units lower than the predictive distance value. The spring and summer scores were also significantly lower than the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 103 units. The historical site median was significantly lower than the REC predictive value but the spring and summer scores were not significantly different.

3.2.8.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 85). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1999-2019) and the most recent ten-years of results (2009-2019) from the site in the Waimoku Stream at Oakura Beach.



N = 39
Kendall tau = 0.424
p level < 0.01
FDR p < 0.01

N = 19
Kendall tau = 0.185
p level = 0.27
FDR p = 0.57

Figure 85 LOWESS trend plot of MCI data at the Oakura Beach site, Waimoku Stream for the full dataset with Mann-Kendall test for the full and ten-year dataset

A positive, highly significant trend in MCI scores has been recorded during the entire monitoring period (FDR p < 0.01) indicating a significant improvement in macroinvertebrate health. The trendline range of scores (12 units) has been ecologically important and has consistently indicated 'fair' generic stream health at this site in the lower reaches of the stream.

The ten-year period also shows a positive trend, however this was neither ecologically or statistically significant.

3.2.8.3 Discussion

Taxa richness was atypically moderate at the upper site and typically moderate at the lower site. The upper site is in the national park within mature native forest and always has higher taxa richness than that recorded during the current monitoring year. The low taxa richness was probably due to the low flows at the time of the survey. A record time since 7x median flow fresh of 182 days was recorded indicating low preceding rainfall. The spring survey indicated that the macroinvertebrate community at the upper site was in 'very good' health while the summer survey recorded 'good' health, but had the lowest recorded result to date at the site. Again, this was likely due to low flows. The lower site had typical MCI scores indicating 'fair' health. MCI scores fell in a downstream direction in spring and summer by 29 and 22 units respectively, over a short stream distance of only 4.0 km downstream from the National Park boundary. This was a large decrease in condition for a relatively short distance and greater than what would be expected given the relatively intact upper catchment. This was likely due to a combination of factors including poorer habitat quality at this urban stream site, along with poorer water quality.

The time trend analysis indicated no trends at the upper site which would be expected given its pristine nature. The lower site had a significant positive trend over the full dataset indicating that macroinvertebrate health had improved though improvements may have plateaued over the last ten-years. Increases in the amount of riparian fencing and planting of waterways in the catchment have probably contributed to this improvement.

3.2.9 Waingongoro River

The Waingongoro River is a large ringplain river with a source inside Egmont National Park. The river flows in a southerly direction and there are six SEM sites situated along the length of the river.

3.2.9.1 Site near National Park boundary (WGG000115)

3.2.9.1.1 Taxa richness and MCI

Forty-six surveys have been undertaken at this upper reach site, 700m downstream of the National Park boundary in the Waingongoro River, between October 1995 and March 2018. These results are summarised in Table 47, together with the results from the current period, and illustrated in Figure 86.

Table 47 Results of previous surveys performed in the Waingongoro River 700m downstream of the National Park, together with 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000115	46	23-40	31	122-144	133	30	136	27	133

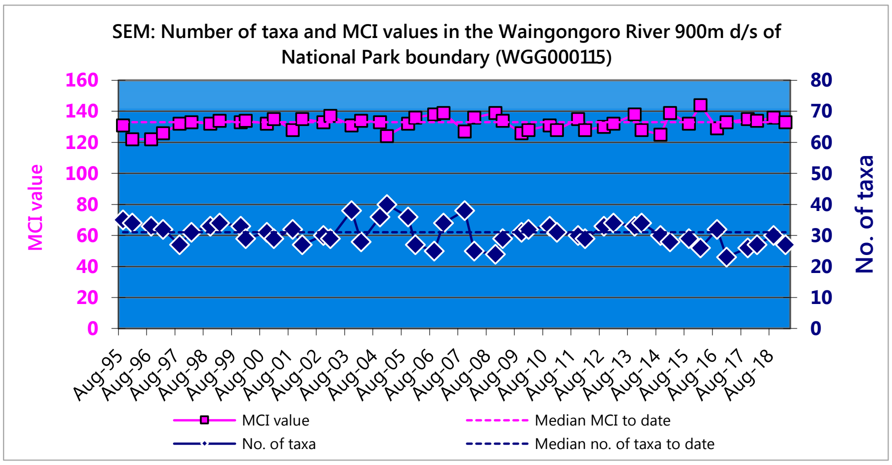


Figure 86 Numbers of taxa and MCI values in the Waingongoro River 700 m d/s National Park

A relatively wide range of richness (23 to 40 taxa) has been found with a high median richness of 31 taxa, typical of richness in ringplain streams and rivers near the National Park boundary. During the current period, spring (30 taxa) and summer (27 taxa) richness were slightly less than the historical median.

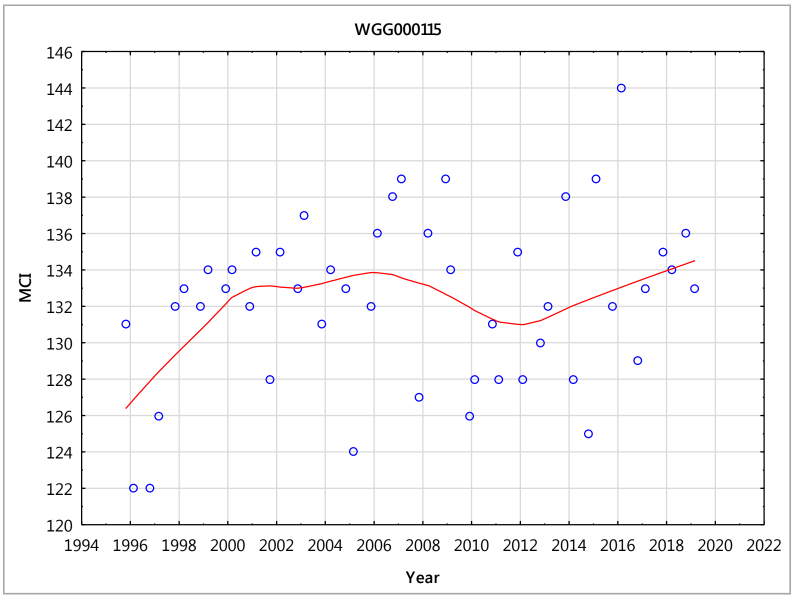
MCI values have had a moderate range (22 units) at this site, typical of a National Park boundary site. The median value (133 units) has also been typical of upper reach sites elsewhere on the ringplain. The spring (136 units) and summer (133 units) scores were not significantly different from the historical median. The MCI scores categorised this site as having 'very good' health generically (Table 3). The historical median score (133 units) placed this site in the 'very good' category for generic health.

3.2.9.1.2 Predicted stream 'health'

The Waingongoro River site near the National Park is 0.7 km downstream of the National Park boundary at an altitude of 540 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median, spring and summer scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 131 units. Again, the historical median, spring and summer and scores were also all not significantly different to this value.

3.2.9.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 87). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waingongoro River near the National Park.



N = 48
Kendall tau = 0.168
p value = 0.09
FDR p = 0.15

N = 20
Kendall tau = 0.394
p value = 0.02
FDR p = 0.14

Figure 87 LOWESS trend plot of MCI data at the site near the National Park, Waingongoro River

A positive, non-significant trend has been found over the entire period. Previously, prior to 2008, there had been a statistically significant improvement over the earlier period (1995-2007). After 2007 there was some decline followed by some recent improvement but the overall trendline range of scores (eight units) was of minor ecological importance. Throughout the period, the trend has indicated 'very good' generic river health.

Congruent with the full dataset there was a non-significant positive trend in MCI scores over the most recent ten-year period after FDR. In particularly there was an increase in the trendline from 2012 onwards. This trend was significant prior to FDR adjustment. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.9.2 Opunake Road site (WGG000150)

3.2.9.2.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Waingongoro River at this upper mid-reach site at Opunake Road (approximately 7km downstream of the National Park) between October 1995 and March 2018. These results are summarised in Table 48, together with the results from the current period, and illustrated in Figure 88.

Table 48 Results of previous surveys performed in the Waingongoro River at Opunake Road together with 2018-2019 results.

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000150	46	22-39	27	119-139	129	24	128	26	119

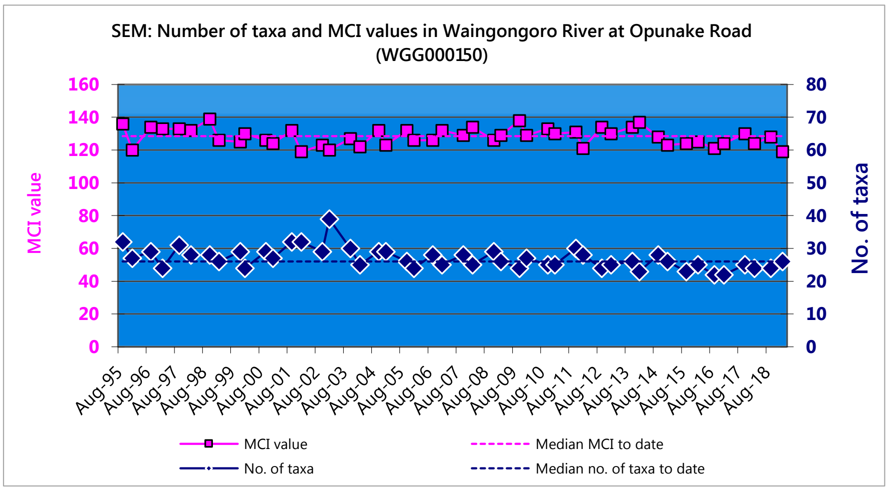


Figure 88 Numbers of taxa and MCI values in the Waingongoro River at Opunake Road

A relatively wide range of richness (22 to 39 taxa) has been found; wider than might be expected, with a median richness of 27 taxa. During the current period spring (24 taxa) and summer (26 taxa) richness were slightly lower than the historical median.

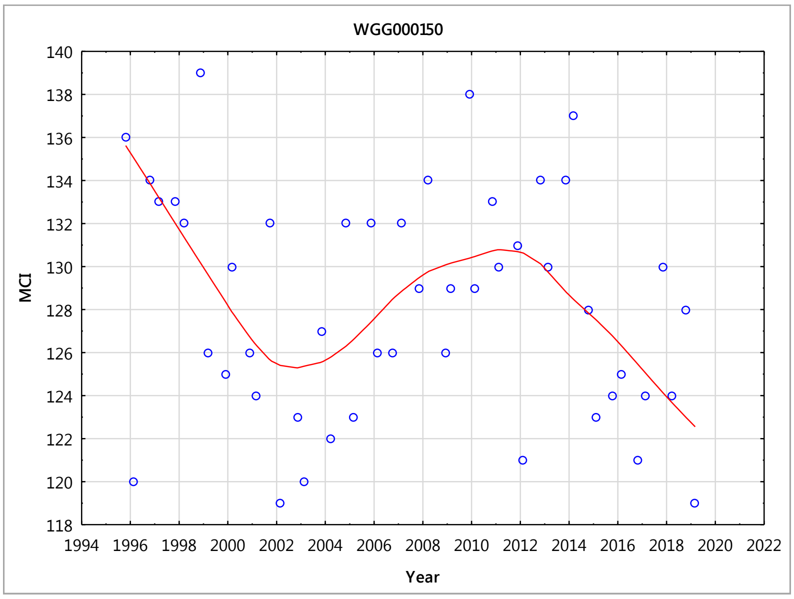
MCI values have had a moderate range (20 units) at this site, typical of sites in the upper mid reaches of ringplain rivers. The median value (129 units) has been higher than typical of upper, mid reach sites elsewhere on the ringplain. The spring (128 units) and summer (119 units) scores were not significantly lower than the median value or each other (Stark, 1998). These scores categorised this site as having 'very good' (spring) and 'good' (summer) health generically (Table 3). The historical median score placed this site in the 'very good' category for generic health.

3.2.9.2.2 Predicted stream health

The Waingongoro River at Opunake Road is 7.2km downstream of the National Park boundary at an altitude of 380 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 110 for this sites. The historical site median and spring score were significantly higher than this value and the summer score was not significantly different (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 124 units. The historical site median, spring and summer values were not significantly different from this value.

3.2.9.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 89). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waingongoro River at Opunake Road.



N = 48
Kendall tau = -0.122
p value = 0.22
FDR p = 0.31

N = 20
Kendall tau = -0.404
p value = 0.01
FDR p = 0.14

Figure 89 LOWESS trend plot of MCI data at the Opunake Road site, Waingongoro River

A non-significant negative trend in MCI scores has occurred in the upper mid-reaches of the river (some seven km below the National Park). The trendline range of scores (13 units) has been of minor ecological importance over the entire monitoring period. Localised erosion had caused sediment deposition on the riverbed during 1999 with a subsequent five year decline in MCI scores. This decline ceased with a gradual improvement in MCI scores towards earlier levels over the latter twelve years. The erosion event was very localised and site specific, as corresponding biological and physiochemical monitoring data showed no significant trends at the nearest downstream site (Eltham Road). The trendline has again started to decline from 2012 onwards, possibly due to erosion again. The dry summer period with subsequent lack of freshes may also have contributed to the low summer MCI score. The trendline range of scores have been consistently indicative of 'very good' generic river health.

Congruent with the full dataset, there was a non-significant, but stronger, negative trend in MCI scores over the most recent ten-year period. The trendline was significant prior to FDR adjustment. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.9.3 Eltham Road site (WGG000500)

3.2.9.3.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Waingongoro River at this mid-reach site at Eltham Road between October 1995 and March 2018. These results are summarised in Table 49, together with the results from the current period, and illustrated in Figure 90.

Table 49 Results of previous surveys performed in the Waingongoro River at Eltham Road, together with 2018-2019 results.

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000500	46	15-29	22	93-125	103	24	112	24	109

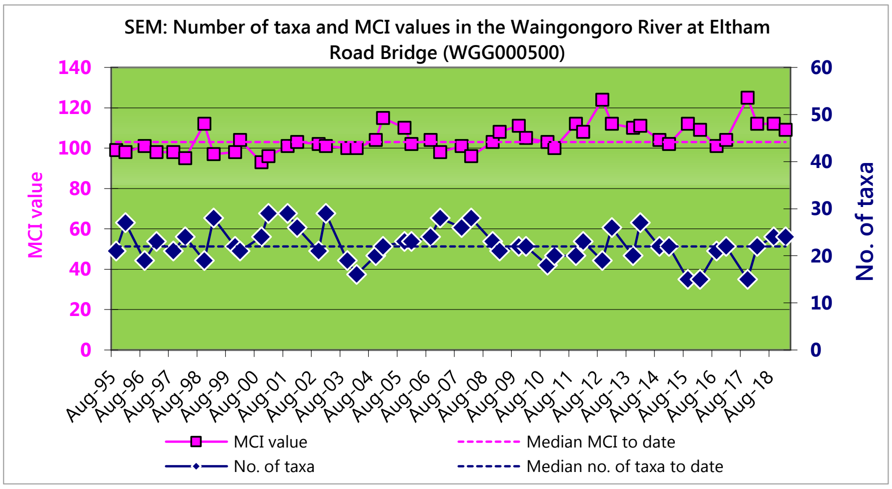


Figure 90 Numbers of taxa and MCI values in the Waingongoro River at Eltham Road

A wide range of richness (15 to 29 taxa) has been found with a median richness of 22 taxa, typical of richness in the mid reaches of ringplain streams and rivers. During the current period spring (24 taxa) and summer (24 taxa) richness were similar to the historical median.

MCI values have had a relatively wide range (33 units) at this site, more typical of sites in the mid reaches of ringplain rivers. The historical median value (103 units) has been typical of mid reach sites elsewhere on the ringplain. The spring (112 units) and summer (109 units) scores were not significantly higher than the historic median. These scores categorised this site as having 'good' health (Table 3). The historical median score (103 units) placed this site in the 'good' category for generic health.

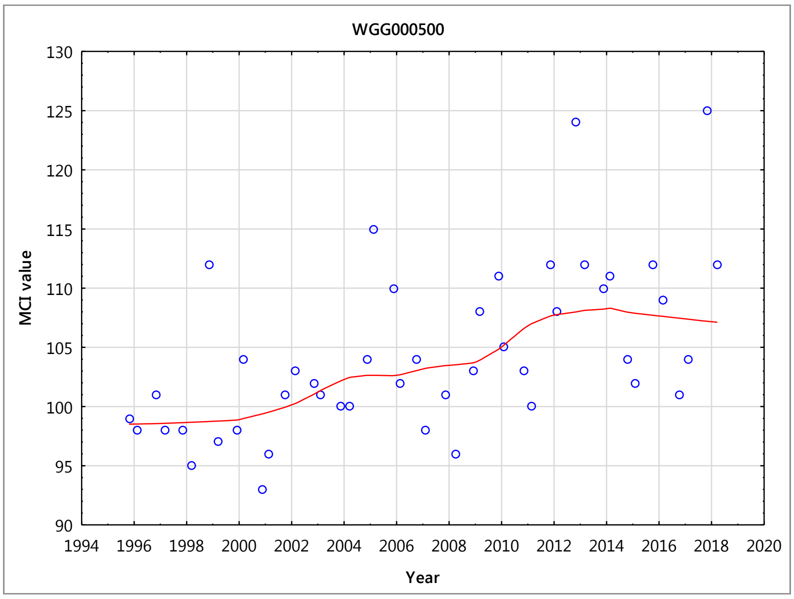
3.2.9.3.2 Predicted stream 'health'

The Waingongoro River site at Eltham Road is 23.0 km downstream of the National Park boundary at an altitude of 200 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 97 for this site. The historical site median score was not significantly different to the distance predictive value and the spring and summer scores were both significantly higher (Stark, 1998).

The REC predicted MCI value (Leathwick, et al. 2009) was 110 units. The historical median, spring and summer scores were not significantly different to this value.

3.2.9.3.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 91). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waingongoro River at Eltham Road.



N = 48
Kendall tau = 0.456
p value < 0.01
FDR p < 0.01

N = 20
Kendall tau = 0.104
p value = 0.52
FDR p = 0.76

Figure 91 LOWESS trend plot of MCI data at the Eltham Road site, Waingongoro River

A significant positive temporal trend in MCI scores has been found over the entire period (FDR p< 0.01). This has been more pronounced since 2001 but scores plateaued for about three years before a more recent further improvement and another most recent plateau in scores. The trendline range of scores (10 units) has been of marginal ecological importance. The trendline MCI scores wre indicative of 'fair' generic health prior to 2002 and since then have been in the 'good' category.

There was a non-significant, positive trend in MCI scores over the most recent ten-year period. The trendline for the most recent ten-year period was indicative of 'good' health.

3.2.9.4 Stuart Road site (WGG000665)

3.2.9.4.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Waingongoro River at this mid-reach site at Stuart Road between October 1995 and March 2018. These results are summarised in Table 50, together with the results from the current period, and illustrated in Figure 92.

Table 50 Results of previous surveys performed in the Waingongoro River at Stuart Road, together with spring 2018 and summer 2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000665	46	14 - 30	20	77-111	96	20	108	24	88

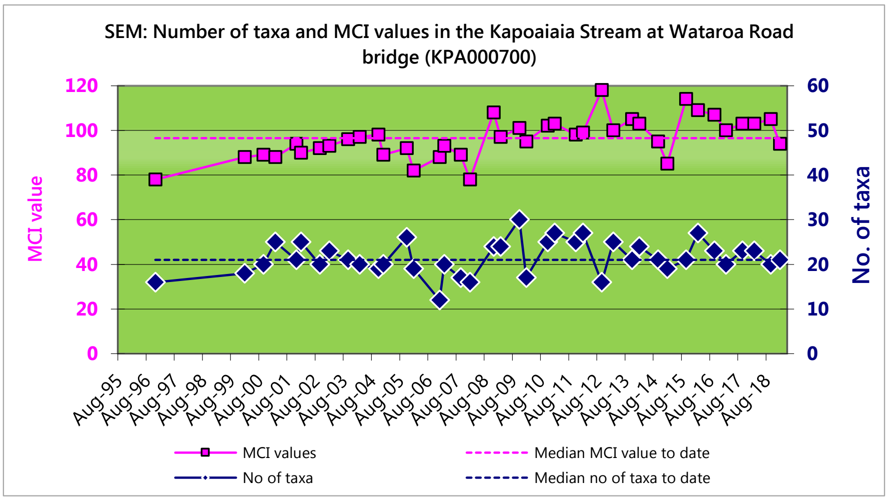


Figure 92 Numbers of taxa and MCI values in the Waingongoro River at Stuart Road

A wide range of richness (14 to 30 taxa) has been found with a median richness of 20 taxa (more representative of typical richness in the mid reaches of ringplain streams and rivers). During the current period spring (20 taxa) and summer (24 taxa) richness were the same/ similar to the historical median (20 taxa).

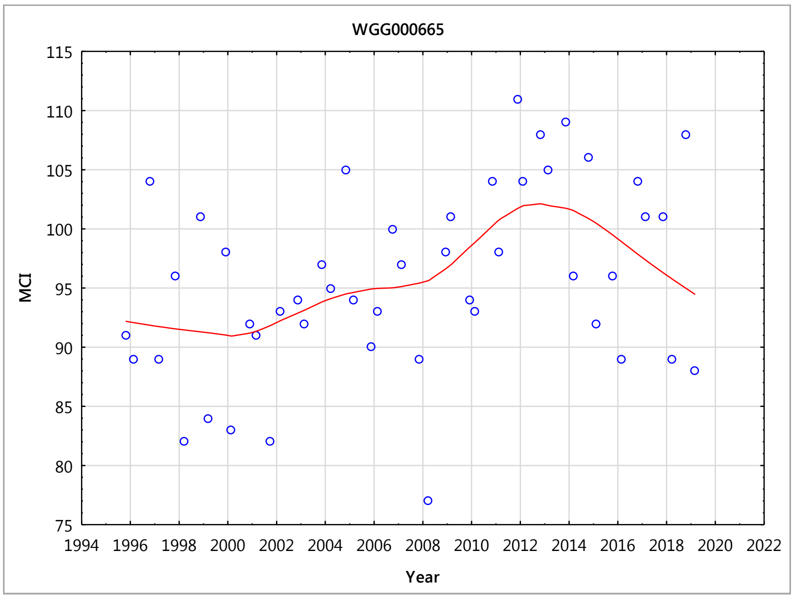
MCI values have had a moderately wide range (34 units) at this site, typical of sites in the mid reaches of ringplain rivers. The median value (96 units) has been lower than typical of mid reach sites elsewhere on the ringplain. The spring (108 units) score was significantly higher than the historic median while the summer (88 units) score was not significantly different to the historical median but significantly lower than the spring score. These scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically (Table 3). The historical median score (96 units) placed this site in the 'fair' category for generic health.

3.2.9.4.2 Predicted stream 'health'

The Waingongoro River site at Stuart Road is 29.6 km downstream of the National Park boundary at an altitude of 180 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI value of 94 for this site. The historical site median and summer survey scores were not significantly different to the distance predictive value and the spring score was significantly higher (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 102 units. The historical median and spring scores were not significantly different to the REC predictive value but the summer score was significantly lower (Stark, 1998).

3.2.9.4.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 93). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waingongoro River at Stuart Road.



N = 48
Kendall tau = 0.269
p value = 0.01
FDR p = 0.02

N = 20
Kendall tau = -0.166
p value = 0.31
FDR p = 0.57

Figure 93 LOWESS trend plot of MCI data at the Stuart Road site, Waingongoro River

A positive significant trend in MCI scores has been found over the entire period (FDR p = 0.02). There has been an improvement in MCI scores since 2002 (coincident with summer diversion of the treated meatworks wastes discharge at Eltham from the river to land irrigation) and particularly most recently (since 2009) following the diversion of treated municipal Eltham wastewater out of the catchment (to the Hawera WWTP and ocean outfall). However, since 2013 scores have declined sharply. The trendline range of scores (12 units) has also been ecologically importance. The trendline has been indicative of 'fair' generic river health apart from a brief period where it was at 'good' generic health from 2011 to 2015.

In contrast to the full dataset, there was a non-significant, negative trend in MCI scores over the most recent ten-year period, due to the decline in MCI scores since 2013. The trendline has been indicative of 'fair' generic river health apart from a brief period where it was at 'good' generic health from 2011 to 2015.

3.2.9.5 SH45 site (WGG000895)

3.2.9.5.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Waingongoro River at this lower reach site at SH45 between October 1995 and March 2018. These results are summarised in Table 51, together with the results from the current period, and illustrated in Figure 94.

Table 51 Results of previous surveys performed in the Waingongoro River at SH45, together with spring 2018 and summer 2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000895	46	13 - 25	21	73-106	95	15	88	20	96

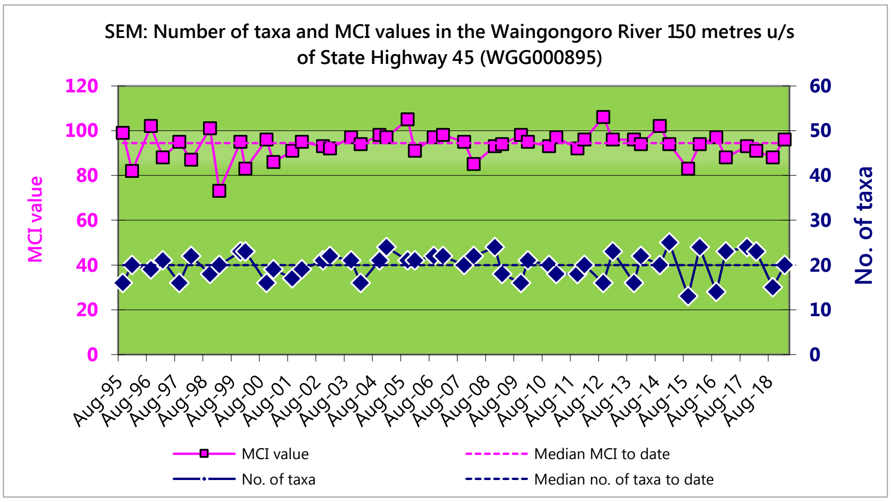


Figure 94 Numbers of taxa and MCI values in the Waingongoro River 150 m u/s of SH45

A moderate range of richness (13 to 25 taxa) has been found with a median richness of 21 taxa which was more representative of typical richness in the lower reaches of ringplain streams and rivers. During the current period, spring (15 taxa) richness was slightly lower than the historic median and summer (20 taxa) richness was the same as the historical median (20 taxa).

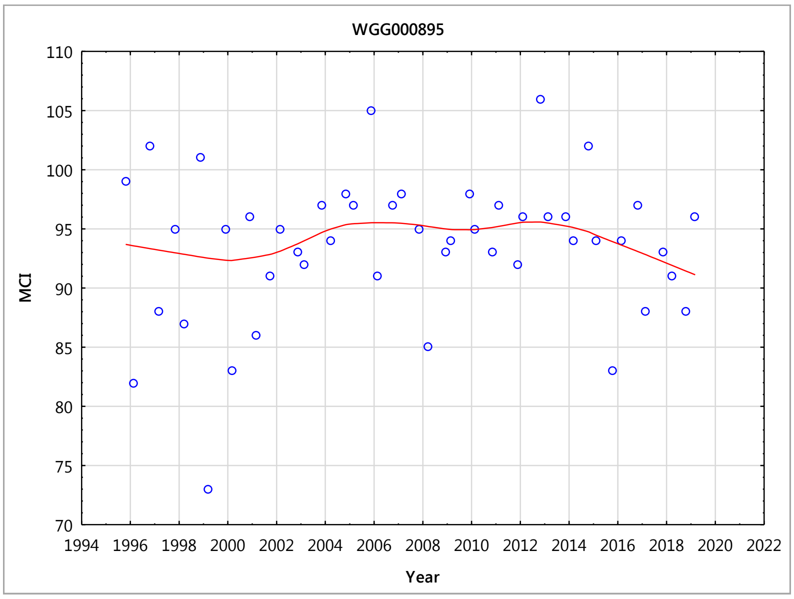
MCI values have had a wide range (33 units) at this site, more typical of sites in the lower reaches of ringplain streams and rivers. The median value (95 units) has been higher than typical of scores at lower reach sites elsewhere on the ringplain. The spring (88 units) and summer (96 units) scores were not significantly different to the historical median. These scores categorised this site as having 'fair' health (spring and summer) generically (Table 3). The historical median score (95 units) placed this site in the 'fair' category for generic health.

3.2.9.5.2 Predicted stream 'health'

The Waingongoro River site at SH45 is 63.0 km downstream of the National Park boundary at an altitude of 40 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict MCI values of 85 for this site. The historical site median and spring score were not significantly different from the distance predictive value and the summer score was significantly higher (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 92 units. The historical, spring and summer scores were not significantly different to this value (Stark, 1998).

3.2.9.5.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 95). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waingongoro River at SH45.



N = 48
Kendall tau = 0.022
p value = 0.83
FDR p = 0.88

N = 20
Kendall tau = -0.305
p value = 0.06
FDR p = 0.31

Figure 95 LOWESS trend plot of MCI data for the SH45 site, Waingongoro River

A very small, non-significant, positive trend in MCI scores has been found over the entire period. A general plateauing in the trend has occurred since 2005. The narrow trendline range (five units) of scores has not been ecologically important. The range of trendline scores have consistently indicated 'fair' generic river health throughout the period.

In contrast to the full dataset, there was a non-significant, negative trend in MCI scores over the most recent ten-year period, with a small increase from 2008 to 2014 followed by a slightly larger decrease in MCI scores. The trendline has been indicative of 'fair' generic river health over the most recent ten-year period.

3.2.9.6 Ohawe Beach site (WGG000995)

3.2.9.6.1 Taxa richness and MCI

Forty-six surveys have been undertaken in the Waingongoro River at this lower reach site at Ohawe Beach between October 1995 and March 2018. These results are summarised in Table 52, together with the results from the current period, and illustrated in Figure 96.

Table 52 Results of previous surveys performed in the Waingongoro River at the Ohawe Beach site, together with spring 2018 and summer 2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGG000995	46	12 - 25	18	69-100	91	21	97	17	79

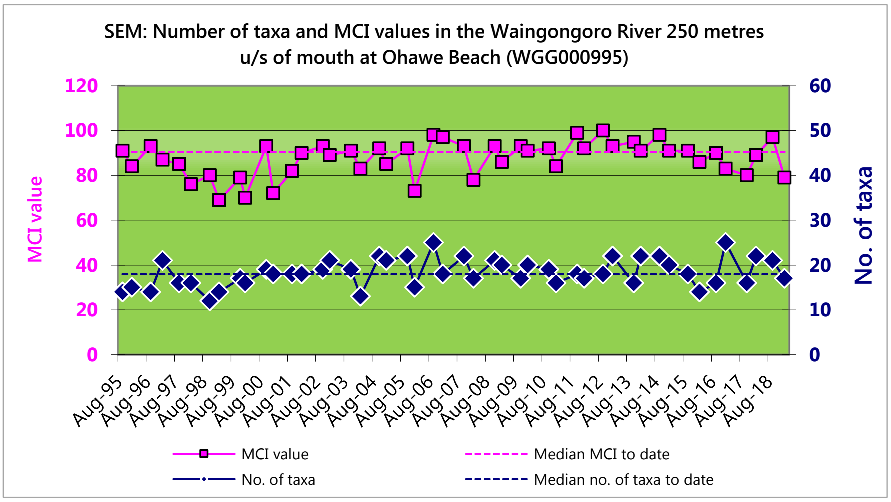


Figure 96 Numbers of taxa and MCI values in the Waingongoro River at the Ohawe Beach site

A wide range of richness (12 to 25 taxa) has been found, with a median richness of 18 taxa. During the current period, spring (21 taxa) and summer (17 taxa) richness were similar to the historical richness.

MCI values have had a relatively wide range (31 units) at this site, typical of sites in the lower reaches of ringplain streams and rivers. The median value (91 units) has been more typical of scores at lower reach sites elsewhere on the ringplain. The spring (97 units) score was not significantly different to the historic median but the summer (79 units) score was significantly lower. These scores categorised this site as having 'fair' health in spring and 'poor' health in summer (Table 3). The historical median score (91 units) placed this site in the 'fair' category for generic health.

3.2.9.6.2 Predicted stream 'health'

The Waingongoro River at the Ohawe Beach site is 66.6km downstream of the National Park boundary at an altitude of 5 m asl. Relationships for ringplain streams and rivers developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of and 85 for this site. The historical median and summer score were not significantly different to predictive value and the spring score was significantly higher (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 95 units. The historical and spring scores were not significantly different to this value but the summer score was significantly lower (Stark, 1998).

3.2.9.6.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 97). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waingongoro River at Ohawe Beach.

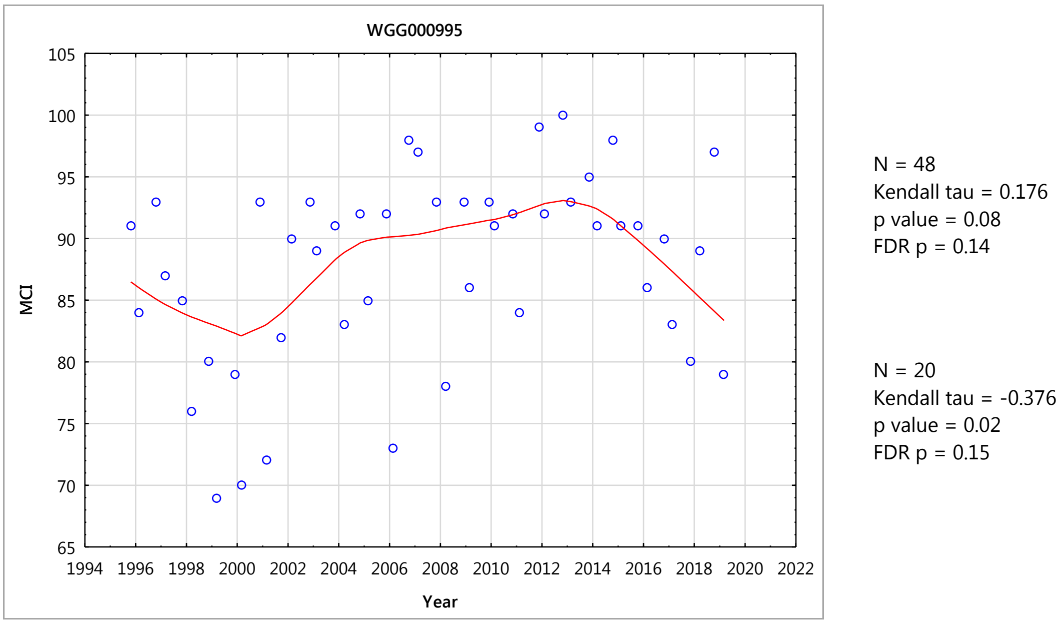


Figure 97 LOWESS trend plot of MCI data at the Ohawe Beach site, Waingongoro River

There was a non-significant positive trend over the entire. There has been improvement since 2001, followed by a sharp decrease recently since 2014. The trendline range of scores (10 units) has been of marginal ecological importance. Trendline scores were consistently indicative of 'fair' generic river health.

In contrast to the full dataset, there was a non-significant, negative trend in MCI scores over the most recent ten-year period. Before FDR application, the negative trend was significant. This was due to the decrease after 2014. The trendline was indicative of 'fair' generic river health but is heading towards 'poor' health.

3.2.9.7 Discussion

Taxa richness varied among sites and seasonally but no real trend was apparent between sites or between spring and summer.

The surveys indicated that the macroinvertebrate community at the upper two sites were generally in 'very good' health, the middle two sites were in 'good' to 'fair' health, and the bottom two sites were generally in 'fair' health. The MCI scores consistently fell in a downstream direction between sites in this agriculturally dominated landscape with the upper site and the furthest downstream lower reaches site by 39 units in spring and 54 units in summer, over a river distance of 65.9 km. These seasonal falls in MCI scores were typical and always occurred to varying extents. The particularly dry summer for the current year likely contributed to the slightly larger than normal seasonal differences.

The time trend analysis indicated no significant trends at the upper two sites which would be expected given their relatively pristine nature. The middle two sites had significant positive trends over the full dataset indicating improvements in macroinvertebrate health but these improvements have plateaued over the last ten-years. The lowest two sites had no significant trends though the lowest site had a significant negative trend before FDR application for the most recent ten-year period. The lower middle site in particular, but also the two lower sites, would have benefitted from the summer diversion of the treated meatworks wastes discharge at Eltham from the river to land irrigation and later in 2009 the diversion of treated municipal Eltham wastewater out of the catchment to the Hawera WWTP and ocean outfall. However, recently some concerns about the impact the Eltham meatworks was having on water quality (e.g.

phosphorus levels) have arisen and this may potentially be one cause of the negative trends at the three most bottom for the most recent ten year period.

3.2.10 Waiokura Stream

Two sites in this small, southerly flowing ringplain seepage-sourced stream, were included in the SEM programme in recognition of a long-term collaborative study of the effects of best-practice dairy-farming initiatives being evaluated in five dairying catchments throughout the country (Wilcock et al, 2009). Fonterra, Kapuni lactose factory also irrigates wastewater to land in the mid reaches of this catchment. One site is located upstream of the irrigation area (in mid-catchment) and the other site approximately ten km further downstream toward the lower reaches of the stream. Some consent monitoring data have been collected from the upper site since 2003 whereas the downstream site was established for biological temporal trend purposes in the 2008-2009 period to provide an additional monitoring component of the collaborative study.

3.2.10.1 Skeet Road site (WKR000500)

3.2.10.1.1 Taxa richness and MCI

Twenty-seven surveys have been undertaken, between 2003 and March 2018, at this mid-reach, partially shaded site in the Waiokura Stream, draining open developed farmland upstream of the Fonterra, Kapuni wastewater irrigation area. These results are summarised in Table 53, together with the results from the current period, and illustrated in Figure 98.

Table 53 Results of previous surveys performed in the Waiokura Stream at Skeet Road, together with 2018-2019 results

Site code	SEM data (2003 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000500	27	18 - 29	23	88-114	100	27	112	19	104

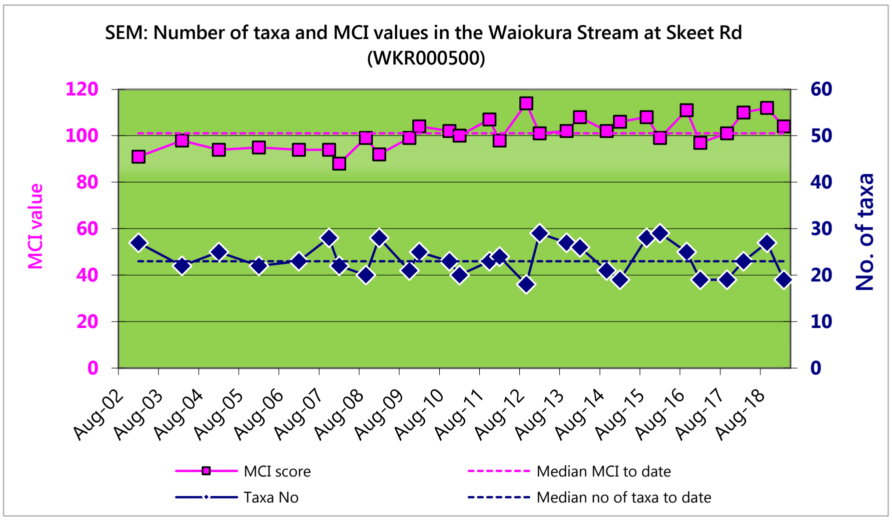


Figure 98 Numbers of taxa and MCI values in the Waiokura Stream at Skeet Road

A relatively narrow range of richness (18 to 29 taxa) has been found to date with a median richness of 23 taxa more typical of richness in the mid reaches of ringplain streams rising outside the National park boundary. During the current period spring (27 taxa) and summer (19 taxa) richness were similar to the historical median of 23 taxa though eight taxa different from each other.

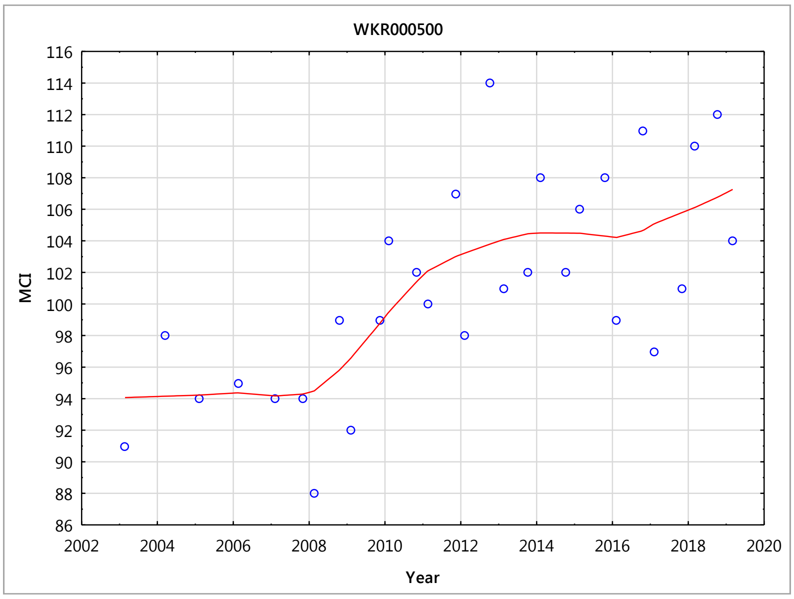
MCI values have had a moderate range (26 units) at this site, more typical of mid reach sites on the ringplain, although the monitoring period has been relatively short to date. The historical median value (100 units) has been typical of mid-reach sites in streams rising outside the National Park elsewhere on the ringplain. The spring (112 units) score was significantly higher than the historical median and the summer (104 units) score was not significantly different to the historical median (Stark, 1998). The scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (100 units) placed this site in the 'good' category for generic health.

3.2.10.1.2 Predicted stream 'health'

The Waiokura Stream rises below the National Park boundary and the site at Skeet Road is in the mid-reaches at an altitude of 150m asl. The REC predicted MCI value (Leathwick, et al. 2009) was 97 units. The historical median and summer score were not significantly different, while the spring score was significantly higher (Stark, 1998).

3.2.10.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 99). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (2003-2019) and the most recent ten-years of results (2009-2019) from the site in the Waiokura Stream at the site on Skeet Road.



N = 29
Kendall tau = 0.518
p level <0.01
FDR p < 0.01

N = 20
Kendall tau = 0.209
p level = 0.11
FDR p = 0.40

Figure 99 LOWESS trend plot of MCI data in the Waiokura Stream at the Skeet Road site for the full dataset with Mann-Kendall test for the full and ten-year dataset

This site shows a statistically significant positive trend (FDR p < 0.01). Since 2009, there has been relatively strong temporal improvement in MCI scores at this site, with a plateau between 2014 and 2016. The trendline range of MCI scores (13 units) was of ecological importance. Increases in scores may have been related to improvements in farming practices and/or wastes disposal in the rural catchment between the stream's seepage sources (below the National Park) and mid reaches at Skeet Road, although the shorter duration and less frequent initial monitoring must be noted.

Trendline MCI scores have been indicative of 'fair' generic stream health for the first eight years of the period improving to the 'good' health category over the most recent seven years.

The ten-year period shows a positive trend, congruent with the full dataset, however this trend was not statistically significant.

3.2.10.2 Manaia golf course site (WKR000700)

3.2.10.2.1 Taxa richness and MCI

Twenty-two surveys have been undertaken at this more recently established lower reach site in the Waiokura Stream at Manaia between 2007 and March 2018. These results are summarised in Table 54 together with the results from the current period, and illustrated in Figure 100.

Table 54 Results of previous surveys performed at Waiokura Stream at Manaia golf course, together with 2018-2019 results

Site code	SEM data (2007 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		Mar 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKR000700	22	16-27	23	92-109	98	20	102	27	100

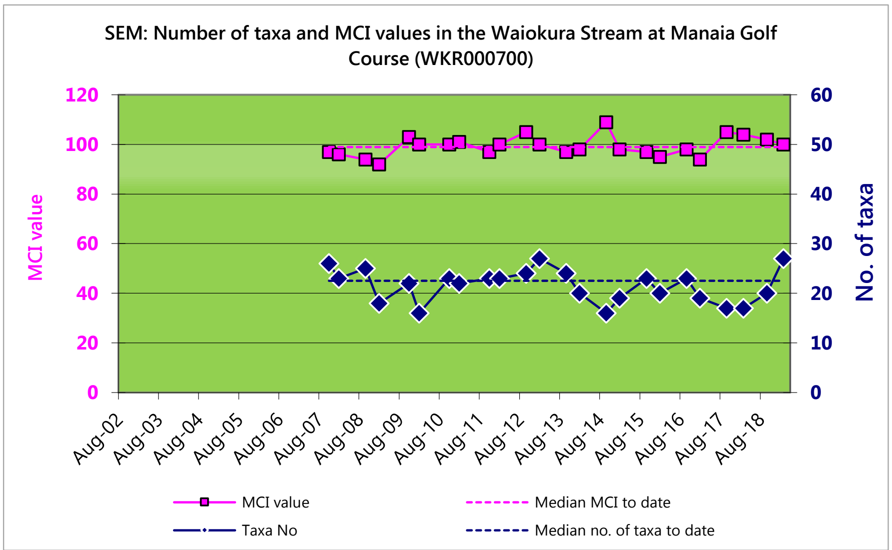


Figure 100 Numbers of taxa and MCI values in the Waiokura Stream at Manaia Golf course

A moderate range of richness (16 to 27 taxa) has been found, with a median richness of 23 taxa (more representative of typical richness for the lower reaches of ringplain streams rising outside the National Park boundary). During the current period spring (20 taxa) and summer (27 taxa) richness were similar to the historical median but seven taxa apart.

MCI values have had a narrow range (17 units) at this site partly due to the short duration of the monitoring period to date. The median value (98 units) has been slightly higher than typical of similar lower reach sites elsewhere on the ringplain. The spring (102 units) and summer (100 units) scores were not significantly different to the historical median score. These scores categorised this site as having 'good' (spring and summer) health generically (Table 3). The historical median score (98 units) placed this site in the 'fair' category for generic health.

3.2.10.2.2 Predicted stream 'health'

The Waiokura Stream rises below the National Park boundary and the site at the Manaia golf course is in the lower reaches at an altitude of 70 m asl. The REC predicted MCI value for this site (Leathwick, et al. 2009) was 95 units. The historical median, spring and summer scores were not significantly different from the REC predictive value.

3.2.10.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 101). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the entire SEM data (2007-2019) and the most recent ten-years of SEM results (2009-2019) from the site in the Waiokura Stream at Manaia golf course.

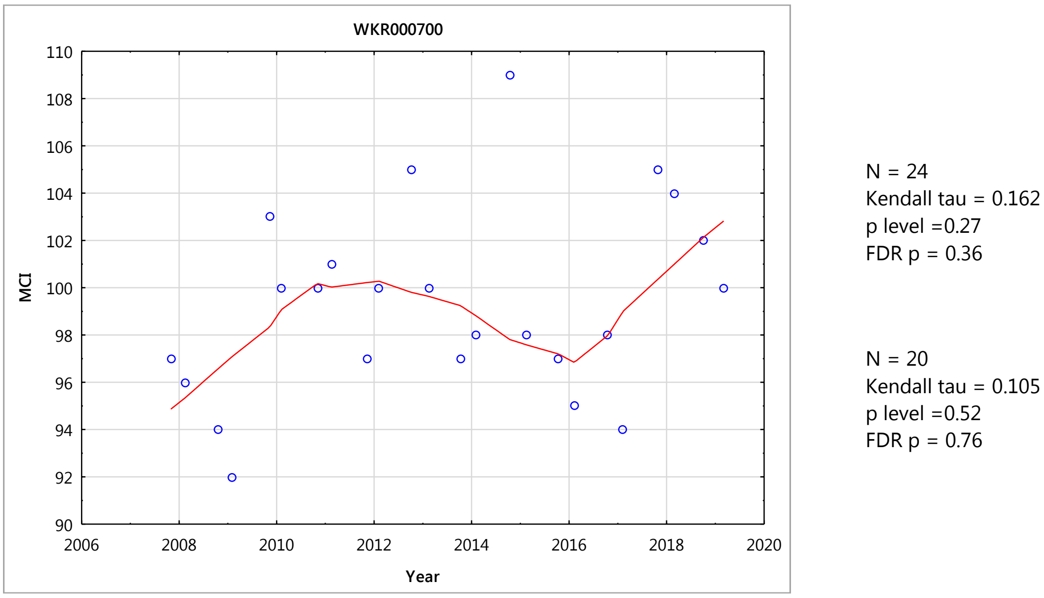


Figure 101 LOWESS trend plot of MCI data in the Waiokura Stream for the Manaia golf course for the full dataset with Mann-Kendall test for the full and ten-year dataset

A positive, non-significant trend of improvement in MCI scores since 2009 to that found at the upstream site (at Skeet Road) was identified at this site at the Manaia golf course (although more stable since 2010). The relatively narrow range of scores (eight units) has no ecological importance to date.

The trendline range indicated 'fair' generic stream health for two years of the monitoring period, improved to 'good' stream health for about three years before falling to 'fair' stream health until returning to 'good' stream health this past monitoring period.

The ten-year period had a positive trend. As with the full dataset, this was neither statistically or ecologically significant.

3.2.10.3 Discussion

Taxa richness for both surveys were moderate at both sites and similar to historical medians.

The surveys indicated that the macroinvertebrate community at both sites were in 'good' health and in typical condition. The MCI score decreased by nine units in spring and decreased by four units in summer in a downstream direction over the 9.7 km reach, between the more open farmland mid-reach site (Skeet

Road) and the lower reach Manaia golf course site. This was despite some improvement in habitat provided by patches of riparian vegetation cover through the golf course.

The time trend analysis indicated a significant positive trend after FDR adjustment at the upper site over the full period. There have been farming initiatives to improve water quality in the catchment, which appear to have succeeded in improving macroinvertebrate health at the upper site. In contrast, the lower site had a weak positive trend. This result may be influenced by the shorter monitoring period at the lower site. There were no significant trends at either site over the most recent ten-year period.

3.2.11 Waiongana Stream

The Waiongana Stream has a source within Egmont National Park and flows in an easterly direction with a mouth just east of Bell Block. There are two sites on the stream used for SEM surveys.

3.2.11.1 State Highway 3a site (WGA000260)

3.2.11.1.1 Taxa richness and MCI

Forty-five surveys have been undertaken at this mid reach site in the Waiongana Stream between October 1995 and February 2018. These results are summarised in Table 55, together with the results from the current period, and illustrated in Figure 102.

Table 55 Results of previous surveys performed in the Waiongana Stream at SH3A together with the 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGA000260	45	9-31	24	82-112	97	22	99	25	90

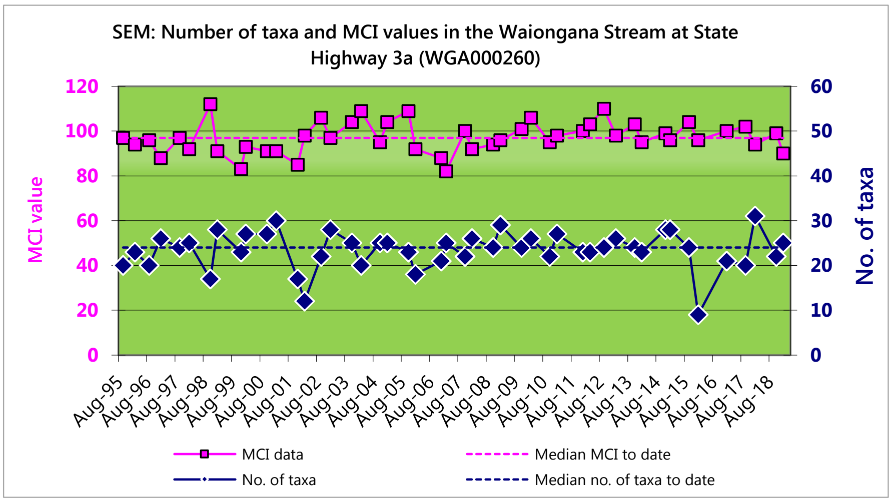


Figure 102 Numbers of taxa and MCI values in the Waiongana Stream at State Highway 3A

A wide range of richness (9 to 30 taxa) has been found; with a median richness of 24 taxa (more representative of typical richness in the mid-reaches of ringplain streams and rivers. During the current period, the spring (22 taxa) and summer (25 taxa) richness were similar to the historical median.

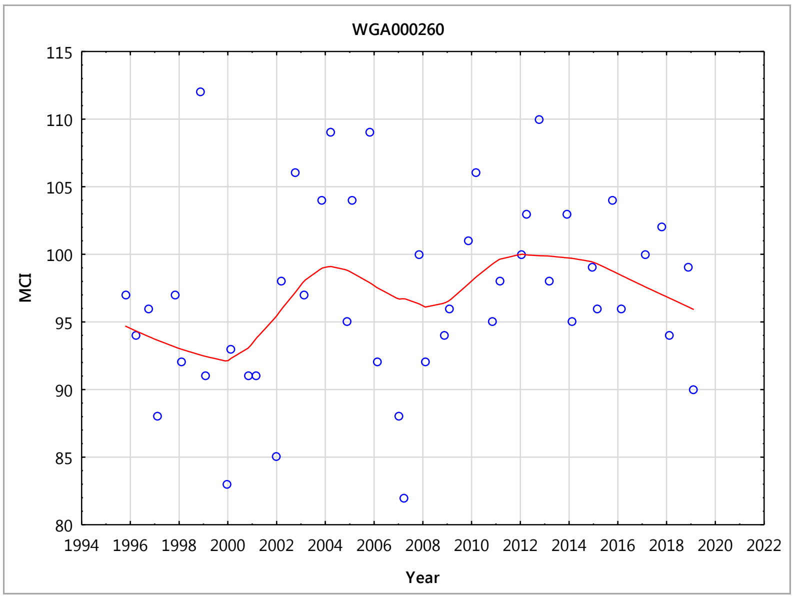
MCI values have also had a relatively wide range (30 units) at this site, relatively typical of a site in the mid reaches of a ringplain stream. The median value (97 units) also has been typical of mid-reach sites elsewhere on the ringplain. The spring (99 units) and summer (90 units) surveys were not significantly different to the historical median. These scores categorised this site as having 'fair' health in spring and summer (Table 3). The historical median score (97 units) placed this site in the 'fair' category.

3.2.11.1.2 Predicted stream 'health'

The Waiongana Stream site at SH3a is 16.1 km downstream of the National Park boundary at an altitude of 140 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 100 for this site. The historical site median, spring and summer scores were not significantly different from this value. The REC predicted MCI value (Leathwick, et al. 2009) was 99 units. Again, the historical site median, srping and summer scores were also not significantly different to this value.

3.2.11.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 103). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waiongana Stream at SH3A.



N = 47
Kendall tau = 0.166
p level = 0.10
FDR p = 0.16

N = 19
Kendall tau = -0.244
p level = 0.14
FDR p = 0.4

Figure 103 LOWESS trend plot of MCI data at the SH3A site

There has been a non-significant positive trend in the MCI scores with a steady improvement in scores between 2001 and 2004 followed by a decline in scores until 2008, and another steady increase until 2012, where subsequently another gradual decline is evident. This site's trendline had a range of eight units indicative of minor ecologically important variability over the period. Overall, the trendline was indicative of 'fair' generic stream health for the majority of the period, improving toward 'good' 'health' briefly in 2011 and 2012.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, with a decline in the trendline from 2012 onwards. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.11.2 Devon Road site (WGA000450)

3.2.11.2.1 Taxa richness and MCI

Forty-five surveys have been undertaken at this lower reach site, at SH45 in the Waiongana Stream, between October 1995 and February 2018. These results are summarised in Table 56, together with the results from the current period, and illustrated in Figure 104.

Table 56 Results of previous surveys performed in the Waiongana Stream at Devon Road together with spring 2018 and summer 2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WGA000450	45	12-29	22	72-102	89	21	90	21	82

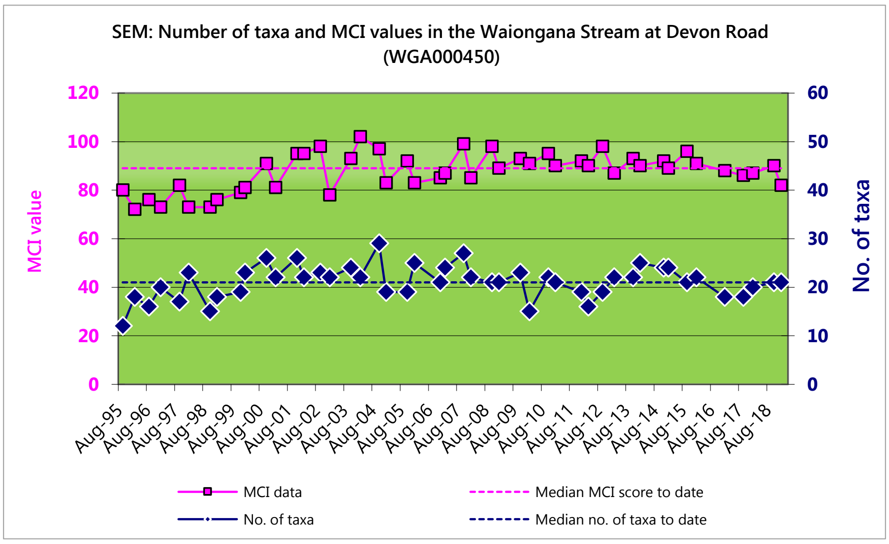


Figure 104 Numbers of taxa and MCI values in the Waiongana Stream at Devon Road

A wide range of richness (12 to 29 taxa) has been found with a median richness of 22 taxa, more representative of typical richness in ringplain streams and rivers in the lower reaches. During the current period, spring (21 taxa) and summer (21 taxa) richnesses were similar to the historic median.

MCI scores have had a relatively wide range (30 units) at this site typical of sites in the lower reaches of ringplain streams. The median value (89 units) also has been typical of lower reach sites elsewhere on the ringplain. The spring (90 units) and summer (82 units) scores were not significantly different from the historical median or to each other. These scores categorized this site as having 'fair' (spring and summer) health (Table 3). The historical median score (89 units) placed this site in the 'fair' category for generic health.

3.2.11.2.2 Predicted stream 'health'

The Waiongana Stream at Devon Road is 31.2 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict MCI values of 93 for this site. The historical site median and spring score were not significantly different from this value but the summer score was significantly lower.

The REC predicted MCI value (Leathwick, et al. 2009) was 88 units. The historical site median, spring and summer scores were also not significantly different to this value.

3.2.11.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 105). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waiongana Stream at Devon Road.

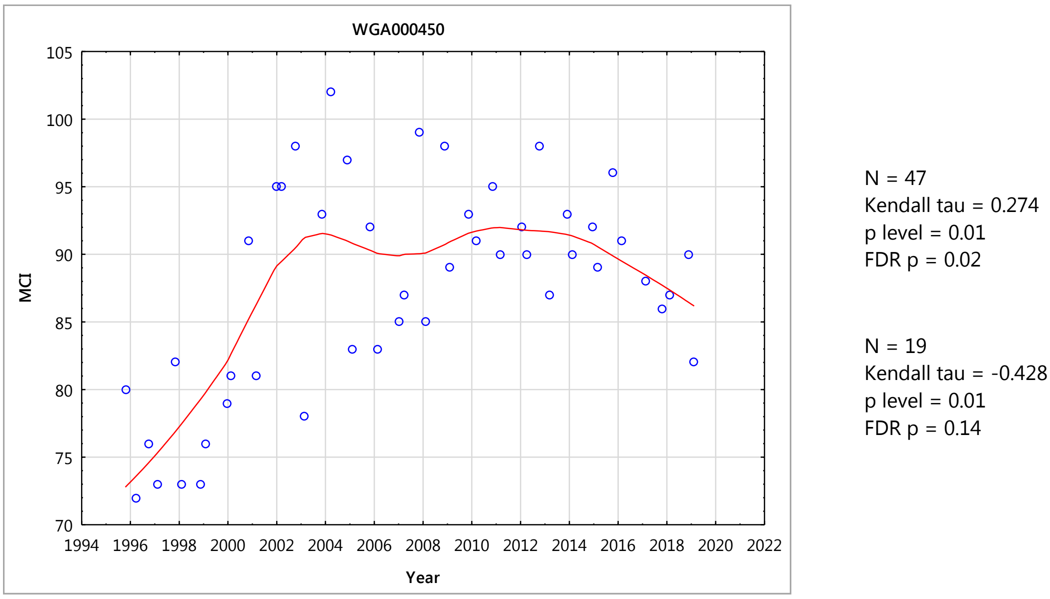


Figure 105 LOWESS trend plot of MCI data at the Devon Road site

MCI scores at this site have shown a statistically significant (FDR p =0.02) improvement over the period, despite little change since 2003. The trendline has varied over an ecologically important range of 19 units. This trend of improvement in stream 'health' at this site is much more pronounced than the trend at the site some 15 km upstream, indicating that activities in the catchment between these two sites have had a significant influence on the bottom site. Overall, the trendline has indicated significant improvement in generic stream 'health' from consistently 'poor' prior to 2000 to 'fair' where it has remained.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, in contrast with the full dataset with a decline in the trendline from 2011 onwards. There was a significant decline prior to FDR application. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.11.3 Discussion

Taxa richness for both sites were moderate and typical. The surveys indicated that the mid-reach (SH3a) site and the lower reach (Devon Road) were in 'fair' health. MCI scores typically decreased in a downstream for both spring (by nine units) and summer (by eight units) surveys, over a stream distance of 15.1 km. The decrease in score was probably attributable to diffuse and point source discharges that have caused nutrient enrichment.

The time trend analysis indicated non-significant trends at the upper site and a significant positive trend after FDR adjustment at the lower site over the entire monitoring period. Improvement has been coincident with a reduction in consented NPDC water abstraction and tighter control of an upstream piggery's waste loadings into the stream. However, there was a significant negative trend for the site prior to FDR adjustment over the most recent 10-year period suggesting a more recent decline in macroinvertebrate health which may become significant if the trend persists. This decline mirrors that of the upper site but was more pronounced.

3.2.12 Waitara River

The Waitara River is Taranaki's largest river with significant catchment areas in both the eastern hill country and on the eastern side of the Taranaki ringplain. Two SEM sites are situated on the mainstream of the Waitara River.

3.2.12.1 Autawa Road site (WTR000540)

3.2.12.1.1 Taxa richness and MCI

This is the fourth set of surveys at this recently established middle reach site in the Waitara River, with surveys carried out between October 2015 and February 2018. These results are summarised in Table 57 and illustrated in Figure 106.

Table 57 Results of previous surveys performed in the Waitara River at Autawa Results with spring 2018 and summer 2019 results

Site code	SEM data (2015 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WTR000540	6	19-26	24	95-110	99	24	108	20	93

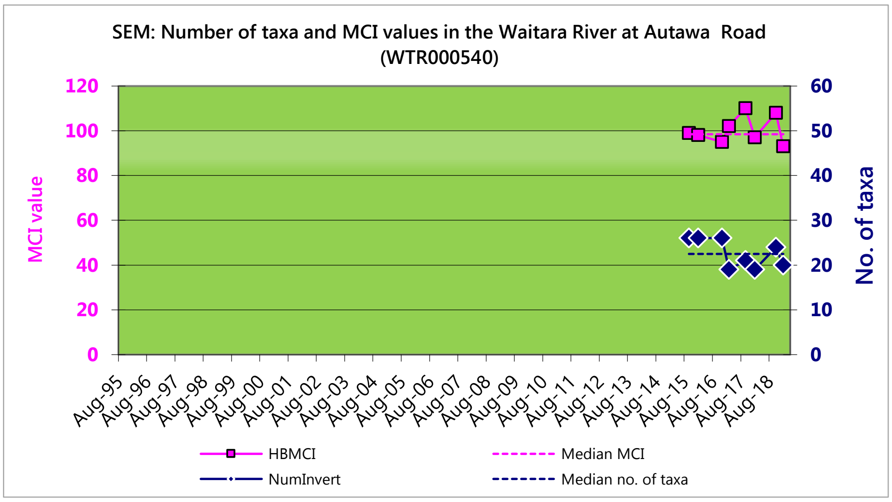


Figure 106 Numbers of taxa and MCI values in the Waitara River at Autawa Road

Slight variation in taxa richness (seven taxa) has been found with a median richness of 24 taxa. The low variation was to be expected given the small number of surveys that have been undertaken at the site. A moderate richness of 24 taxa was recorded for the spring survey with a lower, but still moderate taxa richness of 20 taxa recorded for the summer survey.

MCI values have had a relatively narrow range (15 MCI units) at this site. The median value (99 units) was slightly higher than typical lower reach sites elsewhere although lower reach sites in large hill country rivers tended to have had lower MCI values. The spring (108 units) and summer (93 units) were not significantly different to the historical median score though significantly different from each other. The summer score was the lowest score recorded to date for the site. These scores categorised this site as having 'good' health in spring and 'fair' health in summer (Table 3). The historical median score (99 units) placed this site in the 'fair' category for generic health.

3.2.12.1.2 Predicted stream 'health'

The Waitara River site at Autawa Road, at an altitude of 100 m asl, is in the middle reaches the river draining a catchment comprised of eastern hill country. The REC predicted MCI value (Leathwick, et al. 2009) was 110 units. The historical median and summer score were significantly lower than this value and the spring score was not significantly different to this value.

3.2.12.1.3 Temporal trends

There is insufficient data to perform a time trend analysis for the site.

3.2.12.2 Mamaku Road site (WTR000850)

3.2.12.2.1 Taxa richness and MCI

Forty-five surveys have been undertaken at this lower reach site in the Waitara River between November 1995 and February 2018. These results are summarised in Table 58, together with the results from the current period, and illustrated in Figure 107.

Table 58 Results of previous surveys performed in the Waitara River at Mamaku Road together with spring 2018-2019 results

Site code	SEM data (1995 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WTR000850	45	8-32	18	64-107	86	19	93	9	64

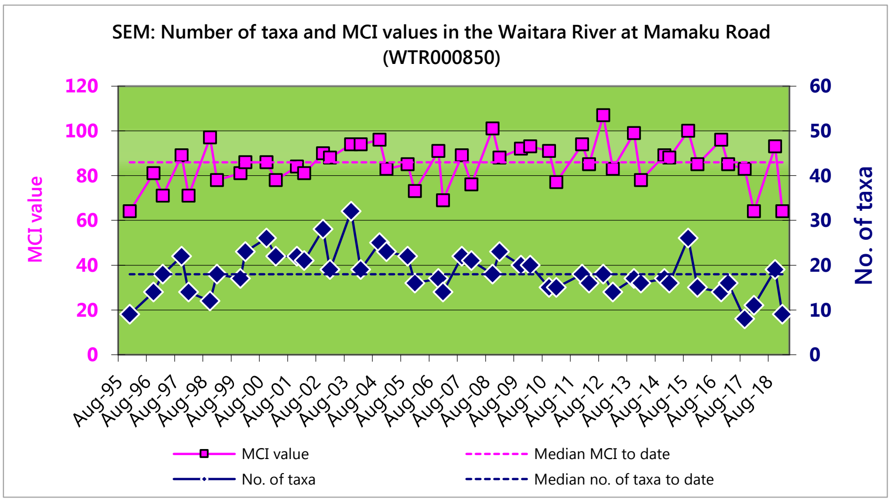


Figure 107 Numbers of taxa and MCI values in the Waitara River upstream of Methanex at Mamaku Road

A very wide range of richness (8 to 32 taxa) has been found with a moderate median richness of 18 taxa which was more representative of typical richness in the lower reaches of streams and rivers. During the current period, spring richness (19 taxa) was similar to the historical median but summer richness (9 taxa) was substantially lower and the second lowest taxa richness recorded to date at the site.

MCI values have had a very wide range (43 units) at this site which has not been unusual for sites in the lower reaches of large rivers. The historical median value (86 units) has also been typical of lower reach sites elsewhere although lower reach sites in large hill country rivers tended to have had lower MCI values. The spring score (93 units) was not significantly different to the historical median, but the summer score (64 units) score was significantly lower than this historical median and was the equal lowest MCI score recorded at this site to date (Stark, 1998). These scores categorised this site as having 'fair' (spring) and 'poor' (summer) health generically (Table 3). The historical median score (86 units) placed this site in the 'fair' category.

3.2.12.2.2 Predicted stream 'health'

The Waitara River site at Mamaku Road, at an altitude of 15 m asl, is in the lower reaches of a river draining a catchment comprised of both hill country and ringplain sub-catchments. The REC predicted MCI value (Leathwick, et al. 2009) was 98 units. The historical site median and summer score were significantly lower than this value while the spring score was not significantly different.

3.2.12.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) was produced (Figure 108). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1996-2019) and the most recent ten-years of results (2009-2019) from the site in the Waitara River at Mamaku Road.

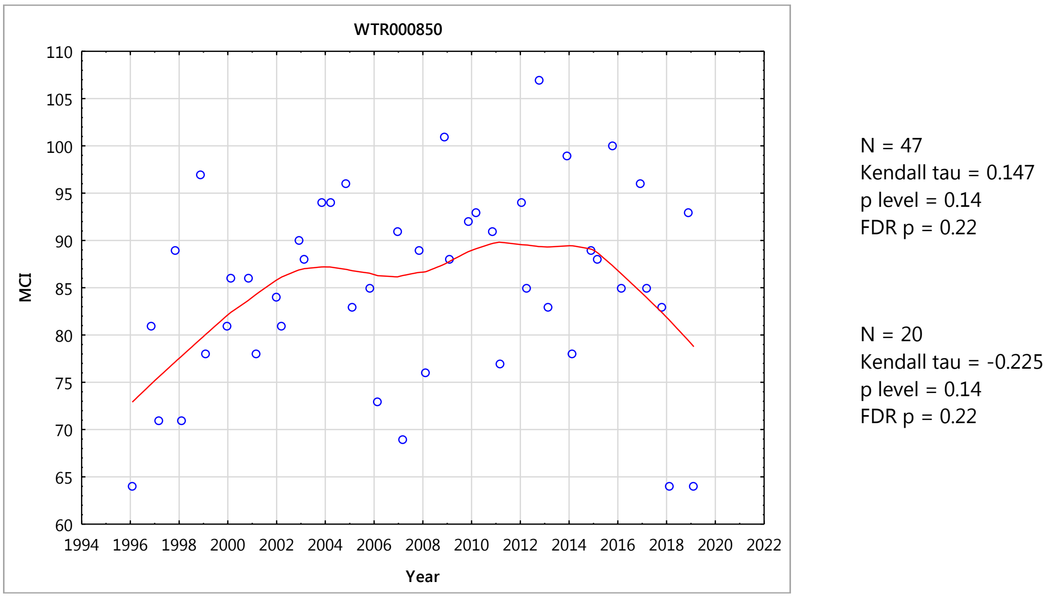


Figure 108 LOWESS trend plot of MCI data for the Mamaku Road site, Waitara River

There was a non-significant positive trend for the entire period. The trendline range (17 units) has been ecologically important over the period. The trendline has been indicative of a general improvement from 'poor' (in the first few years) to 'fair' generic river health but for the current period has declined back to 'poor' generic health.

There was a non-significant negative trend in MCI scores over the most recent ten-year period, in contrast with the full dataset, with a decline in the trendline from 2011 onwards. The trendline for the most recent ten-year period was indicative of 'fair' health health but for the current period has declined back to 'poor' generic health.

3.2.12.3 Discussion

Taxa richness for the upper site was moderate but the lower site had unusually low richness for the summer survey. The summer survey richness of nine taxa was the lowest recorded taxa richness to date while the taxa richness of 11 taxa for the summer survey was the third lowest richness to date.

The upper site had a new record low result for MCI but as there were only nine previous surveys this result was not unexpected. However, of far more concern, and coincident with the low summer taxa richness, was the lower site summer MCI score which was the equal lowest recorded to date for the site and indicated 'poor' health. The exact same score was recorded the previous summer indicating that it was not an aberrant result. Based on the taxa composition of the survey which contained a very abundant midge and caddisfly, acute pollution was unlikely. A combination of the long, dry summer period and nutrient enrichment has caused extensive algae to form in the riffle, which was observed at the time of sampling, is probably the main reason for the low score.

There was a downstream deterioration in macroinvertebrate health, 15 MCI units in spring and 29 MCI units in summer. The decrease in score was probably attributable to diffuse and point source discharges that have caused sedimentation and nutrient enrichment.

The time trend analysis found no significant trends over the full or ten-year datasets and it appears that there has been no significant change in macroinvertebrate community health though it should be noted the full dataset had a positive trend while the most recent ten-year period had a negative trend.

3.2.13 Waiwhakaiho River

The Waiwhakaiho River has a source inside Egmont National Park and flows in an easterly direction with its mouth situated in the city of New Plymouth. An additional site was established in the upper reaches of the Waiwhakaiho River for the 2002-2003 SEM programme, to complement the three sites in the central to lower reaches of this large ringplain river, in recognition of its importance as a water resource and particularly its proximity to New Plymouth city. The site was established a short distance inside the National Park boundary at an elevation of 460 m asl.

3.2.13.1 National Park site (WKH000100)

3.2.13.1.1 Taxa richness and MCI

Thirty-one surveys have previously been undertaken at this upper reach site just inside the National Park boundary in the Waiwhakaiho River between November 2002 and March 2018. These results are summarised in Table 59, together with the result from the current period, and illustrated in Figure 109.

Table 59 Results of previous surveys performed in the Waiwhakaiho River at National Park together with the 2018-2019 results

Site code	SEM data (2002 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000100	31	4-29	19	115-147	130	21	139	33	126

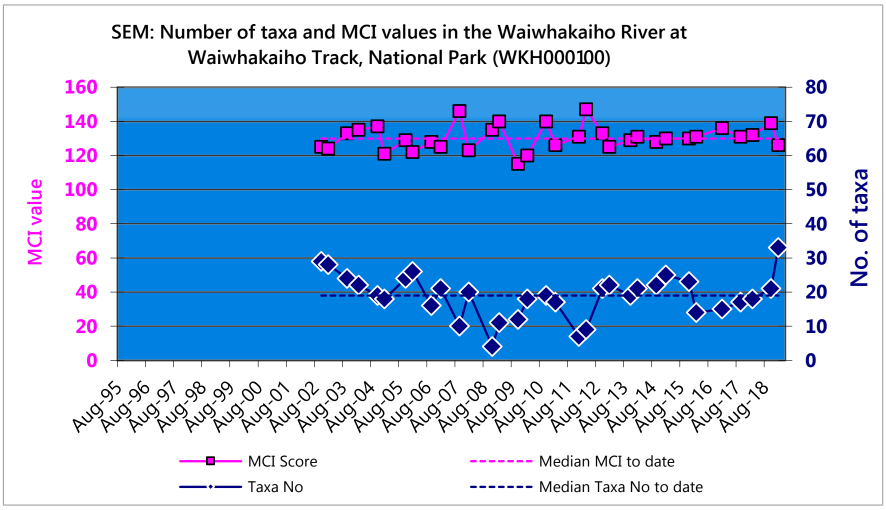


Figure 109 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont National Park

A wide range of richness (4 to 29 taxa) has been found, wider than might be expected due to headwater erosion effects over the 2008-2009 period with a median richness of 19 taxa, much lower than typical richness in ringplain streams and rivers near the National Park boundary. During the current period, spring (21 taxa) and summer (33 taxa) richness were similar to the median richness.

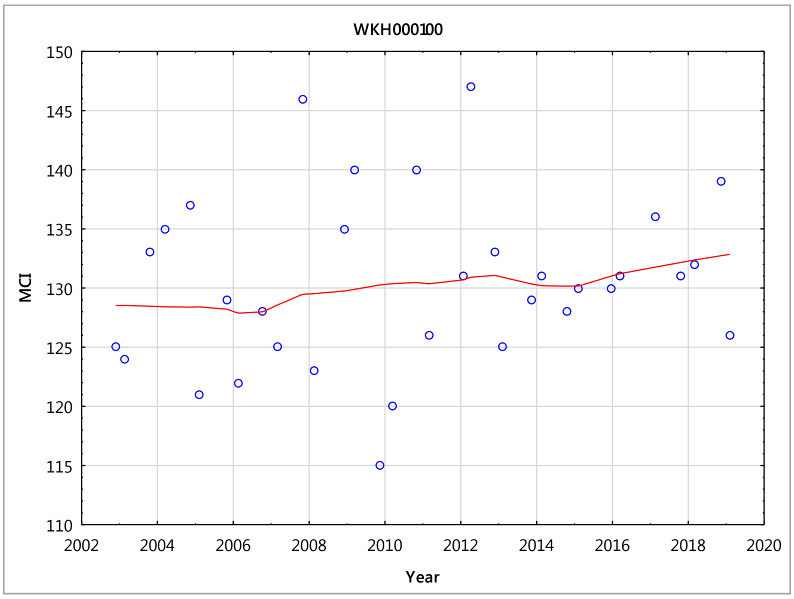
MCI values have had a wider range (32 units) at this site than typical of a National Park boundary site, due in part to an atypically very high value in 2008 following a marked drop in richness and low values after the 2008-2009 headwater erosion period. The spring (139 units) and summer (126 units) scores were not significantly different to the historical median but were significantly different to each other. The scores categorised this site as having 'very good' (spring and summer) health generically. The historical median score (130 units) placed this site in the 'very good' category for health.

3.2.13.1.2 Predicted stream 'health'

The Waiwhakaiho River site at the National Park is just inside the National Park boundary at an altitude of 460 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009) predict a MCI value of 132 for this site. The historical site median, spring and summer scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 137 units. The historical site median and spring score were not significantly different to this value but the summer score was significantly lower.

3.2.13.1.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 110). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (2002-2019) and the most recent ten-years of results (2009-2019) from the site in the Waiwhakaiho River at the National Park.



N = 33
Kendall tau = 0.158
p level = 0.20
FDR p = 0.28

N = 19
Kendall tau = 0.246
p level = 0.14
FDR p = 0.40

Figure 110 LOWESS trend plot of MCI data at the National Park site

No significant temporal trend in MCI scores has been found over the entire monitoring period at this site within the National Park. The trendline has a range of only five units and has consistently indicated 'very good' generic river health over the period.

There was a non-significant positive trend in MCI scores over the most recent ten-year period, congruent with the full dataset. The trendline for the most recent ten-year period was indicative of 'very good' health.

3.2.13.2 Egmont Village site (WKH000500)

3.2.13.2.1 Taxa richness and MCI

Forty-five surveys have been undertaken in the Waiwhakaiho River at this mid-reach site at SH 3, Egmont Village (above the Mangorei Power Scheme) between October 1995 and March 2018. These results are summarised in Table 60, together with the results from the current period, and illustrated in Figure 111.

Table 60 Results of previous surveys performed in the Waiwhakaiho River at Egmont Village together with the 2018-2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000500	45	14-32	22	87-125	111	20	103	25	96

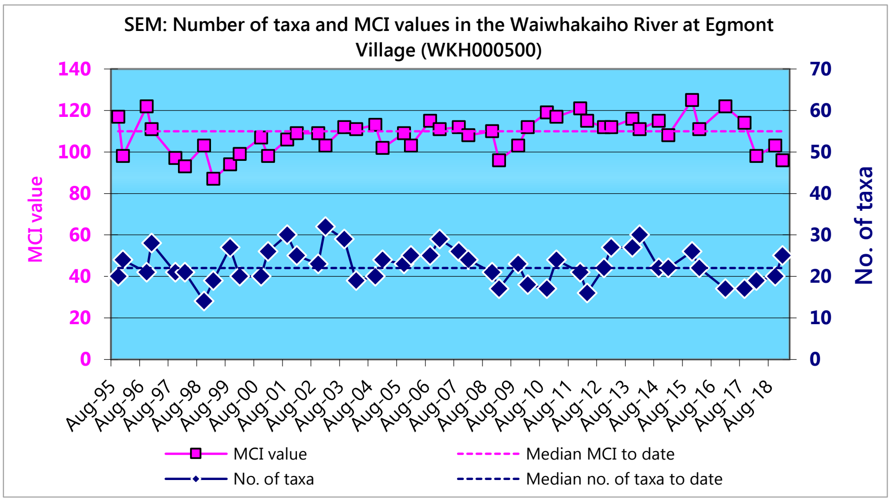


Figure 111 Numbers of taxa and MCI values in the Waiwhakaiho River at Egmont Village

A wide range of richness (14 to 32 taxa) has been found; wider than might be expected, with a median richness of 22 taxa (more representative of typical richness in the mid reaches of ringplain streams and rivers. During the current period the spring (20 taxa) and summer (25 taxa) surveys had moderate richness and were similar to the historical median.

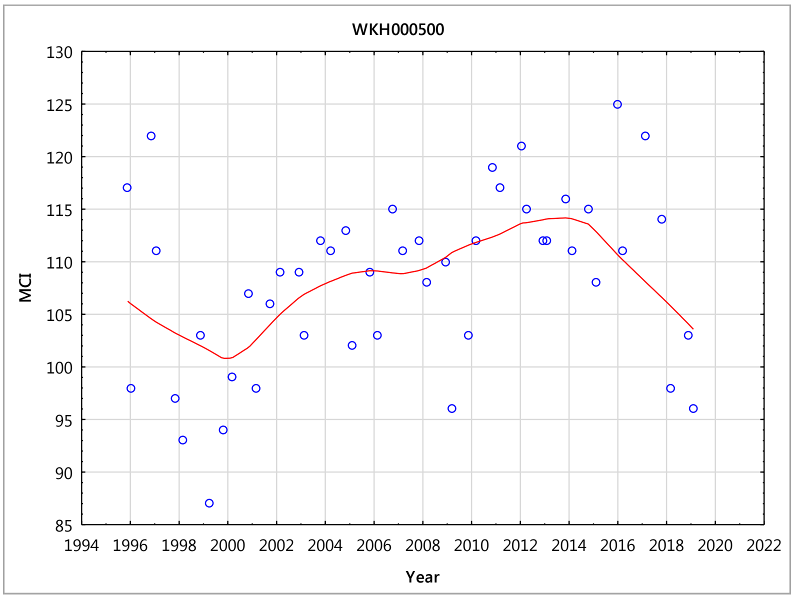
MCI values have had a slightly wider range (38 units) at this site than typical of sites in the mid reaches of ringplain rivers but the median value (111 units) has been relatively typical of mid reach sites elsewhere on the ringplain. The spring (103 units) score was not significantly lower than the historical median but the summer score (96 units) was significantly lower than the historical median. The scores categorised this site as having 'good' (spring) and 'fair' (summer) health generically. The historical median score (111 units) placed this site in the 'good' category for generic health.

3.2.13.2.2 Predicted stream 'health'

The Waiwhakaiho River site at Egmont Village is 10.6 km downstream of the National Park boundary at an altitude of 175 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 105 for this site. The historical site median, spring and summer scores were not significantly different to the distance predictive value. The REC predicted MCI value (Leathwick, et al. 2009) was 115 units. The historical site median was not significantly different to this value but the spring and summer scores were significantly lower.

3.2.13.2.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 112). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waiwhakaiho River at Egmont Village.



N = 47
Kendall tau = 0.261
p level = 0.01
FDR p = 0.02

N = 19
Kendall tau = -0.268
p level = 0.11
FDR p = 0.40

Figure 112 LOWESS trend plot of MCI data at the Egmont Village site

A significant positive trend in MCI scores (FDR p = 0.02) has been found during the entire monitoring period indicating an overall improvement in macroinvertebrate health at the site. After some initial deterioration in scores, there has been a steady improvement from 1999 to 2016, where recently there has been a decline in scores. The trendline had a range of 13 units indicating some ecological variability and has consistently indicated 'good' generic river health over the period.

In contrast to the full dataset, there was a non-significant negative trend in MCI scores over the most recent ten-year period. The trendline for the most recent ten-year period was indicative of 'good' health.

3.2.13.3 Constance Street site (WKH000920)

3.2.13.3.1 Taxa richness and MCI

Forty-five surveys have been undertaken in the Waiwhakaiho River at this lower reach site at Constance Street, New Plymouth (below the Mangorei Power Scheme), between 1995 and March 2018. These results are summarised in Table 61, together with the results from the current period, and are illustrated in Figure 113.

Table 61 Results of previous surveys performed in the Waiwhakaiho River at Constance Street, New Plymouth, together with 2018-2019 results

Site code	SEM data (1995 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000920	45	12-29	20	71-110	94	16	89	7	60

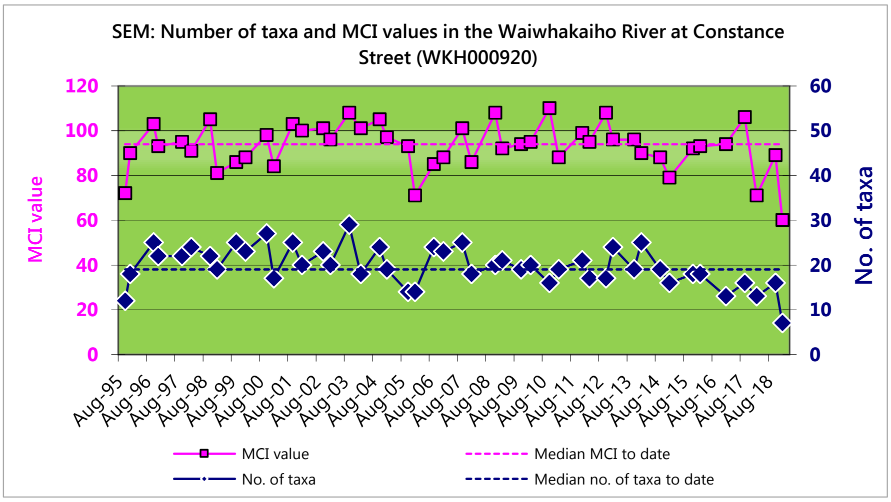


Figure 113 Numbers of taxa and MCI values in the Waiwhakaiho River at Constance Street

A wide range of richness (12 to 29 taxa) has been found with a median richness of 20 taxa which was more representative of typical richness in the lower reaches of ringplain streams and rivers. During the current period, spring (16 taxa) and summer (7 taxa) richness were four and 13 taxa lower than the median richness respectively. The summer richness of only seven taxa was the lowest recorded taxa richness to date at the site and furthermore was nearly half the previous lowest result of 12 taxa.

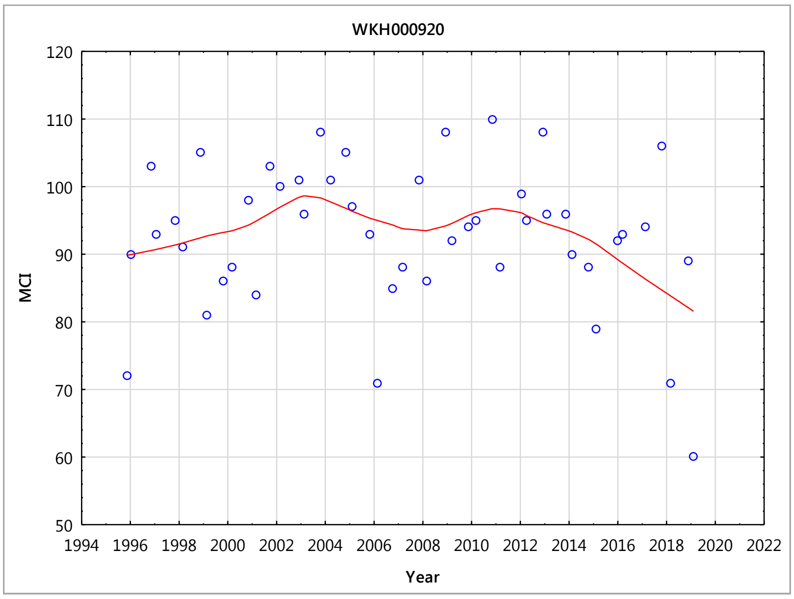
MCI values have had a wide range (39 units) at this site. The median value (94 units) has been relatively typical of scores at lower reach sites elsewhere on the ringplain. The spring (89 units) score was not significantly different to the historical median but the summer (60 units) score was significantly lower than the historical median and spring score and was the lowest score recorded at this site to date by a significant 11 units. There was a large decrease of 29 units between spring and summer, suggesting a rapid deterioration in water quality between the two sampling dates. The MCI scores categorised this site as having ‘fair’ (spring) and ‘poor’ (summer) health generically (Table 3). The historical median score (95 units) placed this site in the ‘fair’ category.

3.2.13.3.2 Predicted stream ‘health’

The Waiwhakaiho River site at Constance Street, New Plymouth is 26.6 km downstream of the National Park boundary at an altitude of 20 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 95 for this site. The historical site median and spring score was not significantly different to the distance predictive value while the summer score was significantly lower (Stark, 1998). The REC predicted MCI value (Leathwick, et al. 2009) was 97 units. The historical site median and spring scores were not significantly different to this value, while the summer score was again significantly lower.

3.2.13.3.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 114). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1995-2019) and the most recent ten-years of results (2009-2019) from the site in the Waiwhakaiho River at Constance Street.



N = 47
Kendall tau = -0.057
p level = 0.57
FDR p = 0.65

N = 19
Kendall tau = -0.349
p level = 0.04
FDR p = 0.22

Figure 114 LOWESS trend plot of MCI data at the Constance Street site

The overall negative trend in MCI scores has not been statistically significant for the period, due mainly to some decline and subsequent recovery in scores after 2003 and again since 2011. The trendline had a range of 16 units which indicates variability of ecological importance. Improvements from 1995 to 2003 may be due to a small increase in summer residual flows from the upstream HEPS, but conversely, the declines from 2011 may also be linked to an increase in the permitted take of the HEPS, among other factors. The trendline range indicated 'fair' generic river health for the entire period.

There was a non-significant negative trend in MCI scores over the most recent ten-year period with a decline in the trendline evident from 2011 onwards. The trendline was significant before FDR adjustment. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.13.4 Site adjacent to Lake Rotomanu (WKH000950)

3.2.13.4.1 Taxa richness and MCI

Forty-three surveys have been undertaken in the Waiwhakaiho River at this lower reach site adjacent to Lake Rotomanu between November 1996 and March 2018. These results are summarised in Table 62, together with the results from the current period, and illustrated in Figure 115.

Table 62 Results of previous surveys performed in the Waiwhakaiho River the site adjacent to Lake Rotomanu, together with the 2018-2019 results

Site code	SEM data (1996 to March 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Nov 2018		Feb 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WKH000950	43	12-30	21	70-111	89	15	84	8	80

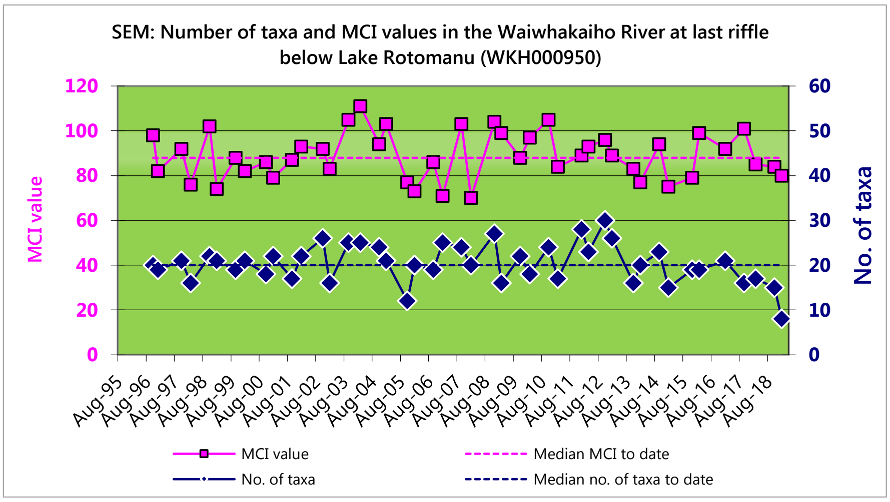


Figure 115 Numbers of taxa and MCI values in the Waiwhakaiho River at Lake Rotomanu

A wide range of richness (12 to 30 taxa) has been found; wider than might be expected, with a median richness of 21 taxa. During the current period spring (15 taxa) taxa was lower than the historical median while and summer (8 taxa) richness far lower than the historical median richness and was the lowest taxa richness recorded at the site to date.

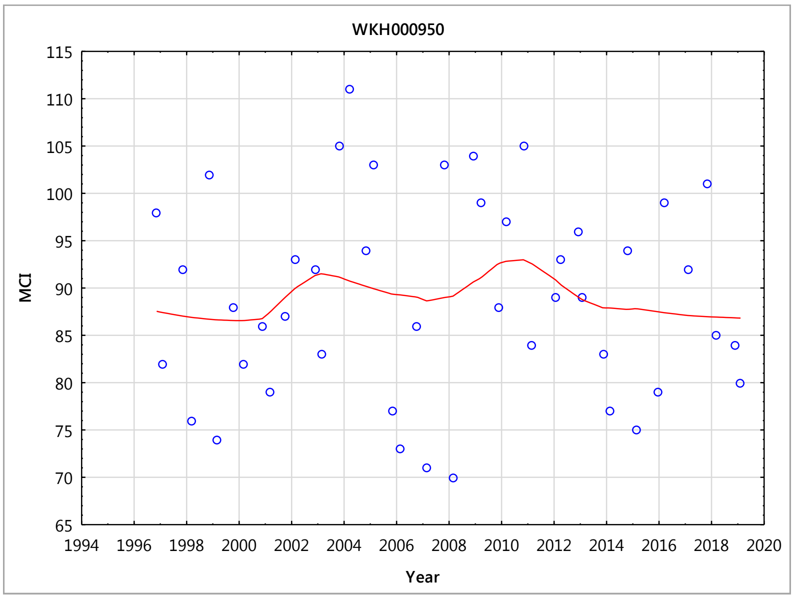
MCI values have had a wide range (41 units) at this site but typical of variable scores at sites in the lower reaches of ringplain streams. The median value (89 units) has been relatively typical of lower reach sites elsewhere on the ringplain. The spring (84 units) and summer (80 units) scores were not significantly different from the historical median (Stark, 1998). The scores categorised this site as having 'fair' health. The historical median score (89 units) placed this site in the 'fair' generic health category (Table 3).

3.2.13.4.2 Predicted stream 'health'

The Waiwhakaiho River at the site adjacent to Lake Rotomanu is 28.4 km downstream of the National Park boundary at an altitude of 2 m asl. Relationships for ringplain streams developed between MCI and distance from the National Park boundary (Stark and Fowles, 2009), predict a MCI value of 94 for this site. The historical site median and spring and summer score were not significantly different to the distance predictive value but the summer score was significantly lower. The REC predicted MCI value (Leathwick, et al. 2009) was 97 units. The historical site median was not significantly different to the distance predictive value but both the spring the summer scores were significantly lower than the REC predictive value.

3.2.13.4.3 Temporal trends

A LOWESS trend plot with a moving average (tension 0.4) trendline was produced (Figure 116). A non-parametric statistical trend analysis of the MCI data using the Mann-Kendall test was then performed on the entire SEM results (1996-2019) and the most recent ten-years of results (2009-2019) from the site in the Waiwhakaiho River adjacent to Lake Rotomanu.



N = 45
Kendall tau = 0.0
p level = 1.0
FDR p = 1.0

N = 19
Kendall tau = -0.182
p level = 0.28
FDR, p = 0.57

Figure 116 LOWESS trend plot of MCI data at the site adjacent to Lake Rotomanu

Overall, MCI scores have shown no statistically significant trend. There was an improvement from 1995 to 2003 but since 2004, there has been a steady decline in scores toward scores typically found in the first two years of the programme, followed by another improvement and subsequent decline. These are relatively similar trends to those found at the nearest upstream site (Constance St). The trendline covered a range of scores (six units) of marginal ecological importance which showed slightly more variability over the 2007 to 2015 period. The trendline indicated 'fair' generic stream 'health' throughout the period.

There was a non-significant negative trend in MCI scores over the most recent ten-year period. The trendline for the most recent ten-year period was indicative of 'fair' health.

3.2.13.5 Discussion

Taxa richness differed markedly between sites and between spring and summer surveys but generally decreased in a downstream direction. Richness was substantially lower than usual at the two lower sites during summer with both sites recording new record low richness. Very low taxa richness is often associated with poor water quality, either from chronic or acute pollution.

The surveys indicated that the upper site had a macroinvertebrate community in 'very good' health while the site near Egmont Village had typical 'good' health during spring but only 'fair' health during summer. The two lowest sites had 'fair' health in spring and 'poor' and 'fair', but only one unit away from 'poor', health in summer. Of particular concern was the Constance St site which had experienced its lowest ever MCI score of only 60 units, which was a significant 11 units lower than its next lowest score recorded score, and only one unit off the 'very poor' category. This poor result was coincident with the record low taxa richness at the site and was possibly due to poor preceding water quality. However, the dry summer period had caused widespread periphyton. The bottom site based on its taxa richness also seems to have been affected but not to the same degree as the Constance St site.

The MCI score consistently decreased in a downstream direction with an overall decrease of a highly significant 55 MCI units in spring and 46 MCI units, over a river distance of 28.7 km.

The time trend analysis indicated a positive significant trend for Egmont Village for the full data set while no other significant trends after FDR application occurred at other sites though there was a significant negative trend before FDR application at the Constance St site. The upper site was unlikely to change in condition as it is in a National Park while the two lower sites are in the city of New Plymouth were subjected to urban and industrial sources of pollution as well as fluctuating flows from a hydro scheme. The site at Egmont Village has an upstream area dominated by agriculture and significant improvements in macroinvertebrate health at this site was likely due to improvements in farming practices. However, physiochemical trends show significantly increasing phosphorus and nitrate at the site, a key algal nutrient, and this may also be contributing to recent negative declines.

3.2.14 Whenuakura River

The Whenuakura River has a catchment that is in Eastern Hill country, with the lowest portion in the Taranaki southern marine terrace. The river flows in a southerly direction, with a mouth between the townships of Patea and Waverly. One site in this river was included in the SEM programme in 2015, for the purpose of monitoring an additional site in the Eastern Hill country. The site is located in the lower reaches of the river, at an altitude of approximately 20 m; some ten km from the coast.

3.2.14.1 Whenuakura River at Nicholson Road site (WNR000450)

3.2.14.1.1 Taxa richness and MCI

This is the fourth year of monitoring at this lower reach site in the Whenuakura River. The results from previous surveys, and the current period, are presented in Table 63, and illustrated in Figure 117.

Table 63 Results of previous surveys performed in the Whenuakura River at Nicholson Road, together with 2018-2019 results

Site code	SEM data (2015 to February 2018)					2018-2019 surveys			
	No of surveys	Taxa numbers		MCI values		Oct 2018		March 2019	
		Range	Median	Range	Median	Taxa no	MCI	Taxa no	MCI
WNR000450	6	17-32	18	81-94	88	16	99	21	71

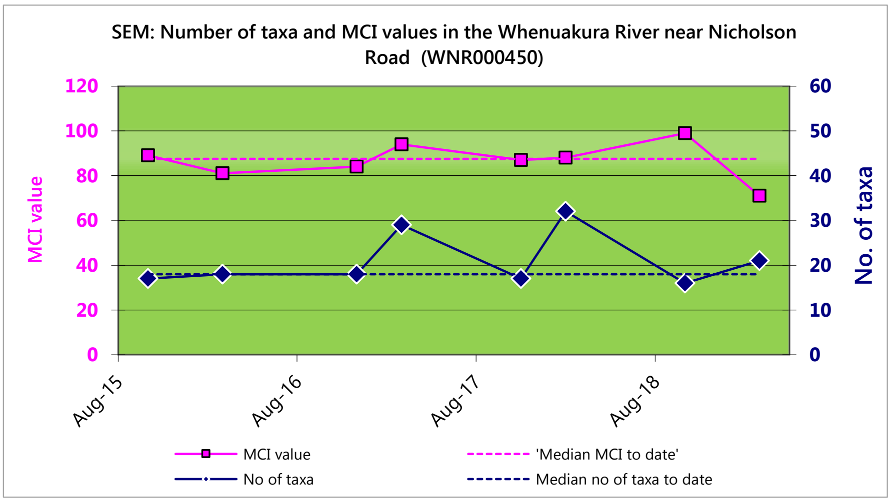


Figure 117 Numbers of taxa and MCI values in the Tangahoe River at Upper Tangahoe Valley Road

During the current period, spring (16 taxa) and summer (21 taxa) richness were moderate but the spring score represented a new minimum for the site, even though it was only two taxa different from the historical median.

Historical MCI values have had a narrow range (13 units) at this site, which was expected given only six surveys have been completed at the site. The historic median value (88 units) was slightly higher than was typical of mid reach sites elsewhere as recorded at 'control' sites located at similar altitudes in hill country rivers and streams. The spring (99 units) and summer (71 units) scores were both significantly different from each other and to the historical median with the spring score representing a new maximum for the site and the summer score a new minimum. Again, as there have been so few surveys conducted at the site new minimum and maximum values are likely to be regularly recorded in the first few years of monitoring. The scores categorised this site as having 'fair' health in spring and 'poor' health in summer. The historical median classified this site as having 'fair' health (Table 3).

3.2.14.1.2 Predicted stream 'health'

The Whenuakura River at Nicholson Road, at an altitude of 20 m asl, is toward the lower reaches of this low gradient river draining an eastern hill country catchment. The REC predicted MCI value (Leathwick, et al. 2009) was 109 units and therefore the historical median and summer scores were both significantly lower than this value and the spring score was not significantly different (Stark, 1998).

3.2.14.1.3 Temporal trends in data

There was insufficient data to perform time trend analysis which requires a minimum of ten years data.

3.2.14.2 Discussion

Taxa richness were moderate during spring and summer with minor seasonal variation of five taxa. The spring taxa richness represented a new low but given this was very similar to the current historical median was of no consequence. The site was in 'fair' health during both spring and summer at the time of surveys. However, there was significant variation in MCI score between the spring and summer surveys with new maximum and minimum scores recorded. In particular, the summer score was ten units lower than the next lowest value and even for such a small dataset would appear to be an atypically low score.

4 General discussion and conclusions

The detection of trends in the biological data requires a data set of suitable period and collected using rigid, acceptable protocols, to be statistically valid e.g. a minimum of ten-years of spring and summer surveys. With 24 years of data available for most sites, temporal trend analyses have been updated further within this report. For the fourth time, there has also been analysis presented of the results from the most recent ten-year period for each site where available. This represents a compromise between degree of certainty in any apparent trends, and an indication of current as distinct from historical directions of travel. Other comments in relation to the data collected in the period 1995 to 2019, are presented briefly below. These data are summarised in Appendix II and illustrated in Figure 118 to Figure 124.

4.1 Macroinvertebrate fauna communities

In general terms, data have indicated that the macroinvertebrate communities at sites in upper reaches of catchments have been comprised of a greater proportion of taxa that are 'sensitive' to the effects of nutrient enrichment or a poorer state of habitat, compared with communities in the mid and lower reaches of catchments. These changes in community composition have resulted from the effects of nutrient enrichment, sedimentation, turbidity, increased sunlight (less riparian shading and potentially wider rivers), higher temperatures, increased algal and macrophyte growth, lower water levels, and less aeration (mixing) resulting in lower dissolved oxygen.

Taxa richness: (number of different taxa) at most sites in these streams and rivers more often showed higher richness in the upper reaches of catchments. However, a range of factors may influence taxa richness, and some upper sites were negatively affected by headwater erosion events. Taxa richness can sometimes be increased by mild nutrient enrichment and therefore care needs to be taken when interpreting taxa richness results. However, taxa richness is very useful when determining the presence or effects of pollution events as releases of toxic discharges will invariably lower richness. At middle and lower reach sites there was more seasonal variability in richness, probably as a result of greater seasonal changes in periphyton and to a lesser extent macrophyte biomass. Seasonal richness often have tended to be higher in summer than in spring, particularly at lower reach sites.

Macroinvertebrate community index: sites in the middle and the lower reaches of streams and rivers generally had lower summer MCI scores than spring MCI scores as evidenced by overall decreases in mean scores by twelve and nine units respectively whereas mean seasonal scores at upper reach sites decreased by only four units for the current monitoring year. These differences were due to the reasons outlined above, and possibly due to lifecycle patterns as well. Some taxa will be present in spring as large nymphs but will not be recorded in summer samples as they will be at an egg or first instar (usually impossible to ID to genus) stage. This has resulted in additional less 'sensitive' taxa being present and/or increases in the presence of lower scoring 'tolerant' taxa in summer surveys.

Furthermore, the results from the 2018-2019 have shown that:

- The mean (106 units) and median (102 units) spring MCI scores were higher than the mean (97 units) and median (94 units) summer MCI scores.
- A paired two sample t-test of spring and summer MCI scores showed that there was highly significant seasonal variation (N = 59, t-value = 7.07, $p < 0.01$).
- At upper reach sites there was an decrease in average MCI score of four MCI units in summer which was not statistically significant (N = 8, t-value = 1.42, $p < 0.10$).
- At mid reach sites, a decrease in average MCI score of nine units in summer was highly statistically significant ((N = 28, t-value = 5.62, $p < 0.01$).

- At lower reach sites, a decrease in average MCI scores of 12 units in summer was highly significant (N = 23, t-value = 4.66, $p < 0.01$).
- The historical spring medians (average 104 MCI units) were significantly higher, by three MCI units on average, than the historical summer medians (average 101 MCI units) (N = 59, t-value = 7.69, $p < 0.01$)

There were three new maxima and eight new minima MCI scores recorded during the 2018-2019 period. This result was considerably worse than the seven new maxima and one new minima recorded in the preceding 2017-2018 period. One of the three new maxima and one of the eight new minima were from one of the two sites established in the 2015-2016 period and hence was of little comparative significance.

Furthermore, seven sites in summer had 'poor' scores and one site had a 'very poor' score while only two sites in spring had 'poor' scores, which were in the Mangati Stream. The Mangati Stream is known to have a variety of water quality issues and therefore the stream typically has poor scores.

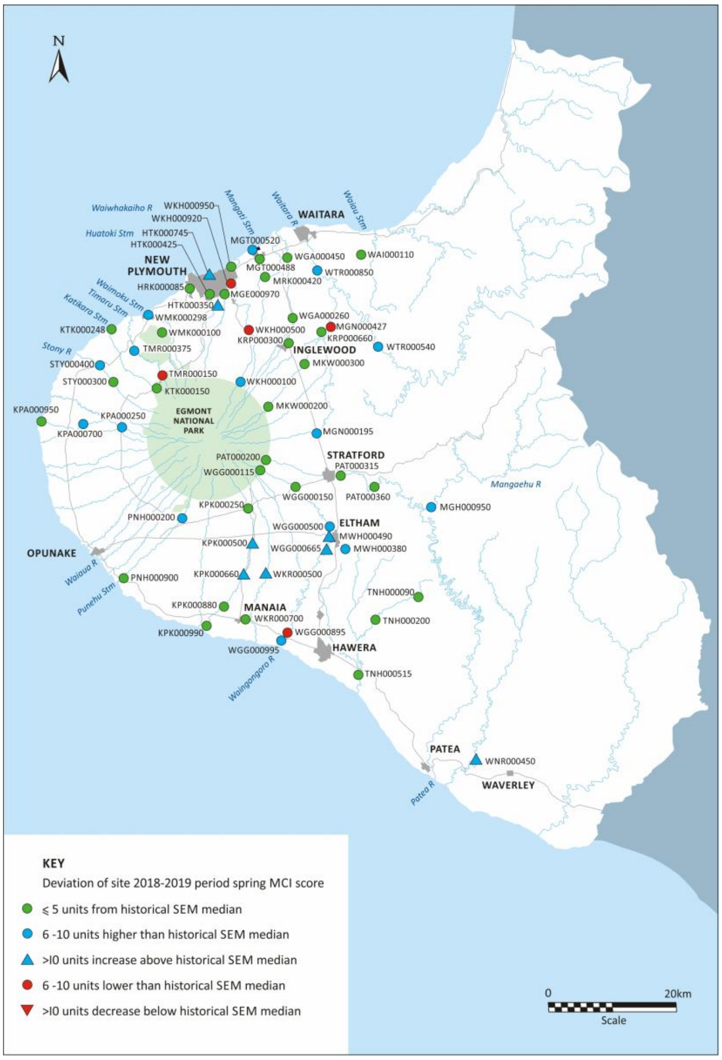
4.1.1 Spring and summer MCI values vs median values and predictive scores

The MCI scores from the spring and summer surveys are compared with the historical medians generated from 23 years of data (1995-2018) from the SEM programme and with two predictive scores (summarised in Appendix II): modelled based on distance from the National Park, and referenced against equivalent REC sites (national). Those sites' median MCI scores which deviated significantly (> 10 MCI units) from predicted scores are listed individually in Appendix II.

4.1.2 Spring surveys

4.1.2.1 Historical SEM

Forty-nine of the 59 sites had spring MCI scores which were not significantly different (within ten units) to their historical medians. Ten sites had a significantly better than normal scores and there were no sites that had significantly worse than normal scores (Figure 118). In addition, 14 sites had scores that were between six to ten units higher and four sites had scores that were between four to ten units lower than historical spring medians. This indicates slightly better than average results for the spring period.

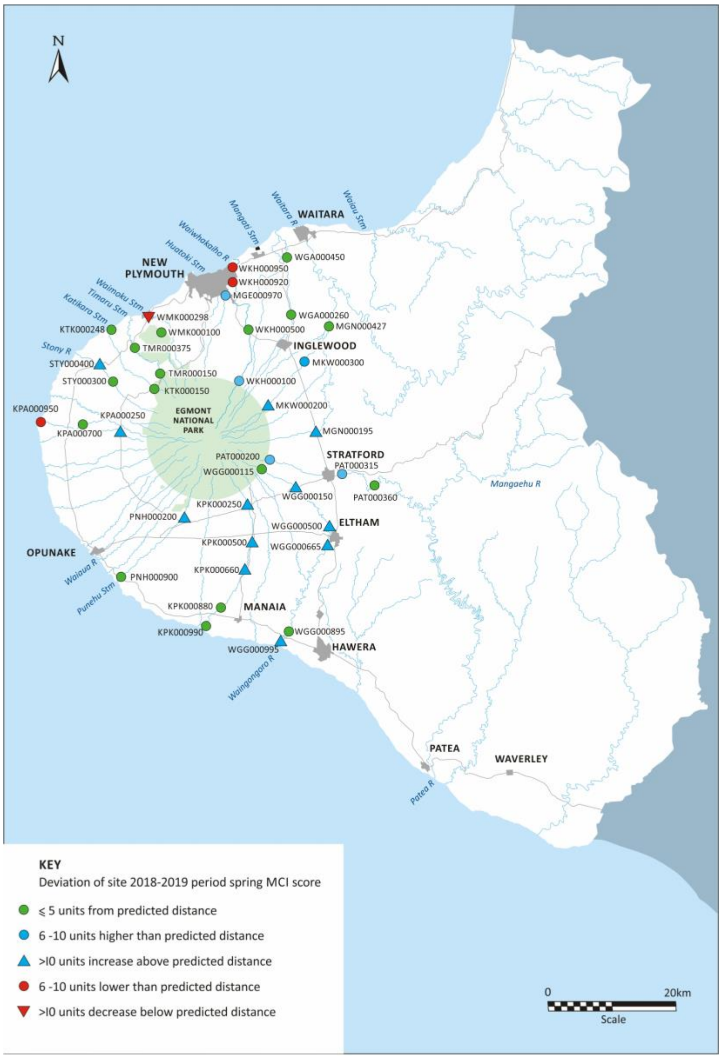


Spring MCI scores relation to SEM historical median values

Figure 118 Spring MCI scores in relation to SEM historical spring median values

4.1.2.2 Predictive TRC ringplain distance model (distance from Egmont National Park)

Predictive scores have been developed for ringplain sites (38 sites) with their sources inside the National Park in relation to distance from the National Park (Stark and Fowles, 2009). Spring scores have been assessed against predicted scores for distance in Figure 119.



Spring MCI scores relation to predicted downstream distance scores

Figure 119 Spring MCI scores in relation to predicted downstream distance scores

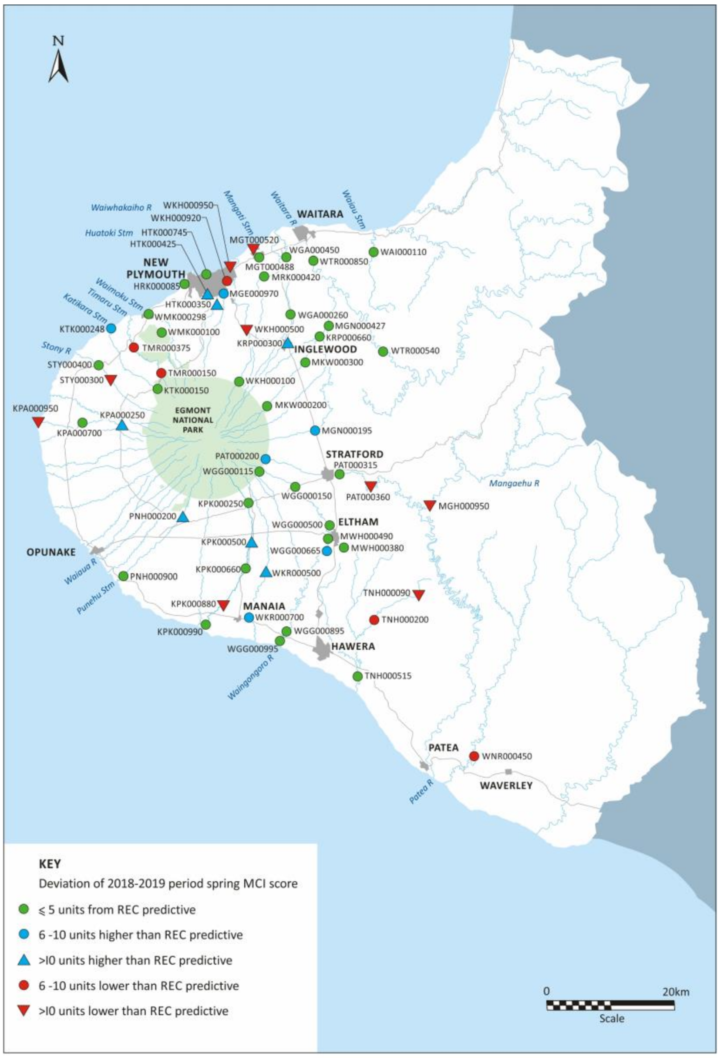
Twenty-five of the 38 sites had spring MCI scores which were not significantly different (within ten units) to their predicted MCI scores based on distance from the National Park. Twelve sites had spring MCI scores more than ten units above the distance predicted values while only one site had a score significantly lower than predicted. Five sites had a score between six to ten units above the predicted value while three sites had a score between six to ten units below the distance predictive value. Again, this indicates slightly better than average results for the spring period with more sites significantly better than predictive results than significantly worse.

4.1.2.3 Spring MCI scores in relation to the REC predictive score

Leathwick (2009, pers comm.) has developed predictive scores based upon the River Environmental Classification (REC) system for New Zealand rivers and streams (Snelder et al, 2004). REC classifies and maps river and stream environments in a national spatial framework for management purposes.

Spring MCI scores have been compared with the REC predictions for all sites surveyed in spring. REC predictions are calculated by averaging current MCI scores for a particular REC segment type as well as taking into account other additional environmental and physical factors (see Leathwick, 1998).

Seven sites had spring MCI scores more than ten units above predicted values (Figure 120) and nine sites had values significantly lower than predicted values. A further seven sites had scores between six to ten units above the predicted value and five sites had scores between six to ten units below the predicted value. Generally, REC predictive scores are higher than historical and distance predictive scores and therefore current survey results do not perform as well against them compared with the other two predictive measures.



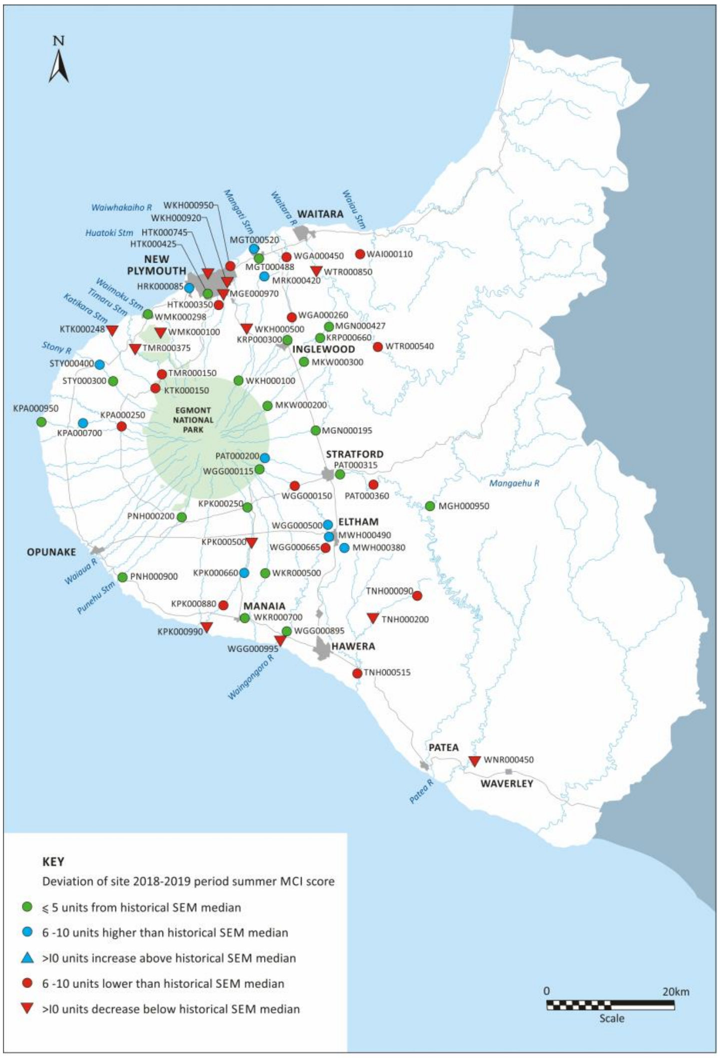
Spring MCI scores relation to REC predictive values

Figure 120 Spring MCI scores in relation to REC predictive values

4.1.3 Summer surveys

4.1.3.1 Historical SEM

A majority (47 of 59 sites) of sites' faunal communities' MCI scores were similar to (within 10 units) historical SEM site median scores (Figure 121). There were no significantly higher scores found while twelve sites had MCI scores significantly lower than their respective historical median score. A further seven sites had scores between six to ten units above the long-term value and 14 sites had scores between six to ten units below the long-term value.



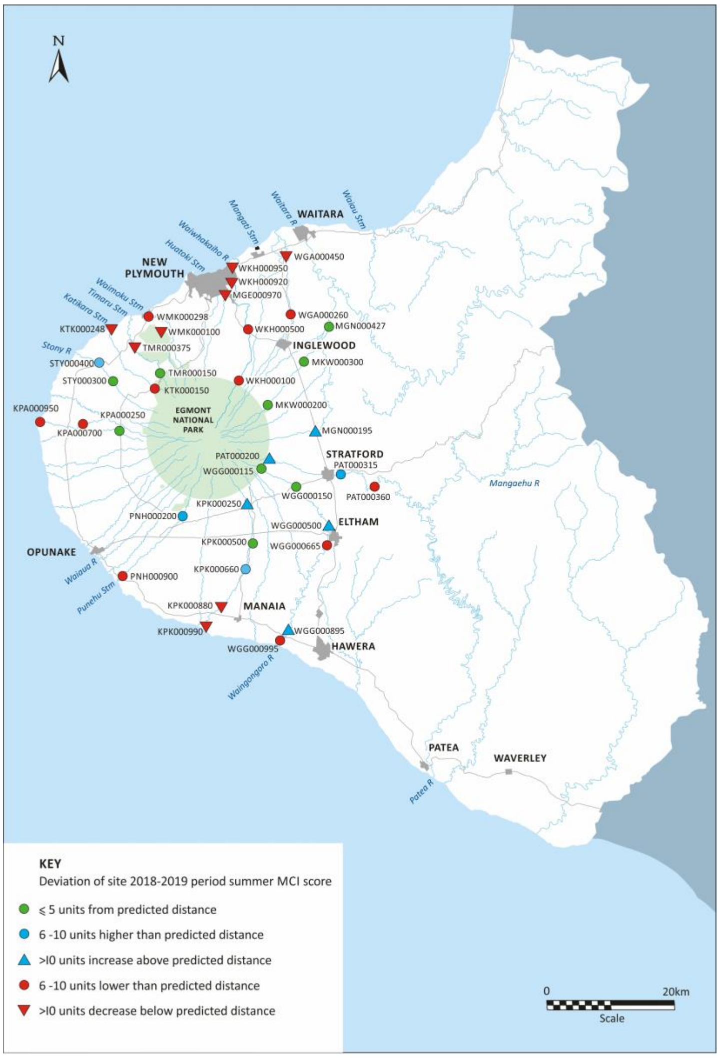
Summer MCI scores relation to SEM historical median values

Figure 121 Summer MCI scores in relation to SEM historical median values

This indicates that summer macroinvertebrate health was significantly poorer than usual. This could be attributed to the drier than usual summer period which had very low flows and long times between when a survey was undertaken and time since the last significant fresh.

4.1.3.2 Predictive TRC ringplain distance model

Summer scores for each ringplain site (38 sites) have been assessed against predicted scores (Stark and Fowles, 2009) for distance from the National Park boundary for those ringplain sites with sources inside the National Park. A majority (24 of 38 sites) of sites' faunal communities' MCI scores were similar to (within 10 units) their distance-based predictive scores (Figure 122).



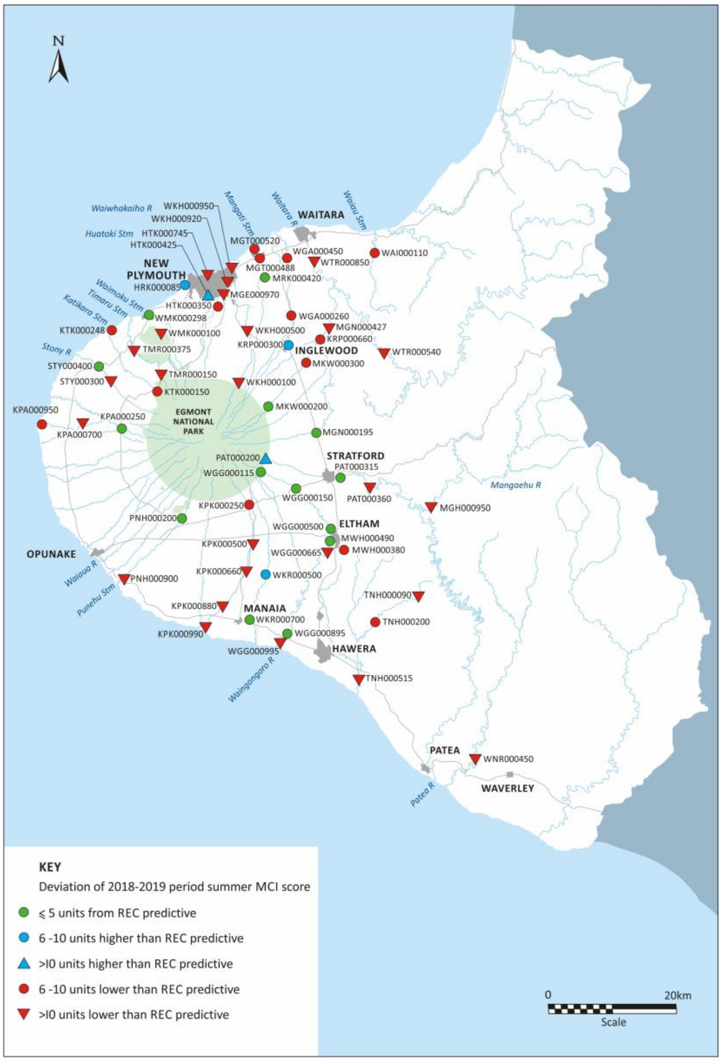
Summer MCI scores relation to predicted downstream distance scores

Figure 122 Summer MCI scores in relation to predicted downstream distance scores

Four sites had scores more than ten units above predicted values and ten sites had scores more than ten units below predicted values. A further six sites had scores between six to ten units above the predicted value and ten sites had scores between six to ten units below the predicted value. Again, this could be attributed to the drier than usual summer period. All the sites with a greater than 10 units decrease from predicted distance had a significant negative relationship between 3x and/or 7x days since a median flow fresh and MCI scores. This, in combination with the long recession periods between freshes and sampling for the current summer period would explain the poorer than usual scores.

4.1.3.3 Summer MCI scores in relation to the REC predictive scores

Summer MCI scores have been compared with the REC predictions for all 59 sites. REC predictions were calculated by averaging current MCI scores for a particular REC segment type as well as taking into account other additional environmental and physical factors (see Leathwick, 1998).



Summer MCI scores relation to REC predictive values

Figure 123 Summer MCI scores in relation to REC predictive values

One site had a summer MCI score more than ten units above predicted values (Figure 123) with 28 sites significantly lower than predicted. A further three sites had scores between six to ten units above the predicted value and 14 sites had scores between six to ten units below the predicted value.

Generally, REC predictive scores are higher than historical and distance predictive scores and therefore current survey results do not perform as well against them compared with the other two predictive measures. As Taranaki summer MCI scores are usually lower than spring scores this discrepancy is further exasperated.

4.1.3.4 Predictive value overview

The general seasonal trend in MCI scores is summarised in Table 64, which provides the percentages of sites' scores in relation to historical medians and predicted scores.

Table 64 Percentages of spring and summer MCI scores for ringplain sites with sources arising in the National Park in relation to historical median, predicted distance from National Park boundary score (Stark and Fowles, 2009) and national REC-based scores (Leathwick, 1998)

Season	Spring			Summer		
Prediction	> 10 units higher	± 10 units	> 10 units lower	> 10 units higher	± 10 units	> 10 units lower
Median	17%	83%	0%	0%	80%	20%
Distance	32%	66%	3%	11%	63%	26%
REC	12%	73%	15%	2%	51%	47%

In general, MCI scores were more likely to be significantly higher than lower compared with historical medians in spring and significantly lower than higher for summer with the majority of sites not significantly different to its historical median.

Again, MCI scores were more likely to be significantly higher than lower for predictive distance scores in spring and significantly lower than higher for summer with the majority of sites not significantly different to predictive scores. Usually both spring and summers scores were significantly higher, which was probably due to sites having improved since the distance-based predictive equations were created using data from 1981-2006. However, the current summer scores were poorer than usual indicating a particularly poor summer result. The summer period had significantly longer than usual recession flows, as measured by days since 3x and 7x median flow fresh, than usual resulting in low flows and longer than usual times between bed moving freshes.

An analysis of the data where information on freshes is available indicates that stream health, as measured by MCI scores, was negatively correlated with the time between sampling and the last significant fresh. This was likely due to a variety of factors. Freshes scour and mobilise the streambed, removing periphyton mats and filaments whose biomass can accumulate to levels likely to have a negative impact on macroinvertebrate community health. In particular, more 'pollution tolerant' species graze on and inhabit excessive periphyton growths. Fine sediment will accumulate over time in even relatively energetic flows such as those found in riffles, which are targeted for sampling in the TRC SEM macroinvertebrate monitoring programme. In lower flows filling in of interstitial spaces in riffles, which are an important habitat for 'pollution sensitive' species such as EPT (mayflies, stoneflies and caddisflies), will remove that habitat and lead to poorer stream health. This loss of habitat is in conjunction with the loss of habitat from smothering of the streambed from periphyton. However, research focused on the 2019 drought in the Tasman Region found "when water quality is good, periphyton will not usually proliferate to nuisance levels and invertebrate diversity will be maintained during low flow conditions" (Shearer and James, 2020). Less flow could also result in less available wetted area which would decrease available habitat even with good water quality. This was considered an important hydrologic effect of the drought in the Tasman Region (Shearer and James, 2020), and though this would reduce total macroinvertebrate numbers in a stream less habitat would not necessarily reduce MCI scores, though other associated factors may have a significant effect.

Other factors such as nutrients and temperature can have important interactive and antagonistic effects and therefore the importance of the preceding hydrological regime will vary at the site level (Piggott et al., 2015). Excessive periphyton will also cause increases in pH due to photosynthesis, which would make other contaminates, such as ammonia, more toxic. Furthermore, photosynthesis will cause diurnal changes in dissolved oxygen, with potentially supersaturated dissolved oxygen levels during daylight hours followed by large drop-offs in dissolved oxygen at night when the periphyton respires and uses oxygen. In addition, low stream flows could lead to greater diurnal temperature variation within a stream and thermal stress. Essentially, the dry weather could potentially cause changes to a range of a factors that will interact with each and other site specific factors resulting in a range of different effects that will influence local macroinvertebrate communities making cause and effect for specific variables difficult to ascertain, which is further compounded by correlation of variables not necessarily indicating causation.

The more recently created REC predictive scores showed a similar pattern except there was little difference between significantly higher versus significantly lower spring scores, with again the majority not significantly different. The summer results showed nearly as many sites were significantly lower than not significantly different with only one site significantly higher (Table 64). This again highlights that the summer results were particularly poor and that Taranaki sites were in not as good a condition as general NZ sites during the summer under review.

Sites were ranked based on the deviation from historical median compared with predictive values for distance from the National Park and REC values. This effectively indicates which sites are 'better than expected' or 'worse than expected' once the particular characteristics of the site are taken into account (to the extent that these characteristics are accounted for in the modelling). Table 65 provides the rankings on this basis of the best and poorest sites in the SEM programme.

Table 65 Ranking of five best and worst sites' based on deviation from historical medians from predictive scores

	Distance from National Park	REC
BEST	Waingongoro R @ Opunake Rd	Huatoki S @ Domain
	Manganui R. SH3	Patea R @ Barclay Rd
	Patea R @ Barclay Rd	Kapoaiaia S @ Wiremu Rd
	Kaupokonui S @ Opunake Rd	Katikara S @ coast
	Waingongoro R @ SH45	Waingongoro R @ Opunake Rd
WORST	Waimoku S @ coast	Mangaehu Rd @ Raupuha Rd
	Kapoaiaia S @ coast	Whenuakura R @ Nicholson RD
	Punehu S @ SH 45	Mangati S @ Bell Block
	Kapoaiaia S @ Wataroa Rd	Kaupokonui S @ u/s Lactose Co.
	Waiwhakaiho R @ coast	Mangawhero S @ Eltham

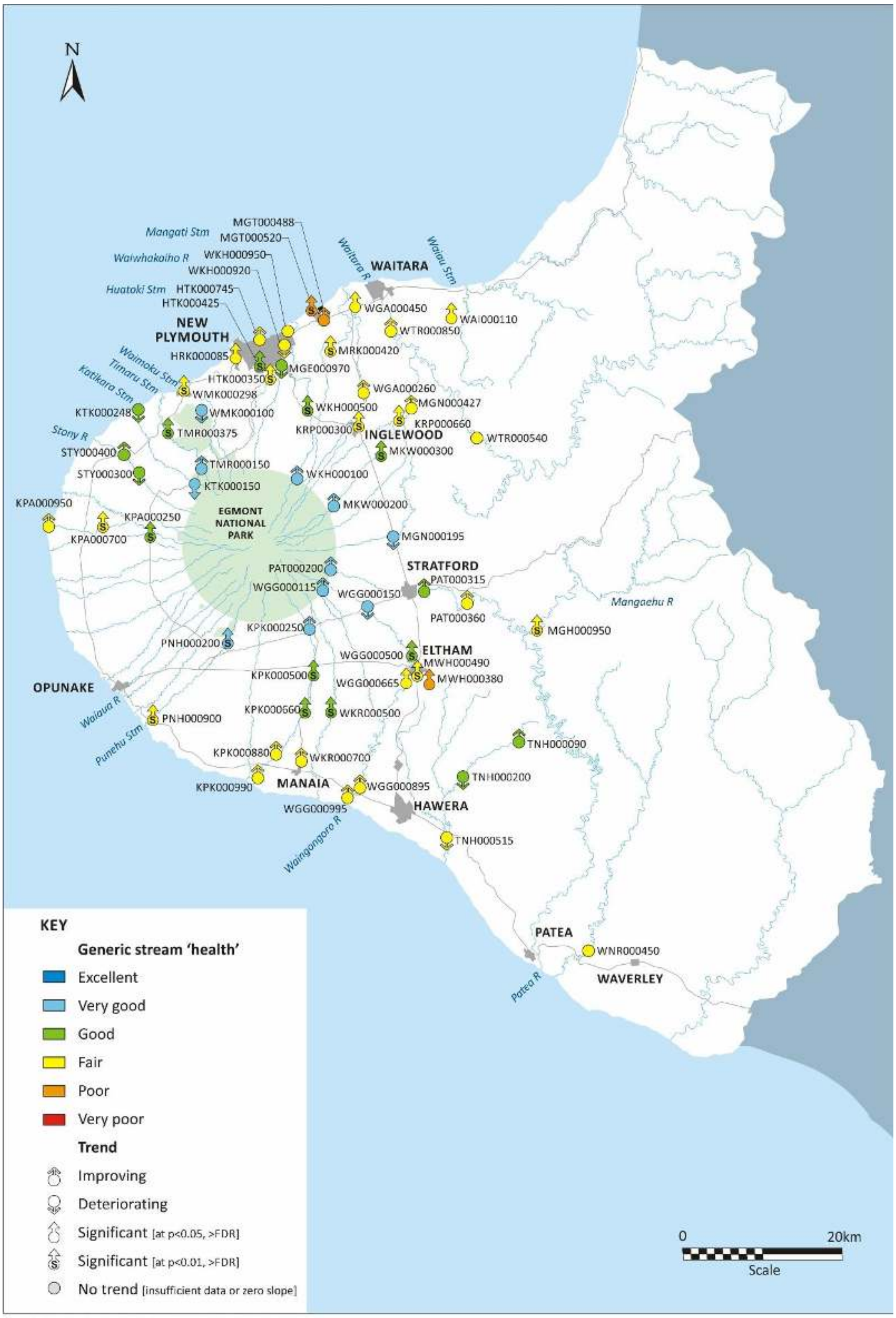
The majority of the best ranked sites were located higher up the catchment for both predictive measures but with some exceptions. The Waingongoro River site at SH45 is located in the lower reach close to the coast. The site has good riparian cover, cobble substrate and swift, well aerated flow which probably contributed to its better than predicted score. The Huatoki Stream in the Domain at New Plymouth also has extensive riparian cover provided by the Domain constituting intact native bush, but is excluded from the distance ranking as this stream is sourced outside of the National Park. The other notable exception is the coastal Katikara site. This site had some riparian vegetation but was otherwise unremarkable.

Sites in the lower reaches of shorter ringplain streams (e.g. Punehu, Kapoaiaia and, in particular the Waimoku Stream), have had historical median MCI scores showing the greatest disparity between actual and predicted scores for distance from the National Park (see Appendix II). Care needs to be used when comparing actual scores with predictive scores as there is likely to be discrepancies, as predictive values are not likely to be perfect and give only a generalised indication of what a site's MCI score is expected to be.

The majority of the poorest ranked streams were located in the lower reaches of catchments with the Kapoaiaia Stream (with very limited riparian cover) notable for its poor ranking as demonstrated by the stream having two sites in the bottom five worst sites for the Distance predictive value. The Mangaehu River and the two small, non-National Park sourced streams (Mangati and Mangawhero), which used to receive significant point source discharges rank poorly in terms of the REC predictions. (Note: these streams and river sites were excluded from the distance predictive rankings as these catchments are located well away from the National Park).

4.1.4 Stream 'health' categorisation

A gradation of biological water quality conditions based upon ranges of MCI scores has been used to determine the 'health' generically (Table 3) of each site by utilising the historical median score. These assessments are summarised in Figure 124 along with the time trend analysis indicating whether a site was significantly improving, improving, stable, deteriorating or significantly deteriorating after FDR adjustment.



Generic biological health trends for SEM sites 95 to 19

Figure 124 Generic biological 'health' based on the historical median MCI and trends in biological quality for SEM sites

No sites had historical medians in 'excellent or 'very poor' health. Sites in 'very good' health were invariably close to the National Park with sites in 'good' health typically in mid-reach sites. Sites in the lower reaches of streams and rivers and Eastern Hill Country sites tended to be in 'fair' condition while two sites in Bell Block and one site in Eltham were in 'poor' condition.

The 'health' of streams in relation to the location of sites (upper, middle and lower reaches) in catchments is summarised in Table 66.

Table 66 Stream 'health' site assessments according to catchment reach in terms of historical median MCI score

'Health' grading (Median MCI score range)	Reaches		
	Upper	Middle	Lower
Excellent (≥140)	0	0	0
Very good (120-139)	7	4	0
Good (100-119)	1	12	3
Fair (80-99)	0	11	18
Poor (60-79)	0	1	2
Very poor (<60)	0	0	0
Median ranges (MCI units)	100-138 (38)	74-130 (55)	67-108 (41)

Typically generic 'health' (in terms of median MCI scores) decreases in a downstream direction from 'very good' in the upper reaches of catchments, through predominantly 'good-fair' in the middle reaches, to mainly 'fair' in the lower reaches toward the coast. Each site's 'health' may vary between seasons, but seldom by no more than one category (grading) either side of this median grading in response to preceding stream flow and associated habitat (physical and physicochemical water quality) conditions. In this regard generally there has been a similar level of seasonal variability in scores between middle and lower catchment sites. Upper catchment sites tend to show far less variability. However, there were also far fewer upper reach sites surveyed compared with middle or lower reach sites which limits the usefulness of direct comparisons examining total variability.

The Government's *National Policy Statement for Freshwater Management 2014*, as amended in 2017, does not specify a 'bottom line', or minimum standard, for MCI. However, it does specify that a council must establish '*methods…to respond to a Macroinvertebrate Community Index score below 80*'. The grounds given for this requirement are the more general requirement that councils must establish methods for responding to any monitoring results that indicate freshwater objectives will not be met (one compulsory objective being that ecosystem processes are safeguarded) and/or that values will not be provided for (the relevant compulsory value being ecosystem health). While there are only three sites that have a median MCI value of less than 80, the Council is pursuing methods that are expected to lift MCI values across the ring plain, namely the reduction of dairy effluent discharges to waterways together with the completion of the Council's riparian management programme in association with the farming community.

4.1.5 Comments

The decreasing gradient of stream 'health', from 'very good' in the upper reaches of ringplain streams to 'fair' in the lower reaches, is indicative of a downstream change in macroinvertebrate communities towards those that are comprised of taxa more 'tolerant' of nutrient enrichment and/or physical habitat deterioration in the lower reaches. These communities have become well adapted to the cumulative impacts of upstream point source discharges and diffuse run-off and are particularly resistant to further impacts (other than toxic discharges). Therefore, in most lower reach communities significant improvement of water quality and habitat would have to occur before changes would be statistically and ecologically significant.

Thus, while maintenance of ('fair') stream 'health' occurs in the lower reaches of ringplain catchments (as these communities are very 'tolerant' of cumulative organic impacts), temporal trends of improvement in stream 'health' are unlikely to be statistically evident until appropriate management initiatives are substantially progressed on a catchment wide basis. However, of the three sites that are graded 'poor', all three have positive trends with one showing very significant improvement (Figure 124). Enhancement of stream health, particularly at the sites in the lower reaches of ringplain streams, is unlikely to be significant and/or important until marked improvements in habitat and water quality occur. These may be implemented for instance by way of a combination of riparian fencing/planting initiatives and re-direction of dairy pond treatment system discharges from direct disposal into surface waters to irrigation to land.

4.2 Macroinvertebrate fauna MCI trends

Temporal trends measured over the monitoring period between 1995 and 2019 (Table 67 and Appendix II) indicated that 46 sites had positive trends, with 25 of those sites having statistically significant (FDR p<5%) improvements (after application of FDR tests[3]), all but two of which have also been of ecological importance. That is, not only is there confidence that the observed trends are real, but the degree of change that has occurred in the state of the in-stream communities is substantial. Only ten sites had negative trends and only one of these was statistically significant. That site, along with two other sites with negative trends, were adversely affected by natural headwater erosion inside the National Park. However, the LOWESS graphs indicate a number of sites have unimodal trendlines, indicating that sites have improved in condition, plateaued, and are now in decline. There were two sites that could not be trended due to the shorter duration of monitoring at these sites and one site with an indeterminate trend.

For the most recent ten-year data set, there were no sites that had a significant trend once FDR adjustment was applied. Prior to FDR adjustment being applied, there were no sites that showed a significant improvement and ten sites that showed a significant decline. In total 20 sites had a positive trend, 36 sites had a negative trend, and one site had no trend.

Trends have plateaued recently at some sites. This could be due to a variety of reasons. In some catchments riparian management initiatives have largely been completed and therefore stream health will likely have stabilised at monitoring sites. Some sites have shown step change improvements due to the removal of point source discharges such as wastewater treatment plant removal, with these improvements now resulting in a new baseline at those sites. There are also other factors that could be counteracting improvements such as increased agricultural inputs or warmer/drier weather. The majority of sites affected by low summer flows in summer 2019 show a negative relationship between days since a significant fresh and MCI scores. Data analysis using regressions indicates that the time between sampling and the last significant fresh has been increasing in recent years. Therefore, the pattern of drier weather might be having a negative influence on long-term trends at some sites.

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[3] FDR= False Discovery Rate, one of several tests applied to the results to increase confidence in the results by eliminating apparent trends that are the results of co-incidence and random distributions rather than genuine change.

Table 67 Summary of Mann-Kendall test results for MCI scores trended over time (1995-2019) for 59 Taranaki streams/rivers (p with FDR applied) (significant = $p < 0.05$ and highly significant = $p < 0.01$)

River/stream name	Site code	N	FDR[3] p level	+/- (ve)	Significance	Trendline MCI range
Hangatahua (Stony) R	STY000300	47	0.09	-ve	Not significant	15
Hangatahua (Stony) R	STY000400	47	0.95	+ve	Not significant	16
Herekawe S	HRK000085	47	0.02	+ve	Significant	10
Huatoki S	HTK000350	45	<0.01	+ve	Highly significant	16
Huatoki S	HTK000425	45	<0.01	+ve	Highly significant	12
Huatoki S	HTK000745	45	0.95	+ve	Not significant	13
Kapoaiaia S	KPA000250	40	<0.01	+ve	Highly significant	28
Kapoaiaia S	KPA000700	40	<0.01	+ve	Highly significant	28
Kapoaiaia S	KPA000950	40	0.08	+ve	Not significant	13
Katikara S	KTK000150	39	0.04	-ve	Significant	8
Katikara S	KTK000248	37	0.48	-ve	Not significant	11
Kaupokonui R	KPK000250	41	0.14	+ve	Not significant	5
Kaupokonui R	KPK000500	44	<0.01	+ve	Highly significant	20
Kaupokonui R	KPK000660	48	<0.01	+ve	Highly significant	31
Kaupokonui R	KPK000880	48	0.05	+ve	Not significant	15
Kaupokonui R	KPK000990	40	0.09	+ve	Not significant	14
Kurapete S	KRP000300	47	<0.01	+ve	Highly significant	18
Kurapete S	KRP000660	47	<0.01	+ve	Highly significant	24
Maketawa S	MKW000200	38	0.88	+ve	Not significant	9
Maketawa S	MKW000300	37	<0.01	+ve	Highly significant	16
Mangaehu R	MGH000950	48	<0.01	+ve	Highly significant	19
Manganui R	MGN000195	48	0.36	-ve	Not significant	6
Manganui R	MGN000427	48	0.90	+ve	Not significant	10
Mangaoraka S	MRK000420	47	<0.01	+ve	Highly significant	16
Mangati S	MGT000488	47	0.65	+ve	Not significant	8
Mangati S	MGT000520	47	<0.01	+ve	Highly significant	23
Mangawhero S	MWH000380	48	0.01	+ve	Significant	6
Mangawhero S	MWH000490	48	<0.01	+ve	Highly significant	17
Mangorei S	MGE000970	33	0.22	-ve	Not significant	7
Patea R	PAT000200	48	0.18	+ve	Not significant	8
Patea R	PAT000315	48	0.05	+ve	Not significant	8
Patea R	PAT000360	48	0.49	+ve	Not significant	3

River/stream name	Site code	N	FDR[3] p level	+/- (ve)	Significance	Trendline MCI range
Punehu S	PNH000200	48	<0.01	+ve	Highly significant	13
Punehu S	PNH000900	48	<0.01	+ve	Highly significant	18
Tangahoe R	TNH000090	24	0.49	+ve	Not significant	8
Tangahoe R	TNH000200	24	0.88	-ve	Not significant	5
Tangahoe R	TNH000515	24	0.46	-ve	Not significant	10
Timaru S	TMR000150	47	0.64	+ve	Not significant	6
Timaru S	TMR000375	47	<0.01	+ve	Highly significant	18
Waiau S	WAI000110	40	0.02	+ve	Significant	11
Waimoku S	WMK000100	39	0.46	-ve	Not significant	7
Waimoku S	WMK000298	39	<0.01	+ve	Highly significant	12
Waingongoro R	WGG000115	48	0.15	+ve	Not significant	8
Waingongoro R	WGG000150	48	0.31	-ve	Not significant	13
Waingongoro R	WGG000500	48	<0.01	+ve	Highly significant	10
Waingongoro R	WGG000665	48	0.02	+ve	Significant	12
Waingongoro R	WGG000895	48	0.88	+ve	Not significant	5
Waingongoro R	WGG000995	48	0.14	+ve	Not significant	10
Waiokura S	WKR000500	29	<0.01	+ve	Highly significant	13
Waiokura S	WKR000700	24	0.36	+ve	Not significant	8
Waiongana S	WGA000260	47	0.16	+ve	Not significant	8
Waiongana S	WGA000450	47	0.02	+ve	Significant	19
Waitara R	WTR000540	8	N/T	-	-	-
Waitara R	WTR000850	47	0.22	+ve	Not significant	17
Waiwhakaiho R	WKH000100	33	0.28	+ve	Not significant	5
Waiwhakaiho R	WKH000500	47	0.02	+ve	Significant	13
Waiwhakaiho R	WKH000920	47	0.65	-ve	Not significant	16
Waiwhakaiho R	WKH000950	45	1.0	-	Not significant	6
Whenuakura R	WNR000450	8	N/T	-	-	-

[Not significant = ($p \geq 0.05$) after FDR applied, Significant = significant after FDR applied ($p < 0.05$), Highly significant = significant after FDR applied ($p < 0.01$); -ve = negative trend, +ve = positive trend; N/T = not trended, - = no information]

Each of these site's trends is discussed more in the site section of the report. In general, all but two of the sites that had a significant trend exhibited a broad range of MCI scores across the moving average trendline over the monitoring period which suggested trends which were ecologically significant. Those sites with the strongest positive improvement to date, coupled with a large increase in MCI scores have been:

- Kaupokonui Stream upstream of Fonterra, Kapuni factory
- Kapoaiaia Stream at Wiremu Road
- Kapoaiaia Stream at Wataroa Road
- Kurapete Stream downstream of Inglewood WWTP
- Mangati Stream at Bell Block
- Kaupokonui Stream at Kaponga
- Mangaehu River at Raupuha Road
- Punehu Stream at SH45
- Timaru Stream at SH45
- Kurapete Stream upstream of Inglewood WWTP
- Huatoki Stream at Hadley Drive
- Mangawhero Stream upstream of Waingongoro River confluence
- Maketawa Stream at Tarata Road
- Mangaoraka Stream at Corbett Road
- Waiokura Stream at Skeet Road
- Punehu Stream at Wiremu Road
- Waimoku Stream at Oakura Beach
- Huatoki Stream at Huatoki Domain

Generally, the sites with the most statistically significant improvements coupled with the biggest improvements were ones that were in relatively poor health at the start of the monitoring programme. Typically, sites with healthy macroinvertebrate communities at the start of the programme have not shown large improvements which was to be expected.

5 Summary

The 2018-2019 period was the 24th year of the macroinvertebrate state of the environment monitoring (SEM) programme. Sampling was conducted between October to November 2018 for spring samples and February to March 2019 for summer samples. This report describes the macroinvertebrate communities at 59 sites established through the Taranaki region.

Results are discussed in terms of macroinvertebrate taxa richness and MCI scores, which are compared with prior SEM data, and stream 'health' is assessed using generic and predictive methodologies. Trends are identified where possible, and results are discussed in relation to historical data and where applicable also in relation to distance from the National Park (Stark and Fowles, 2009) and the REC system (J Leathwick, pers comm.). Discussion of temporal trends over the 24 years and most recent ten-years of data collection is also provided for each site and causal assessments have been made where trends have been shown to be statistically significant.

6 Recommendations from the 2017-2018 report

In the 2017-2018 report, it was recommended:

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2018-2019 monitoring year by means of the same programme to that undertaken in 2017-2018;
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

These recommendations have been implemented in the 2018-2019 year under review and per this report.

7 Recommendations for 2019-2020

It is recommended for 2019-2020:

1. THAT the freshwater biological macroinvertebrate fauna component of the SEM programme be maintained in the 2019-2020 monitoring year by means of the same programme as that undertaken in 2018-2019, with some site changes. These changes are namely that five Eastern Hill Country sites be added to the programme to provide improved representation, and that the upper Mangawhero site is removed, as this site has very poor site-specific habitat and is not considered representative of the stream or catchment.
2. THAT temporal trending of the macroinvertebrate faunal data continues to be updated on an annual basis.

Bibliography and references

Biggs, BJF, 2000: New Zealand Periphyton Guideline: Detecting, Monitoring and Managing Enrichment of Streams. Prepared for Ministry for the Environment. NIWA, Christchurch, New Zealand. 122 pp.

Biggs, BJF and Kilroy C, 2000: Stream Periphyton Monitoring Manual. Published for Ministry for the Environment. NIWA, Christchurch, New Zealand. 228 pp.

Collier, KJ; Winterbourn, MJ, 2000 (eds.): New Zealand stream invertebrates: ecology and implications for management. NZ Limnological Society, Christchurch. 415pp.

Death, RG, 2000: Invertebrate-substratum relationships. In: Collier, KJ; Winterbourn, MJ eds. New Zealand stream invertebrates: ecology and implications for management. New Zealand Limnological Society, Christchurch. Pp 157-178.

Fowles, CR, 2014: Baseline biomonitoring of lower reach sites in three intensive dairying southwestern ring plain catchments (Heimama, Hiniwera, and Mangatawa Streams), surveyed January 2014. TRC Internal Report CF598.

Leathwick, J, Julian, K, and Smith, B. 2009: Predicted national-scale distributions of freshwater macroinvertebrates in all New Zealand's rivers and streams. NIWA Client Report HAM2009-042. 69pp.

Piggott, J. J., Townsend, C. R. and Matthaei, C. D. 2015: Climate warming and agricultural stressors interact to determine stream macroinvertebrate community dynamics. Global change biology, 21(5): 1887-1906.

Ryan, PA, 1991: Environmental effects of sediment on New Zealand streams, a review. NZ Journal of Marine and Freshwater Research, Vol 25, 207-221.

Shearer, K., and James, T. 2020. Effects of the 2019 drought on aquatic ecology in selected waterways in Golden Bay

Snelder, T, Biggs, B, Weatherhead, M, 224: New Zealand River Environment Classification User Guide. MfE publication. 145p. Prepared for Tasman District Council. Cawthron Report No. 3361. 22 p. plus appendices.

Stark, JD, 1985: A macroinvertebrate community index of water quality for stony streams. Water and Soil Miscellaneous Publication No. 87.

Stark, JD, 1998: SQMCI: a biotic index for freshwater macroinvertebrate coded abundance data. *New Zealand Journal of Marine and Freshwater Research 32(1):* 55-66.

Stark, JD, 1999: An evaluation of Taranaki Regional Council's SQMCI biomonitoring index. Cawthron Report No. 472. 32pp.

Stark, JD, 2003: The water quality and biological condition of the Maketawa catchment. Cawthron Report No 742. 70pp.

Stark, JD 2000; Boothroyd, IKG, 2000: Use of invertebrates in monitoring. In Collier KJ; Winterbourn, MJ eds. New Zealand Stream Invertebrates: ecology and implications for management. NZ Limnological Society, Chch. Pp 344-373.

Stark, JD; Boothroyd, IKG; Harding, JS; Maxted JR; Scarsbrook, MR, 2001: Protocols for sampling macroinvertebrates in wadeable streams. New Zealand Macroinvertebrate Working Group Report No 1. Prepared for Ministry for the Environment. Sustainable Management Fund Project No 5103 57p.

Stark, JD and Fowles, CR, 2006: An approach to the evaluation of temporal trends in Taranaki state of the environment macroinvertebrate data. Cawthron Institute Report No 1135. 88p.

Stark, JD and Fowles, CR, 2009: Relationships between MCI, site altitude, and distance from source for Taranaki ring plain streams. Stark Environmental Report No 2009-01 47p.

Stark, JD and Fowles, CR, 2015: A re-appraisal of MCI tolerance values for macroinvertebrates in Taranaki ringplain streams, Stark Environmental Report No 2015-03 38p.

Stark, JD and Maxted, JR, 2007: A user guide for the MCI. Cawthron Report No 1166. 56p.

TCC, 1984. Freshwater biology. Taranaki ring plain water resources survey. Taranaki Catchment Commission Report. 196p.

TRC, 1994: Regional Policy Statement for Taranaki. Taranaki Regional Council.

TRC, 1995a: Freshwater macroinvertebrate community data: a review of the results of biomonitoring surveys undertaken between 1980 and 1995. TRC internal report.

TRC, 1995b: Regional Monitoring Strategy for Taranaki Part II: Proposed State of the Environment Monitoring Programme. TRC internal report.

TRC, 1996a: State of the environment regional water quality monitoring network for Taranaki. Biological sampling techniques for freshwater rivers and streams. TRC internal report.

TRC, 1996b: State of the Environment - Taranaki Region 1996. Taranaki Regional Council.

TRC, 1997a: State of the Environment Procedures Document. TRC internal report.

TRC, 1997b: State of the Environment regional water quality monitoring network for Taranaki. Biological sampling techniques for freshwater rivers and streams. TRC internal report.

TRC, 1997c: Annual SEM Report 1995-96 Fresh water biological monitoring programme. Technical report 97-96.

TRC, 1998: Freshwater biological monitoring programme. Annual SEM Report 1996-97. Technical Report 97-100.

TRC, 1999: Freshwater biological monitoring programme. Annual SEM Report 1997-98. Technical Report 99-06.

TRC, 2000: Fresh water biological monitoring programme Annual SEM Report 1998-99. Technical Report 99-90.

TRC, 2001: Fresh water biological monitoring programme Annual SEM Report 1999-2000, Technical Report 2000-40.

TRC, 2002a: Fresh water biological monitoring programme Annual SEM Report 2000-2001, Technical Report 2001-87.

TRC, 2002b: Fresh water biological monitoring programme Annual SEM Report 2001-2002, Technical Report 2002-46.

TRC, 2003a: Taranaki – Our Place, Our Future, Report on the state of the environment of the Taranaki region – 2003. TRC, 206pp.

TRC, 2003b: Fresh water biological monitoring programme Annual SEM Report 2002-2003, Technical Report 2003-18.

TRC, 2004a: Fresh water biological monitoring programme Annual SEM Report 2003-2004, Technical Report 2004-23.

TRC, 2005: Fresh water biological monitoring programme Annual SEM Report 2004-2005, Technical Report 2005-72.

TRC, 2006a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report 2005-2006, Technical Report 2006-94.

TRC, 2006b: An interpretation of the reasons for statistically significant temporal trends in macroinvertebrate (MCI) SEM data in the Taranaki region 1995-2005. TRC Internal Report.

TRC, 2006c: A review of macroinvertebrate monitoring data for large hill country catchments in the Taranaki region. TRC Internal Report.

TRC, 2007a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report 2006-2007, Technical Report 2007-22.

TRC, 2007b: Taranaki Regional Council freshwater biology methods manual Version 3. TRC Internal Report.

TRC, 2008: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report 2007-2008, Technical Report 2008-75.

TRC, 2009a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2008–2009, Technical Report 2009-14.

TRC, 2009b: Taranaki-Where We Stand. State of the environment report. TRC, 282 p.

TRC, 2010: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2009–2010, Technical Report 2010-16.

TRC, 2011a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2010–2011, Technical Report 2011-38.

TRC, 2011b: Freshwater physicochemical programme. State of the Environment Monitoring Annual Report 2010-2011. Technical Report 2011-47.

TRC, 2012a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2011–2012, Technical Report 2012-18.

TRC, 2012b: Freshwater physicochemical programme. State of the Environment Monitoring Annual Report 2011-2012. Technical Report 2012-27.

TRC, 2013a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2012–2013, Technical Report 2013-48.

TRC, 2013b: Freshwater physicochemical programme. State of the Environment Monitoring Annual Report 2012-2013. Technical Report 2013-49.

TRC, 2014a: Freshwater physicochemical programme. State of the Environment Monitoring Annual Report 2013-2014. Technical Report 2014-23.

TRC, 2014b: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2013–2014, Technical Report 2014-28.

TRC, 2015a: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2014–2015, Technical Report 2015-66.

TRC, 2015b: Taranaki - as one. State of the environment report 2015 TRC, 267p.

TRC, 2016: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2015–2016, Technical Report 2016-33.

TRC, 2017: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2016–2017, Technical Report 2017-88.

TRC, 2018: Fresh water macroinvertebrate fauna biological monitoring programme Annual SEM Report: 2017–2018, Technical Report 2018-61.

TRC, 2019: A brief statistical summary of Taranaki freshwater macroinvertebrate surveys for the period January 1980 to July 2019. TRC internal report.

Wilcock RJ, Betteridge K, Shearman D, Fowles CR, Scarsbrook MR, Thorrold BS and Costall D, 2009 : Riparian protection and on-farm best management practices for restoration of a lowland stream in an intensive dairy farming catchment: a case study. NZJ of Marine and Freshwater Research 43: 803-818.

Appendix I

History of Site Selection

Evaluations of the effects of, and recovery from, extensive erosion in the headwaters of the Waiaua River were included in this programme. These surveys commenced in December 1998, with the two sites on the Waiaua River incorporated into the SEM biological monitoring programmes once the initial documentation of the effects and recovery was established. This river has continued to be affected by headwater erosion in more recent years, leading to a review of the programme in 2006, after which the Waiaua River was excluded from the SEM programme. The Kurapete Stream (upstream and 5.5km downstream of the Inglewood oxidation pond system) has been monitored throughout the SEM period, using the appropriate SEM protocols, and thus has been recently included in the programme. Two additional sites in the Waiwhakaiho River catchment were included in 2002-2003 in recognition of the importance of this major catchment. A further two additional eastern hill country sites in the Whenuakura and Waitara Rivers were added to the programme in 2015-2016 to improve the representativeness of the monitoring programme.

Two sites in the Maketawa Stream were also added because of a commitment to continue the documentation of conditions in this catchment following the investigation of baseline water quality conditions during the 2000-2002 period (Stark, 2003). Three sites in the Tangahoe River were established in the 2007-2008 period for the purposes of monitoring land use changes (afforestation) in an eastern hill country catchment. The two sites in the Waiokura Stream were also added in the 2007-2008 period as a long term monitoring commitment to the collaborative best practice dairying catchment project. One site in the Herekawe Stream (a long-term consent monitoring site) was incorporated into the programme in the 2008-2009 period for the purpose of monitoring the local initiatives of walkway establishment and riparian planting of this small catchment on the western outskirts of the New Plymouth urban area.

The Hangatahua (Stony) River was selected for the SEM programme as a waterway of high conservation value. The headwaters of the river are the Ahukawakawa swamp within Egmont National Park, and several tributaries that begin above the tree line on the north-west of Mount Taranaki. Once the river leaves the National Park boundary its catchment becomes very narrow so that it receives little water from surrounding farmland before reaching the sea. This factor and the protection order on the catchment maintains good water quality in the river. However, ecological degradation occurs from time to time after headwater erosion events when sedimentation and scouring of the riverbed may be particularly severe. The sites at Mangatete Road and State Highway 45 are approximately seven kilometres and twelve kilometres downstream of the National Park boundary respectively.

The Timaru and Mangaoraka Streams were chosen for the SEM programme as examples of streams within primary agricultural catchments. The Timaru Stream arises within the National Park boundary, near the peak of Pouakai, in the Pouakai Range. Upon leaving this range, the stream flows along the edge of the Kaitake Range (also part of the National Park) and receives several tributaries that flow through adjacent agricultural land. From the edge of the Kaitake Range, the stream flows north through agricultural land to the sea. Carrington Road crosses the stream within the National Park boundary and State Highway 45 is six kilometres downstream of the confluence with the first farmland tributary. The Mangaoraka Stream rises below the National Park boundary near Egmont Road and flows north through farmland for its entire length before joining the Waiongana Stream near the coast. Corbett Road is 26 kilometres downstream of the source.

The Waiongana Stream was included in the SEM programme as an example of a stream with a major water abstraction. The stream originates within the National Park, near the North Egmont visitor's centre. After crossing the park boundary, it flows northeast through agricultural land to the sea. State Highway 3a crosses the stream fifteen kilometres downstream of the National Park boundary, and the intake for the Waitara industrial water supply is a further five kilometres downstream of that. Devon Road is 30 kilometres downstream of the National Park boundary.

The Waiwhakaiho, Manganui, Waitara, and Mangaehu Rivers were selected for the SEM programme as examples of waterways with large catchments and multiple impacts from human land uses including plantation forestry, rural, urban and industrial activities. They arise either on Mt Taranaki or in the eastern hill country, before flowing across the ring plain.

The Waiwhakaiho River and its headwater tributaries arise above the tree line on the north face of Mount Taranaki. Upon leaving the National Park, the river flows north through agricultural and industrial land for 27 kilometres to the sea. The river passes under State Highway 3 near Egmont Village, nine kilometres downstream of the National Park boundary. The sites at Constance Street and adjacent to Lake Rotomanu are included in the lower Waiwhakaiho River industrial discharges monitoring programme. The site adjacent to Lake Rotomanu has replaced the site immediately downstream of the Mangaone Stream that was used in the 1995-1996 State of the Environment monitoring survey. This allows the State of the Environment monitoring programme to better integrate with the industrial monitoring programme. The Mangorei Stream is the principal tributary catchment in the lower reaches, downstream of the major abstraction of water for hydroelectric and community supply purposes. Occasional headwater erosion events have been documented in the upper river with an instance of severe (orange) discolouration in spring 2014 due to release of naturally occurring iron oxide from a small headwater tributary.

The source of the Manganui River is situated above the tree line on the eastern slopes of Mount Taranaki. After leaving the National Park, the river flows east and then north through agricultural land for 44 kilometres before joining the Waitara River. State Highway 3 is eight kilometres downstream of the National Park boundary. At Tariki Road, much of the flow of the Manganui River is diverted through the Motukawa hydroelectric power scheme to the Waitara River. Therefore, except when the Tariki weir is overtopping, most of the water in the Manganui River at Bristol Road (14 kilometres downstream of the diversion) comes from tributaries such as the Mangamawhete, Waitepuke, Maketawa, and Ngatoro Streams. Like the Manganui River, these streams originate high on the eastern slopes of Mount Taranaki. They flow through agricultural land before joining the river. The Maketawa Stream provides a valued trout and native fish habitat. Sites were included in the upper and lower reaches of the stream.

The small Kurapete Stream, which rises as seepage to the west of Inglewood, was included to monitor trends in relation to the removal of the discharge from the town's Wastewater Treatment Plant from this tributary of the lower Manganui River in 2000. Sites were included upstream and nearly six km downstream of where the discharge was located.

The Waitara River flows south-west and then north-west out of the eastern hill country through a mix of agricultural land and native forest before passing through the town of Waitara and out to sea. It has a different character from the steep ring plain rivers and carries a high silt load. The Autawa Road site is located 46 km from the coast. This site was added only during the 2015-2016 reporting period, to increase the number of eastern hill country sites being monitored. The Mamaku Road site is located six km upstream of the coast above any tidal influence. This site is also part of the monitoring programme for the stormwater discharge from the Waitara Valley Methanex plant to the Waitara River.

The Mangaehu River originates in the eastern hill country and flows south-west through agricultural land for most of its length before joining the Patea River, ten kilometres upstream of Lake Rotorangi. Raupuha Road crosses the river less than one kilometre upstream of the confluence with the Patea River.

The Tangahoe River is a smaller eastern hill country catchment which flows through agricultural land, some of which has undergone afforestation in the upper reaches. Fonterra extracts dairy company processing waters in the lower reaches near the coast, south of Hawera township.

The Whenuakura River is an eastern hill country river which primarily flows through agricultural land. It has a high silt load and is consequently highly turbid. The only site located on the Whenuakura River was at Nicholson Road. This was included from 2015-2016 onwards to increase the number of eastern hill country rivers being monitored.

The Mangati Stream was chosen for the SEM programme as an example of a small, degraded stream. Only five kilometres in length, the stream rises in farmland and flows north through the Bell Block industrial area and suburbs to the sea. The site downstream of the railway line is upstream of all industrial discharges to the stream. The site at Te Rima Place is located within a suburban park, downstream of all Bell Block industrial discharges. Both sites are part of the Mangati Stream industrial monitoring programme.

The Waimoku Stream originates in Egmont National Park where it flows down Lucy's Gully in the Kaitake Ranges. Once the stream leaves the park it flows through farmland for three and a half kilometres, and through the coastal township of Oakura for about 200 metres, before entering the sea. It was included in the SEM programme in the 1999-2000 monitoring year to monitor the effects of a riparian planting programme in the catchment. Sampling sites are located in Lucy's Gully under native forest, and in Oakura township, about 100 metres upstream of the sea.

The Waiau Stream originates in farmland near Tikorangi, and is a small catchment to the north of the Waitara River. It flows for 12.5 km to the sea. The stream was included in the SEM programme in the 1999-2000 monitoring year as an example of a northern lowland catchment. The sampling site at Inland North Road is located in a pasture setting.

The Punehu Stream is representative of a south-western Taranaki catchment subject primarily to intensive agricultural land use with water quality affected by diffuse source run-off and point source discharges from dairy shed treatment pond effluents particularly in the Mangatawa Stream, a small lower reach tributary. No industrial discharges to the stream system are known to occur. Both sites were Taranaki ring plain survey sites (TCC, 1984) and the lower site near the coast remains a NIWA hydrological recording station as a representative basin. The upstream site is representative of relatively unimpacted stream water quality although it lies approximately two km below the National Park boundary.

The small seepage fed, ringplain Waiokura Stream drains an intensively dairy-farmed catchment. The Fonterra, Kapuni factory irrigates wastewater within the mid reaches of this catchment. The catchment is the subject of a collaborative long term study of best practice dairying in five New Zealand catchments (Wilcock et al, 2009).

The Patea River rises on the eastern slopes of Mt Taranaki, within the National Park and is a trout fishery of regional significance, particularly upstream of Lake Rotorangi (formed by the Patea dam) in its mid reaches. Site 1 (at Barclay Road) is representative of the upper catchment adjacent to the National Park above agricultural impacts. Site 2 (at Swansea Road), which is integrated with consent compliance monitoring programmes, was also a ring plain survey site, and is representative of developed farmland drainage and is downstream of Stratford township (urban run-off, but upstream of the rubbish tip and oxidation pond discharges and the combined cycle power station discharge). Site 3 (at Skinner Road) is an established hydrological recorder station downstream of these discharges and the partly industrialised Kahouri Stream catchment.

The Waingongoro River rises on the south-eastern slopes of Mount Taranaki within the National Park and is one of the longest of the ring plain rivers, with a meandering 67 km of river length from the National Park boundary prior to entering the Tasman Sea at Ohawe Beach. The river is the principal trout fishery in Taranaki, is also utilised for water abstraction purposes, and up until mid 2010, received treated industrial and municipal wastes discharges in mid-catchment at Eltham. Site 1 (near the National Park boundary) is representative of high water quality conditions with minimal agricultural impacts. Site 2, six km further downstream (at Opunake Road) represents agricultural impacts, still in the upper reaches of the river. Site 3, (at Eltham Road) a further 16 km downstream remains representative of the impacts of farmland drainage and some water abstraction while upstream of the former major Eltham point source discharges from a meatworks and the municipal wastewater treatment plant. The meatworks wastewaters were diverted to spring and summer land irrigation in the mid 2000s and treated plant wastewater subsequently has been irrigated onto farmland in this manner. The Eltham municipal wastes were permanently diverted by pipeline to Hawera in June 2010. The Stuart Road site, a further six km downstream is located below these former discharges. A further two sites (SH45 and Ohawe Beach) are located 33 km and 37 km downstream of Stuart Road in the intensively developed farmland lower reaches of the catchment. River flow recording sites are located at Eltham Road and SH45.

The Mangawhero Stream is a relatively small, swamp-fed catchment rising to the east of Eltham in the Ngaere Swamp and draining developed farmland. The upper site is located in the mid reaches of the stream upstream of the former point source discharge from the Eltham municipal wastewater treatment plant while the lower site is located a further three km downstream, below the Mangawharawhara Stream confluence, near the confluence with the Waingongoro River. Apart from the municipal point source discharge, which was diverted out of the stream in July 2010 (see above), the catchment is predominantly developed farmland.

The Huatoki Stream was sampled as part of the State of the Environment monitoring programme for the first time in the 1997-1998 monitoring year. The stream rises one kilometre outside the National Park boundary on the foothills of the Pouakai Range. It flows through agricultural land for 12.5 km to the outskirts of New Plymouth where it enters native forest reserve. The stream flows for four and a half kilometres alongside walkways and beneath the central business district of New Plymouth before entering the sea next to Puke Ariki Landing. Within New Plymouth it flows through a culvert in a flood retention dam and over a small weir in the Huatoki Reserve prior to the business section of the city. Beautification works adjacent to 'Centre City' near the stream mouth (in 2010) involved the creation of a weir and fish pass immediately upstream of the lowest site which subsequently has altered the flow regime at this site and created a run-like habitat with intermittent flow variability rather than the previous riffle habitat.

The Herekawe Stream is a small seepage stream on the western boundary of New Plymouth. It drains a mainly urban catchment and receives stormwater discharges particularly in its lower reaches. Completion of a walkway and riparian planting community project now warrants the inclusion of the consent monitoring 'control' site at Centennial Drive for monitoring the effectiveness of these initiatives.

The Kaupokonui River rises on the southern slopes of Mt Taranaki within the National Park. It drains an intensively farmed dairy catchment. The principal point source discharges to the river occur in the mid-reaches from the Kaponga oxidation pond system, and cooling water from NZMP (Kapuni) Ltd. The river has patchy riparian vegetation cover and has been targeted for intensive riparian management initiatives. Site 1 is two and a half kilometres downstream of the National Park boundary and has high water quality, with minor agricultural impacts. Toward the mid-reaches, site 2 (six kilometres further downstream) is subject to some agricultural impacts, but is a short distance upstream of the Kaponga oxidation ponds' system discharge. A further six kilometres downstream, site 3 is upstream of wastes irrigation, cooling water discharges and factory abstraction. The Upper Glenn Road (site 4) is a further 10 km downstream, below all of the factory's activities and is a river flow hydrological recording site. The final site 5, is located near the mouth of the river, 5 km below site 4, upstream of any tidal influence at Kaupokonui beach domain camping ground.

Two western catchments, the Katikara Stream and Kapoaiaia Stream, were included in the programme to monitor trends in relation to riparian planting. Such riparian planting initiatives have been concentrated in certain catchments where past riparian vegetation has been sparce. The Katikara Stream rises on the western slopes of Mt Taranaki, passing through primarily agricultural land in the relatively short distance to the sea. The Kapoaiaia Stream also rises from Mt Taranaki on the western side and south of the Katikara Stream. The Kapoaiaia Stream drains agricultural land throughout its entire catchment below the National Park boundary, passing through Pungarehu township at SH45 before entering the sea at Cape Egmont. A hydrological telemetry recorder is located at Cape Egmont

Appendix II

Summary of SEM sites' information 2018-2019, historical median MCI scores, predicted scores and 1995-2019 trends

Summary of MCI scores at all SEM sites: significance in relation to various predictive methodologies (Stark and Fowles, 2009; Leathwick, 2008), and trends over the SEM period 1995 to 2019

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI values							Median 'health' category	Predictive MCI values		Time Trends (1995-2019)		
				Spring 2018	Summer 2019	Historic Range	5 year mean	Historic Medians				Distance[1]	REC[2]	P value	FDR p value	+ / -
								Spring	Summer	Overall						
STY000300	CX/H/VA/S/MO/MG	160	7.3	109	108	64-140	109	111	113	112	Good	109[0]	128[-]	0.05	0.09	-ve
STY000400	CX/H/VA/S/MO/MG	70	12.5	118	110	0-150	109	107	109	108	Good	103[0]	115[0]	0.95	0.95	+ve
HRK000085	WW/L/VA/U/MO/MG	5	N/A	92	96	68-100	90	89	88	89	Fair	N/A	89[0]	<0.01	0.02	+ve
HTK000350	WX/L/VA/P/MO/LG	60	N/A	109	89	79-115	104	101	96	97	Fair	N/A	95[0]	<0.01	<0.01	+ve
HTK000425	WW/L/VA/P/MO/LG	30	N/A	106	103	91-117	107	106	103	104	Good	N/A	92[+]	<0.01	<0.01	+ve
HTK000745	WW/L/VA/U/MO/MG	5	N/A	98	56*	62-102	83	86	85	86	Fair	N/A	93[0]	0.95	0.95	+ve
KPA000250	CX/H/VA/P/MO/MG	240	5.7	127	107	83-131	120	121	114	117	Good	112[0]	111[0]	<0.01	<0.01	+ve
KPA000700	CX/H/VA/P/MO/MG	140	13.5	105	94	78-118	102	98	94	96	Fair	103[0]	105[0]	<0.01	<0.01	+ve
KPA000950	CX/L/VA/P/MO/LG	20	25.2	86	89	76-101	88	90	81	87	Fair	96[0]	99[-]	0.04	0.08	+ve
KTK000150	CX/H/VA/IF/LO/HG	420	0	135	125	112-148	132	137	135	135	Very good	132[0]	131[0]	0.02	0.04	-ve
KTK000248	WX/L/VA/P/MO/LG	5	18.1	102	80*	87-118	95	102	102	102	Good	99[0]	96[0]	0.39	0.48	-ve
KPK000250	CX/H/VA/IF/MO/MG	380	3.3	135	127	124-139	134	130	128	130	Very good	118[+]	137[0]	0.08	0.14	+ve
KPK000500	CX/H/VA/P/MO/MG	260	9.2	138^	104	98-133	118	121	113	117	Good	107[0]	127[0]	<0.01	<0.01	+ve
KPK000660	CX/H/VA/P/MO/LG	170	15.5	118	110	71-128	108	107	102	103	Good	101[0]	122[-]	<0.01	<0.01	+ve
KPK000880	CW/H/VA/P/MO/LG	60	25.7	92	81	66-110	92	94	88	91	Fair	95[0]	106[-]	0.03	0.05	+ve
KPK000990	CW/L/VA/P/HO/LG	5	31.1	93	80	69-103	91	94	87	91	Fair	93[0]	96[0]	0.05	0.09	+ve
KRP000300	WX/L/VA/P/LO/LG	180	N/A	98	98	80-107	102	94	96	95	Fair	N/A	92[0]	<0.01	<0.01	+ve
KRP000660	WW/L/VA/P/LO/LG	120	N/A	98	93	74-112	99	96	91	94	Fair	N/A	102[0]	<0.01	<0.01	+ve
MKW000200	CX/H/VA/IF/MO/MG	380	2.3	133	126	100-142	129	131	124	129	Very good	121[0]	130[0]	0.83	0.88	+ve
MKW000300	CX/H/VA/P/MO/LG	150	15.5	109	105	90-127	114	110	105	108	Good	101[0]	111[0]	<0.01	<0.01	+ve
MGH000950	CW/L/SS/P/HO/LG	120	N/A	99	96	77-104	97	94	91	92	Fair	N/A	117[-]	<0.01	<0.01	+ve
MGN000195	CX/H/VA/P/MO/LG	330	8.7	133	123	106-143	124	129	123	126	Very good	107[+]	124[0]	0.26	0.36	-ve
MGN000427	CX/L/VA/P/HO/MG	140	37.9	89	93	77-117	99	102	96	98	Fair	91[0]	103[0]	0.87	0.9	+ve
MRK000420	WW/L/VA/P/MO/LG	60	N/A	94	81	75-105	90	93	89	90	Fair	N/A	92[0]	<0.01	<0.01	+ve
MGT000488	WN/L/VA/P/LO/LG	30	N/A	79	74	56-91	75	78	78	78	Poor	N/A	80[0]	0.58	0.65	+ve
MGT000520	WW/L/VA/U/LO/LG	20	N/A	74	73	44-79	71	65	70	67	Poor	N/A	88[-]	<0.01	<0.01	+ve

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI values							Median 'health' category	Predictive MCI values		Time Trends (1995-2019)		
				Spring 2018	Summer 2019	Historic Range	5 year mean	Historic Medians				Distance[1]	REC[2]	P value	FDR p value	+ / -
								Spring	Summer	Overall						
MWH000380	WW/L/M/P/MO/LG	200	N/A	88^	83	58-85	76	74	73	74	Poor	N/A	92[-]	<0.01	0.01	+ve
MWH000490	CN/L/VA/P/MO/LG	190	N/A	96	88	63-102	89	82	79	80	Fair	N/A	93[-]	<0.01	<0.01	+ve
MGE000970	CX/L/VA/P/MO/LG	90	15.6	107	84*	86-113	98	104	99	102	Good	101(0)	101[0]	0.15	0.22	-ve
PAT000200	CX/H/VA/IF/MO/MG	500	1.9	135	148	127-150	140	138	138	138	Very good	125[+]	129[0]	0.12	0.18	+ve
PAT000315	CX/H/VA/P/MO/LG	300	12.4	110	113	99-130	116	116	109	111	Good	103[0]	112[0]	0.03	0.05	+ve
PAT000360	CW/L/VA/P/HO/LG	240	19.2	98	90	86-112	99	99	96	98	Fair	99[0]	109[-]	0.41	0.49	+ve
PNH000200	CX/H/YA/IF/MO/MG	270	4.4	135	122	104-137	127	127	122	124	Very good	115[0]	121[0]	<0.01	<0.01	+ve
PNH000900	CW/L/VA/P/MO/LG	20	20.9	98	88	70-114	97	96	85	90	Fair	98[0]	100[0]	<0.01	<0.01	+ve
TNH000090	WW/L/SS/P/MO/LG	85	N/A	96	93	90-107	101	98	101	100	Good	N/A	110[0]	0.40	0.49	+ve
TNH000200	WW/L/SS/P/HO/LG	65	N/A	101	99	92-111	102	104	102	103	Good	N/A	108[0]	0.80	0.88	-ve
TNH000515	WW/L/SS/P/HO/LG	15	N/A	94	79	78-104	90	96	87	94	Fair	N/A	95[0]	0.35	0.46	-ve
TMR000150	CX/H/VA/IF/LO/HG	420	0	131	130	119-152	140	137	139	138	Very good	132[0]	141[0]	0.55	0.64	+ve
TMR000375	CX/L/VA/P/MO/MG	100	10.9	110	88*	89-120	103	107	103	103	Good	105[0]	117[-]	<0.01	<0.01	+ve
WAI000110	WW/L/VA/P/MO/LG	50	N/A	94	84	79-101	92	93	88	91	Fair	N/A	91[0]	<0.01	0.02	+ve
WMK000100	WW/L/VA/P/LO/HG	160	0	127	119*	121-141	129	132	130	131	Very good	132[0]	128[0]	0.36	0.46	-ve
WMK000298	WW/L/VA/P/MO/MG	1	4	98	97	75-105	97	94	90	92	Fair	116[-]	103[-]	<0.01	<0.01	+ve
WGG000115	CX/H/VA/IF/LO/MG	540	0.7	136	133	122-144	134	132	134	133	Very good	132[0]	131[0]	0.09	0.15	+ve
WGG000150	CX/H/VA/P/LO/MG	380	7.2	128	119	119-139	125	131	126	129	Very good	110[+]	124[0]	0.22	0.31	-ve
WGG000500	CW/L/VA/P/MO/LG	200	23	112	109	93-125	109	103	102	103	Good	97[0]	110[0]	<0.01	<0.01	+ve
WGG000665	CW/L/VA/P/HO/MG	180	29.6	108	88	77-111	97	100	93	96	Fair	94[0]	102[0]	<0.01	0.02	+ve
WGG000895	CW/L/VA/P/HO/LG	40	63	88	96	73-106	93	96	94	95	Fair	85[0]	92[0]	0.83	0.88	+ve
WGG000995	CW/L/VA/P/HO/MG	5	66.6	97	79	69-100	88	93	86	91	Fair	85[0]	95[0]	0.08	0.14	+ve
WKR000500	WW/L/VA/P/MO/LG	150	N/A	112	104	88-114	105	102	98	100	Good	N/A	97[0]	<0.01	<0.01	+ve
WKR000700	WW/L/VA/P/MO/LG	70	N/A	102	100	92-109	100	99	98	98	Fair	N/A	95[0]	0.27	0.36	+ve
WGA000260	CX/L/VA/P/MO/LG	140	16.1	99	90	82-112	98	99	96	97	Fair	100[0]	99[0]	0.10	0.16	+ve
WGA000450	WW/L/VA/P/MO/LG	20	31.2	90	82	72-102	89	92	87	89	Fair	93[0]	88[0]	<0.01	0.02	+ve
WTR000540	WX/L/SS/P/HO/LG	100	N/A	108	93*	95-110	N/T	99	98	99	Fair	N/A	110[-]	N/T	N/T	-
WTR000850	WX/L/SS/P/HO/LG	15	N/A	93	64	64-107	85	91	80	86	Fair	N/A	98[-]	0.14	0.22	+ve

Site code	River Environment Classification (REC)	Altitude (masl)	Distance from National Park (km)	MCI values							Median 'health' category	Predictive MCI values		Time Trends (1995-2019)		
				Spring 2018	Summer 2019	Historic Range	5 year mean	Historic Medians				Distance[1]	REC[2]	P value	FDR p value	+ / -
								Spring	Summer	Overall						
WKH000100	CX/H/VA/IF/LO/HG	460	0	139	126	115-147	131	131	128	130	Very good	132[0]	137[0]	0.20	0.28	+ve
WKH000500	CX/H/VA/P/MO/MG	175	10.6	103	96	87-125	110	112	108	111	Good	105[0]	115[0]	<0.01	0.02	+ve
WKH000920	CX/H/VA/P/HO/LG	20	26.6	89	60*	71-110	86	99	92	94	Fair	95[0]	97[0]	0.57	0.65	-ve
WKH000950	CX/H/VA/P/HO/LG	2	28.4	84	80	70-111	88	92	84	89	Fair	94[0]	97[0]	1.00	1.0	-
WNR000450	WW/L/SS/P/HO/LG	20	N/A	99^	71*	81-94	N/T	87	88	87	Fair	N/A	109[-]	N/T	N/T	-

Notes: ( ) = affected by headwater erosion events; Time trend - highly significant (p <0.01), significant (p <0.05) and not significant (p ≥ 0.05), [+ve/-ve/-] = whether a trend was positive, negative or absent; Predictive MCI values – significant (>10), and not significant (≤10), [+/-/0] = whether a value was significantly higher, significantly lower or not significant, N/A = non-ringplain source inside NP sites; N/A[s] = soft-bedded sites;^ = highest recorded MCI score for that site; * = lowest recorded MCI score for that site, 1 = Stark and Fowles, 2009' 2 = Leathwick, 2009; N/T = not trended (insufficient data at present).

MEMORANDUM
Policy & Planning

Date	1 September 2020
Subject:	**Implementation of the Action for Healthy Waterways regulations**
Approved by:	A D McLay, Director - Resource Management
	M J Nield, Acting Chief Executive
Document:	2561243

Purpose

1. The purpose of this memorandum is to brief members on the implementation of the Government's *Action for Healthy Waterways* policy and regulation package.
2. Links to the documents included in the package are included in the Appendices.

Executive summary

3. On 5 August 2020, the Government released its *Action for Healthy Waterways* policy and regulatory package which comprises of the following component parts the:
   - *Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-F);*
   - *National Policy Statement for Freshwater Management 2020 (NPS-FM);*
   - *Resource Management (Stock Exclusion) Regulations 2020; and*
   - *Resource Management (Measurement and Reporting of Water Takes) Amendment Regulations 2020.*
4. The *Action for Healthy Waterways* policy and regulatory package represents the culmination of a comprehensive consultation process, which the Council submitted on in October 2019. Some changes to the policy and regulations were made because of the submission.
5. Notwithstanding the release of the package, the Government has indicated that more policy reforms will follow in their next term.
6. In 2020/21 no budgetary allowance was made for the implementation of the *Action for Healthy Waterways* package. However, an implementation plan will be developed and then existing commitments and budgets will be reviewed. This may result in the Council running over budget for 2020/2021.
7. A review of the package has been undertaken and immediate, short-term and medium term tasks in relation to the implementation of the package have been identified.

8. Government guidance on the implementation of the package is currently being developed. However, in the interim, noting that some provisions have effect from 3 September 2020, internal practice notes have been developed to assist officers in the interpretation of relevant national policies and provisions.
9. Wider advisory and communication material is also in preparation, which will target key resource users in the region.
10. There is a continuing review to operationalise the package noting that the costs and resourcing implications for implementing the *Action for Heathy Waterways* package will be substantial. The Long-Term Plan process will further consider these changes. All regional councils are in the same position and have significant cost increases to work through with their communities.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum *Action for Healthy Waterways Regulations*
b) notes the timeline for key milestones relating to the implementation of the *Action for Healthy Waterways* package
c) notes that the costs and resources for implementing the *Action for Heathy Waterways* package will be substantial and will commence in 2020/21 and extend into 2021/2022.

Background

11. Central government released its *Action for Healthy Waterways* policy and regulatory package on 5 August 2020, less than a month ago.
12. Members will recall endorsing a comprehensive and extensive submission on this package in October 2019. In brief, substantive elements presented in the Government proposals raised concerns that warranted further consideration to avoid perverse outcomes. Following the submission process, many aspects of the draft package had changed when Cabinet released its decisions on the proposal on 28 May 2020.
13. As Members are aware, and as noted at the Policy and Planning Committee meeting of 21 July 2020, the new regulatory instruments impose a range of new obligations on regional councils to implement. In particular, the new requirements require implementation of a much wider set of objectives, targets and action plans than the previous NPS-FM. However, a review of the extent, cost and timing for implementing these new requirements had to wait until the Government released and confirmed the full details of the package.
14. The *Action for Healthy Waterways* policy and regulatory package was subsequently released on 5 August 2020. The package comprises four component parts, these being:
    - *Resource Management (National Environmental Standards for Freshwater) Regulations 2020 (NES-F);*
    - *National Policy Statement for Freshwater Management 2020 (NPS-FM);*
    - *Resource Management (Stock Exclusion) Regulations 2020; and*
    - *Resource Management (Measurement and Reporting of Water Takes) Amendment Regulations 2020.*

Review of the implications of implementing *Action for Heathy Waterways*

15. With the full details of the *Action for Healthy Waterways* policy and regulatory package now being available, a review of their provisions has commenced. Together, they clearly represent one of the most significant public policy challenges facing councils in recent years.
16. It is mandatory that the Council implement the requirements of the Action for Healthy Waterways package. Implementation will involve significant additional and, at times uncertain (particularly in relation to operationalizing new concepts) work involving most parts of the Council. The challenge is to ensure the Council implements the requirements as efficiently as possible.
17. In relation to policy development, most of the new provisions/requirements will be incorporated into the review of the Freshwater Plan and the development of the proposed *Natural Resources Plan for Taranaki*. The NPS-FM requires full implementation via the public notification of a new or amended plan by **31 December 2024**. However, other provisions/requirements will need to be addressed in other planning processes such as the review of the *Regional Policy Statement for Taranaki* and/or through the day-to-day consenting processes.
18. Of particular note, are new/different regulations/requirements that the Council must immediately include in their current plans and/or enforce, including:
    - wetland degradation;
    - river degradation;
    - natural fish passage; and
    - consent requirements relating to land use change, increases in irrigated pasture, winter forage cropping and dairy support activities.
19. Working to operationalise the *Action for Healthy waterways* package is underway. Required actions to implement the package can broadly be grouped into three timeframes – actions that must immediately be undertaken, actions to be addressed in the short term (over the next two to three years) and actions to be undertaken over the following three to ten years.

Immediate actions

20. Internal practice notes to assist officers in the interpretation of relevant provisions are being prepared. Advice and communication material is also in preparation, which will target key resource users. Both the internal practice notes and the educational material will be setting out advice on meeting new regulatory requirements relating to wetlands, river degradation, fish passage and land use change, pasture irrigation and winter forage cropping. New consents will be required for previously unconsented activities.
21. Other specific activities to be undertaken are to:
    - amend the current Freshwater Plan to ensure compliance with the NES-F and NPS-FM (includes inserting NES-F and NPS-FM policies in relation to natural inland wetlands, rivers and fish passage);
    - process new consents stemming from NES-F provisions (particularly in relation to land use change, increasing in irrigated pasture, increases in winter forage cropping and increases in dairy support activities); and

- set up systems and processes to receive increased information requirements from resource users for some permitted activities in the NES-F. This includes information relating to fish passage, culverts, weirs, dams, fords and other structures. Methods such as online processes are being developed to facilitate this.

22. Members should note that the Council is not expecting to be inundated with new consents or permitted activity information. Most of the new requirements relate to dairy conversions and other activities that have not been common in Taranaki in recent years. However, in the absence of national guidelines it is important to provide guidance.

Short term actions

23. In the short term, scoping the large amount of works required for the implementation of the *Action for Healthy Waterways* package is underway. Significant investment will be needed in the freshwater monitoring programmes to underpin not only our policy development but also revised state of the environment monitoring programmes, particularly in relation to addressing an expanded national objectives framework. This includes:
    - developing monitoring programmes for the 22 water quality attributes in the NPS-FM (13 of which are new within the NPS-FM);
    - establishing baseline states for each water quality attribute as required for inclusion in the Natural Resources Plan;
    - developing action plans for the 12 Appendix 2B attributes which are required to have them;
    - undertaking a sediment assessment for eastern hill country rivers; and
    - implementing the latest variation to the water take regulations.

24. Giving effect to the *Action for Healthy waterways* package will require more intensive work with local iwi and communities in vision setting, prioritising and action planning for waterways, monitoring network design, and to enforce stricter control in relation to current land and water uses.

Long term actions

25. While the NPS-FM's deadline for publicly notifying a new Plan that gives full effect to is 31 December 2024, it is suggested that this should be undertaken sooner if practicable. However, significant additional work is required on the draft *Natural Resources Plan* to include newly introduced concepts and planning requirements. Significant work is also likely to be required to overhaul our current framework set out in the *Freshwater Plan* to more closely align with NPS-FM and NES-F. Further, it is not preferable to be the first plan to be considered because of the likely high costs and litigious environment. Before notifying a new plan, additional investigative and engagement must be undertaken, including:
    - Te Mana o te Wai (new fundamental concept of the NPS-FM);
    - Establishing and incorporating Freshwater Management Units;
    - Incorporating the National Objectives Framework to address the compulsory framework providing for ecosystem health, contact recreation, threatened species and mahinga kai;

- Setting environmental flows (for water quantity/water takes) and other limits;
- Establishing provisions which give effect to the requirements of the NPS-FM, NES-F and Stock Exclusion Regulations.

26. Other major changes which the Council must prepare for in the coming years include:
    - Consents for intensive winter grazing (2021);
    - Consents for synthetic fertiliser use of more than 190 kg N/ha/year (2021);
    - Receiving annual synthetic fertiliser reports from farmers (2022); and
    - Stock exclusion from waterway/wetland regulations enforcement begins (2023 and 2025).
27. Mapping of all natural inland wetlands (larger than 0.05 ha or smaller if of a naturally rare type or known to contain threatened species) (2030). Work on mapping all wetlands is, however, already well advanced and is likely to be completed before publicly notifying a new Plan.
28. Preliminary costs for implementing the *Action for Healthy Waterways* package are estimated at several hundred thousand dollars per year - including the need for significant additional staff resources. This will potentially require a considerable general rate increase and will be considered as part of long-term planning processes. Additional costs for landowners and resource users will also need to be phased in over time, as the various regulations and *Natural Resources Plan* changes come in to effect.
29. In 2020/21 no budgetary allowance was made for the implementation of the *Action for Healthy Waterways* package. However, in the first instance, an implementation plan is being developed and then existing commitments and budgets are being reviewed. The plan will be presented to Council by the end of the year.

    Council will continue to develop and update its material to assist with communicating the implications of the package to resource users. Communications material is expected to be circulated to the rural community on 2 September 2020, mainly by email. This is in addition to the guidance material being developed by the Government for the package (NPS, NES and s360 regulations) along with other forms of implementation support. Appended for Members' information is a table developed by the Ministry for the Environment summarising key milestones, for giving effect to *Action for healthy waterways* package.

Future Government reform

30. In addition to the above, the Government has signalled more freshwater policy reforms are likely to follow in their next term, including:
    - considering a proposal to establish a Freshwater Commission;
    - considering a bottom line for dissolved inorganic nitrogen in 12 months' time;
    - reviewing the cap on the use of synthetic nitrogen fertiliser by 2023;
    - addressing fair allocation and Māori rights and interests in freshwater;
    - developing greater central oversight of the performance of the freshwater management system and councils;
    - making improvements to Overseer; and
    - phasing in mandatory Freshwater Farm Plans (FW-FP) regulations over time.

31. Add to this the potential reform of the RMA. These changes will have significant implications for the rapid plan change development processes that regional councils must progress in response to the current policy package.
32. Council will continue to be involved and have input into these initiatives as opportunities arise.

Decision-making considerations

33. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

34. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

35. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

36. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

37. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices

Copies of the documents included in the package can be found following the links below:

- *Resource Management (National Environmental Standards for Freshwater) Regulations 2020*
  http://www.legislation.govt.nz/regulation/public/2020/0174/latest/LMS364099.html
- *National Policy Statement for Freshwater Management 2020*
  https://www.mfe.govt.nz/publications/fresh-water/national-policy-statement-freshwater-management-2020

- *Resource Management (Stock Exclusion) Regulations 2020* http://www.legislation.govt.nz/regulation/public/2020/0175/latest/LMS379869.html
- *Resource Management (Measurement and Reporting of Water Takes) Amendment Regulations 2020* http://www.legislation.govt.nz/regulation/public/2020/0176/latest/LMS351161.html .

Local government– Summary of Action for healthy waterways milestones

Freshwater modules for farm plans	The Government intends to amend the Resource Management Act to make it mandatory for farmers to have a freshwater module in a farm plan. Once the legislation has been changed, the Government will work with farmers, their industry bodies, councils, iwi and others over the next 12–18 months (ie, 2020 –2022) to develop the operational details of the mandatory freshwater module of farm plans, which will be set out in new regulations.

	2020–21	2021–22	2022–23	2023	2024	2025> 2026> beyond
NPS-FM regional council freshwater planning	The National Policy Statement for Freshwater Management (NPS-FM) requires regional councils to engage with communities and tangata whenua to determine local understandings of Te Mana o Te Wai as applied to fresh waterbodies in the region. This will form the basis for a long-term vision in their regional policy statements that gives expression to Te Mana o Te Wai. Councils will review their plans and ensure they give effect to the new NPS-FM, including new requirements for the National Objectives Framework and in relation to wetlands, fish passage and stream reclamation. By 31 December 2024, councils notify new or amended regional plans that implement the new NPS-FM. These will be progressed using the new freshwater planning process. Natural inland wetlands > 0.05 ha, and any others that are naturally smaller or are known to contain threatened species, must be mapped within 10 years of the NPS-FM coming into force.					By 2026[1] regional plans are in place, including the rules needed to work towards long-term objectives for ecosystem health and other community values. Continue to work with and enable tangata whenua to implement the NPS-FM in relation to Māori values for their local context.
Managing synthetic nitrogen fertiliser use	Work with central government to inform farmers of their new obligations for synthetic fertiliser use. By 1 July 2021 consent is required	Have systems in place to store records of synthetic nitrogen fertiliser use supplied by farmers.	31 July 2022 – deadline for farmers to report synthetic fertiliser use for the year to regional councils. Record synthetic nitrogen fertiliser use	Record synthetic nitrogen fertiliser use information supplied by farmers. Ongoing monitoring and compliance for synthetic nitrogen fertiliser use.	Requirements will depend on the outcome of the 2023 review.	In future, synthetic nitrogen fertiliser use may be part of freshwater modules in farm plans.

[1] Or by 2027 if any extension is granted.

	2020–21	2021–22	2022–23	2023	2024	2025> 2026> beyond
	for synthetic nitrogen fertiliser use of more than 190 kg N/ha/year.		information supplied by farmers. Ongoing monitoring and compliance for synthetic fertiliser nitrogen use.	Government will review the synthetic fertiliser nitrogen cap.		
Excluding stock from lakes and rivers wider than 1m bank-to-bank and their margins. **Requiring a dedicated culvert or bridge for places where dairy and beef cattle and pigs cross these waterbodies more than twice per month.**				By 1 July 2023: – all dairy cattle (except dairy support cattle) and pigs must be excluded regardless of land slope, and – all cattle and deer must be excluded from lakes and rivers, on land used for fodder-cropping, break-feeding, or grazing, and on irrigated pasture regardless of land slope (note extra restrictions apply during winter – see below).		By 1 July 2025, all beef cattle and deer must be excluded when the land is less than or equal to 10 degrees. By 1 July 2025, all dairy support cattle must be excluded regardless of land slope.
Excluding stock from wetlands and their margins				By 1 July 2023, all cattle, deer and pigs must be excluded from wetlands identified in a regional or district		By 1 July 2025, all cattle, deer and pigs must be excluded from wetlands identified in a regional plan that gives effect to the new NPS-FM.

	2020–21	2021–22	2022–23	2023	2024	2025> 2026> beyond
				plan when the regulations are gazetted.		
Interim restrictions on major agricultural intensification	From when the NES freshwater comes into force, resource consent are required for: – land-use change of more than 10 hectares (total since date of gazettal) from any form of farming to dairy farming – land-use change of more than 10 hectares (total since date of gazettal) from woody vegetation or forestry to any form of pastoral farming – increases in irrigated pasture for dairy farming above 10 hectares (total since date of gazettal) – increases in area in winter forage cropping above the annual highest amount in 2014/15–2018/19 – increases in dairy support activities above the highest annual amount in 2014/15–2018/19.				National restrictions removed on 31 December 2024 at the latest. Regional councils must have notified regional plans that give effect to the new NPS-FM by this date.	National restrictions on major agricultural intensification end.
Winter grazing management (note these requirements apply in winter and are more stringent than the stock exclusion requirements in the section 360 regulation)		From 1 May 2021, resource consents are required for intensive winter grazing that does not meet the permitted activity standards related to separation from rivers and contaminant losses.				
Stock-holding areas (eg, feed pads, winter pads, standoff pads, loafing pads)		From winter 2021, resource consents are required for stock-holding areas that do not comply with permitted activity standards related to contaminant losses.				
Feedlots	From when the NES freshwater comes into force, resource consents are required for feedlots that do not comply with permitted activity standards related to contaminant losses.					
Measure and report consented water take over 5 litres per second	Ensure council records can accommodate daily electronic records of		Water permit holders must provide councils with electronic records of water takes more		Water permit holders must provide councils with electronic records of water takes between	By 2026, water permit holders must provide councils with electronic records of

	2020–21	2021–22	2022–23	2023	2024	2025> 2026> beyond
	water permit information that will be required two years after the regulations come into force.		than 20 litres per second.		10 and 20 litres per second.	water takes between 5–10 litres per second.
Rivers and wetland protection and maintenance	From when the NES freshwater comes into force: – Resource consents are required for structures in rivers that do not comply with permitted activity standards for fish passage so that desirable fish movement is not prevented. – Resource consents are required for reclaiming rivers, and applications must demonstrate there is no other option. – Resource consents are required for most earthworks in wetlands and rivers, and consents granted will need conditions to minimise and offset damage. – Resource consents required for clearance of vegetation, earthworks, drainage or taking, damming or diverting water from in and around a wetland, and consents granted will need conditions to minimise and offset damage. – The current sustainable sphagnum harvesting from wetlands is permitted subject to conditions that the effects are no more than minor. – Some cultural and restoration activities in wetlands are permitted subject to conditions that the effects are no more than minor.					

MEMORANDUM
Policy & Planning

Taranaki Regional Council

Date	1 September 2020
Subject:	**Commencing a review of the Regional Policy Statement**
Approved by:	A D McLay, Director – Resource Management
	M J Nield, Acting Chief Executive
Document:	2552776

Purpose

1. The purpose of this memorandum is to seek Members' agreement to commence a review of the *Regional Policy Statement for Taranaki* (RPS) in accordance with the First Schedule requirements of the *Resource Management Act 1991* (RMA).
2. Appended to this item is a draft project brief for the review setting out the methodology, process and general timeline for preparing a draft RPS ready for public notification under the First Schedule of the RMA.

Executive summary

3. The RPS is the Councils most important planning tool for resource management.
4. The purpose of the RPS is to provide broad direction and a framework for resource management across the region. The RPS sets out an overview of the resource management issues of the region and the objectives, policies and methods of implementation to achieve integrated management and address those issues.
5. All regional and district plan are required to 'give effect' to the RPS.
6. In January 2010 the Taranaki Regional Council (the 'Council') adopted its' second *Regional Policy Statement for Taranaki*.
7. Ten years on, the Council is now required to undertake a statutory review of the RPS to ensure that it continues to be relevant and to take into account any change factors that have occurred over the life of the Plan including changes to legislation, changes to resource management pressures or changes in community expectations.
8. Major change factors so far identified and which will need to be addressed through the RPS review include:
   - New and amendments provisions to give effect to equivalent provisions in national policy statements and environmental standards.

- Incorporation of new vision and concepts, as required by national policy statements and environmental standards, such as Te Mana o te Wai, Matauranga Māori, and Hutia Te Rito.
- Incorporation of new targets and provisions relating to urban growth.
- Incorporation of new information and maps identifying taonga species and ecosystems, and highly productive lands.
- Review and update of the 'code of conduct' and the 'declaration of understanding' for the principles of the Treaty of Waitangi and iwi engagement.
- Review and update RPS provision to incorporate increased climate change considerations and direction from Central Government.
- Review of the overall approach of the RPS in terms of being much more directive to local territorial authorities in relation to their responsibilities and methods for implementing RPS policies.

9. Significant engagement and consultation is anticipated to ensure tangata whenua principles and values are properly recognised and provided for in the RPS. This will be ongoing and undertaken in a variety of forms up to and following the preparation of a draft RPS. Engagement and consultation will also target other stakeholders as necessary to inform draft Plan provisions addressing their particular issues.
10. The attached Project Brief sets out the process for the preparation of a draft RPS and subsequent engagement on the Draft RPS, prior to preparing and notifying a Proposed RPS.
11. The Councils small policy team will be kept very busy with all the policy changes occurring over the next few years, including the RPS review.
12. Of note, the implementation of recently announced proposals to reform the resource management system would have a major bearing on the preparation and engagement process for developing a new RPS. In particular, recommendations are that the RPS be developed and combined with regional plans and district plans.

Recommendations

That the Taranaki Regional Council:

a) receives this memorandum and attached project brief entitled Draft Project Concept Brief: Preparation of the Draft Regional Policy Statement for Taranaki.
b) notes that the Council is required by the RMA to commence a full review of the Regional Policy Statement for Taranaki once every 10 years;
c) agrees to commence a full review of the Regional Policy Statement for Taranaki.

Background

13. Under the RMA, the Council must, at all times have an RPS (section 60). The purpose of a RPS, as prescribed under section 59 of the RMA, is twofold:
    - first, it provides an overview of the resource management issues of the region. This includes the identification of, and the response to, the significant resource management issues of the region; and

- second, it sets strategic directions for achieving integrated management – not just across the different natural and physical resources (land, water, air, coast), but also between district and regional councils, and within a council.

14. The first *Regional Policy Statement for Taranaki* (RPS) - New Zealand's first under the RMA - became operative on 1 September 1994. It was subsequently reviewed, with the current (second) RPS becoming operative on 1 January 2010.
15. The RPS is one of the most important planning tools for Taranaki. The RPS does not contain rules but provides broad direction to the relevant regional and district councils on addressing resource management issues in the region. In so doing, it identifies the issues and sets out the objectives, policies and methods of implementation on how natural and physical resources (land, water, air, soil, minerals, and energy) in the Taranaki region should be managed.
16. The RPS's stated purpose is to:

"… promote the sustainable management of natural and physical resources in the Taranaki region by:

- *providing an overview of the resource management issues of the Taranaki region*
- *identifying policies and methods to achieve integrated management of the natural and physical resources of the whole region."*

17. All regional and district plans are required to 'give effect' to the RPS.
18. Section 79 of the RMA specifies that regional councils must commence a review of their regional policy statements no later than ten years from the date of implementation. Therefore, a full statutory review of the RPS is now required.

Review of the current RPS

19. A review of the operative RPS is now required to ensure that the policy statement continues to be relevant and to take into account any change factors that have occurred over the life of the RPS. Change factors may include changes to legislation, national directions and community expectations or in response to new and emerging issues.
20. Members may recall that in 2016, the Council completed a non-statutory interim review on the efficiency and effectiveness of the RPS. The interim review determined that the RPS was working well, that the issues identified continue to be relevant, that there were no new or emerging environmental issues, that its methods were being implemented, and that the RPS was generally on track to meet its objectives[1].
21. Notwithstanding that, the interim review recommended that Council, when next carrying out a full RPS review, consider opportunities to use digital and spatial technology to improve the accessibility of our planning documents and their 'user friendliness', and options to better incorporate Māori values and principles.
22. It is now timely to commence a full review of the current RPS. Attached to this memorandum is a draft project brief entitled *Draft Project Concept Brief: Preparation of the Draft Regional Policy Statement for Taranaki*. The draft project brief sets out the methodology, process and general timeline for preparing a draft RPS.
23. The RPS review will be led by the Policy and Planning section but will require input and support from across the Council, particularly consenting, environment quality and

[1] *Report to Policy and Planning Committee 25 July 2017.*

environment services, GIS services, communications and IT support. In work done to date, a preliminary assessment to identify major areas of work has been undertaken. Key issues to be addressed by the review of the RPS include:

a) giving effect to new national directions including National Planning Standards, national policy statements, national environmental standards and Government climate change initiatives;
b) policy and drafting alignment between the RPS and the *Proposed Coastal Plan for Taranaki* and draft provisions for the *draft National Resources Plan*;
c) take into account any relevant planning document recognised by an iwi authority, and
d) taking into account any other 'change' factors identified through the planning and engagement process.

Change factors

24. Most changes so far identified as required to the current RPS arise from new and amended national policy directions.
25. First, there is a requirement for new RPS to follow a prescribed form and structure as set out in the National Planning Standards. This also includes e-Planning capabilities.
26. Second, the promulgation of new and amended national policy statements and national planning standards will require substantive changes to chapters relating to freshwater, biodiversity, coastal waters and tangata whenua of the RPS. Some of the changes required are relatively easy to implement where direction in the statement is clear and definitive (i.e. include objectives, policies or methods with wording specified in the policy statement). Other changes may require more significant resourcing and time to undertake the necessary investigative and engagement work to develop new and/or amended RPS provisions. In particular, it is expected that increased requirements to engage will result in additional time and resource expenditure:

a) National Policy Statement for Freshwater Management 2020

- **Te Mana o te Wai** - Engage in discussion with communities and tangata whenua to determine local understandings of Te Mana o te Wai as applied to freshwater bodies in the region.
- **Long term vision for waterbodies-**
  - developed through discussion with communities and tangata whenua about their long-term wishes for waterbodies in the region
  - be informed by an understanding of the history of, and current pressures on, waterbodies in the region
  - express what communities and tangata whenua want their waterbodies to be like in the future
  - assess whether waterbodies in the region can both sustain current pressures on them and provide for the long-term vision.

b) *Draft National Policy Statement for Indigenous Biodiversity*[2]

[2] *Currently draft but expected to be promulgated in early 2021.*

- **Tangata whenua as Kaitiaki** - Collaborate with tangata whenua to:
    - identify taonga species and ecosystems
    - develop objectives, policies and methods that recognise and provide for Hutia Te Rito (an overarching framework to achieve the integrated and holistic wellbeing on indigenous biodiversity).

c) *New Zealand Coastal Policy Statement*

- **Incorporate Mātauranga Māori into RPS** – requires engagement and discussion with tangata whenua.

d) *National Policy Statement for Highly Productive Land*

- Identify and map highly productive land.

e) Tangata whenua generally

- Review and update the 'code of conduct' and the 'declaration of understanding' for the principles of the Treaty of Waitangi and iwi engagement.

f) Climate change to have a higher profile with relevant provisions to be revised and updated in light of changes to the RMA and other Government climate change initiatives. This includes requirements for RPS documents to have regard to any emission reduction plans and national adaptation plans. Likely to become more clear in 2021.

27. Third, Council may wish to review of the overall approach adopted in the RPS in terms of being much more directive to local territorial authorities in relation to their responsibilities and methods for implementing RPS policies. The current RPS generally only requires that territorial authorities **consider** adopting methods of implementation to achieve the objectives and policies. More directive and specific methods of implementation would ensure that the obligations of territorial authorities are certain and are consistent across the region.

Process from here

28. The preparation of a draft RPS involves the following component parts:

    a) a comprehensive review of current RPS provisions to identify areas of no change, minor change, and significant change. Of particular import, is ensuring draft RPS provisions align with relevant legislation (national policy statements, planning standards and environmental standards requirements for regional policy statements), including e-Planning standards;

    b) undertake investigations to identify and map highly productive land to give effect to the National Policy Statement for Highly Productive Land;

    c) undertake internal workshops with subject matter experts to confirm and report on the size of the review including the development of issues and options to address complex and contentious matters;

    d) development of draft RPS provisions. Draft provisions to be internally tested in workshops and compared with other second/third (if any) generation RPSs to promote national consistency and alignment (where appropriate);

    e) in conjunction with (c) and (d) above, liase with district councils, tangata whenua and key stakeholders to discuss key concepts and assumptions. For tangata whenua particularly in relation to issues of significance to iwi in the RPS and the expression of tangata whenua principles and values, including Matauranga Māori and Te Mana o Te Wai;

f) commission a legal audit of draft RPS to ensure legal standing and compliance with relevant legislation;

g) preparation of a section 32 report setting out the analysis of the benefits and costs of the draft RPS provisions; and

h) commence targeted consultation on the draft RPS with tangata whenua, stakeholders and the wider community.

29. Of note, this memorandum and attached project brief gives effect to the section 79 RMA requirement to commence a full review of the RPS.

30. Under the RMA, the Council must prepare and engage on a draft RPS. The RMA requires that, in particular, the Council engage with tangata whenua on a draft RPS prior to developing and notifying a proposed plan. Under section 47 of the RMA, the Council must:

- prepare a draft proposed policy statement and provide a copy to tangata whenua of the relevant area through iwi authorities and ensure that there is adequate time and opportunity for iwi authorities to provide advice to the local authority; and
- have particular regard to any advice received on the draft.

31. Clause h) (above) serves to address this requirement, however, the Council may also consult and engage on the draft RPS with stakeholders and the wider community. This consultation and engagement on the draft RPS will inform final changes to a Proposed RPS, which will then be publicly notified for submissions pursuant to Schedule 1 of the RMA. Once notified, the RPS will have legal status through the rest of the review process.

32. The RPS review process (up to the preparation of a draft RPS) will occur over the 2020/2021 and 2021/2022 financial years. Timelines are contingent to investigations and engagement not identifying too many new issues or requirements for change, including new and additional Government policy requirements.

33. In the interim, the current RPS is required to be updated to the National Planning Standards structure by 2022. It is unlikely that the Council will have a notified Proposed RPS by this date and so this additional task will need to be factored into the timeframe of the RPS review.

New directions for Resource Management in New Zealand

34. As noted in a separate item, the Resource Management Review Panel report *New Directions for Resource Management in New Zealand* was released in June 2020. Of particular relevance to the RPS review are recommendations for mandatory plans for each region that combine regional policy statement, regional plans and regional and district plans[3].

35. The process establishing the combined plans would be set out in a new *Natural and Built Environments Act* (that replaces the RMA). RPS/plan development would involve the

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[3] *Page 474.*

establishment of a joint planning committee[4], the drafting of combined plan by the planning committee, a pre-notification audit by the Ministry for the Environment, notification of a combined plan, and the appointment of an independent hearing panel which makes decisions on submissions and hearings. Limited means and rights of appeal are proposed.

36. While the report is advice only, it has received strong support from political parties, including Labour and National. The report recommends that work commences as soon as possible in the preparation of the *Strategic Planning Act*, the *Natural and Built Environments Act* but it is as yet uncertain when these Acts will be promulgated. Following which, mandatory national directions be completed within three years of the introduction of the *Natural and Built Environments Act*. Both Labour and National have made commitments to progress reforms to the RMA following the election, however, National has different ideas about the laws that would replace the RMA.

37. While this represents a risk of planning outcomes associated with the RPS review process being superseded, it is hoped that the substance of the RPS review will be unaffected and could be incorporated into any new planning document. The potential for the review process and outcomes of the RPS review to shift considerably in light of the resource management reforms is significant. Environment Minister David Parker hopes that the reforms will be done by the end of the next parliament in 2023[5].

38. The Councils small policy team will be kept very busy with all the policy changes occurring over the next few years, including the RPS review.

Decision-making considerations

39. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

40. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

41. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

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[4] *To be made up of constituent councils, the Department of Conservation, and mana whenua.*

[5] *https://www.stuff.co.nz/national/politics/300069352/biggest-rma-shakeup-in-a-generation-how-labours-planning-laws-will-work*

Iwi considerations

42. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. In addition to that, and as noted else where in this memorandum, Council will be engaging significantly with tangata whenua, iwi and hapū to seek their involvement and input into the preparation of the Draft Regional Policy Statement.

Legal considerations

43. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 2424370: Draft Project Concept Brief: Preparation of the Draft Regional Policy Statement for Taranaki

Taranaki Regional Council

Draft Project Concept Brief: Preparation of the Draft Regional Policy Statement for Taranaki

Project Description

To commence a statutory review of the *Regional Policy Statement for Taranaki* (RPS) pursuant to Schedule 1 of the *Resource Management Act 1991* (RMA), including:

a) preparation of a draft RPS for targeted consultation
b) undertaking of ongoing investigations and gather supporting information to assess alternatives and the costs and benefits of RPS provisions (section 32 report).

Reason(s) for the Project

The current RPS came into effect in 2010. Under section 79(1) of the RMA (refer Appendix I), the Taranaki Regional Council (the Council) is required to commence a review of the RPS within 10 years.

Of note, the interim review of the RPS carried out in 2017 confirmed that the RPS is achieving its purpose, the issues continue to be relevant, and has been efficient and effective in terms of achieving stated outcomes.

As part of the review process, and if appropriate, the RPS will be updated to ensure its ongoing relevance and to take into account any 'change' factors.

Change factors include needing to give effect to:

- promulgation of the *National Planning Standards (2019)* and requirements that RPS follow a prescribed form and structure
- legislative changes, including amendments to the RMA
- promulgation of new and proposed national policy statements (NPSs), including *National Policy Statement for Freshwater Management*, the *National Policy Statement for Indigenous Biodiversity* (currently draft only), NPS for Urban Development, and NPS for Productive Soils (currently draft only)
- promulgation of new and proposed national environmental standards (NESs), including *National Environmental Standards for Forestry*, and *National Environmental Standard for Freshwater Management* (currently draft only)
- Council commitments to update RPS provisions in response to some submissions on the *Proposed Coastal Plan for Taranaki*.
- national directions relating to new mapping requirements.
- national directions requiring the RPS to be an e-Plan
- new iwi management plans and updating tangata whenua principles, concepts and values in RPS provisions.

Benefits

Compliance with section 79(1) of the RMA.

Increased alignment with new national directions, including:

- *National Planning Standards*
- *National Policy Statement for Freshwater Management & National Environmental Standard for Freshwater Management*
- *National Policy Statement for Indigenous Biodiversity* (if applicable)
- *Stock exclusion regulations*
- Proposed NPSs for productive soils and urban development
- Government climate change initiatives.

Alignment with *Proposed Coastal Plan for Taranaki* provisions.

Alignment with *draft Natural Resources Plan* provisions (drafting stage).

Update RPS to reflect changes in community expectations in environmental issues of regional significance including taking into account any relevant planning document recognised by an iwi authority.

Document number: 2424370

Key Milestones

Commencement date will be contingent upon 1.0 FTE Policy Analyst being available.

Forecast start date: 1 September 2020

Forecast end date: TBD

RPS must be aligned with *National Planning Standards* by 2022.

Resources

This project will require resources from across the organisation. Policy will coordinate the project with input from other sections.

Fred McLay (**Project Owner**)

Grace Marcroft (**Project Manager and lead writer**)

Chris Spurdle, Gary Bedford, Steven Hall, Sam Tamarapa, Colin McLellan (**Key Team Members**)

Grace Marcroft, Chris Spurdle, (**ISOVIST/e-planning support**)

Sam Tamarapa to support and facilitate **Iwi communication and engagement**.

Subject matter experts from across the Council will also be engaged to assist where applicable to develop/peer review draft provisions, including consenting, environment quality and environment services support – Gary Bedford, Colin McLellan, Quin Amoore, Sheree Tidswell, Bruce Pope, Regan Phipps, Victoria McKay, Helen Gerrard, and Don Shearman.

The Council's **GIS services** section to ensure timely preparation of mapping or data needs. Mapping to be integrated with GIS component of ISOVIST ePlan and connected to RPS provisions.

In Scope

- Section 30 and 31 functions
- Section 62 content requirements for an RPS
- Rewriting and/or redrafting of current provisions.
- Tangata whenua principles and values
- Engagement with tangata whenua, including through Wai Māori group
- Any Mana Whakahono a Rohe agreement
- Review of the Treaty of Waitangi declaration of understanding between Iwi o Taranaki and the Taranaki Regional Council and the Code of Conduct.
- Confirmation/identification of regional issues of significance
- Review of interim review findings of the RPS
- Alignment with equivalent provisions of the draft Natural Resources Plan and Proposed Coastal Plan for Taranaki
- Alignment where appropriate with proposed and current district plans
- Mapping and schedules
- Legal review of draft RPS provisions.

Out of Scope

- Reviewing operative RPS provisions that do not require change
- Complete rewrite.

Project Method

This project involves undertaking a statutory review of the RPS under Schedule 1 of the RMA. The project involves the following component part:

1. **Council decision to commence an RPS review**: Policy to present memorandum and refer it and this project brief to the Policy and Planning Committee with project brief to formally commence a review; *Target date – 1 September 2020*.

2. **Review RPS scope and content and align with National Planning Standard requirements for regional policy statements:** This involves the following e-planning and mapping tasks that can be worked on/completed in tandem:
   a) Plan alignment
      i. Investigate what (if any) changes to structure and content are required to comply with section 62 of the RMA and the requirements of the National Planning Standards.
      ii. Current plan is restructured into National Planning Standards structure and new sections identified.
      iii. New structure is migrated into the ISOVIST editor taking into consideration requirements for the submission module and current ePlans styles (Coastal and Natural Resources Plan) – refer Appendix II.

      Note: alignment with *National Planning Standards* is required by 2022.
      This stage can also identify provisions/sections within the RPS that do not require major updating and which continue to be relevant and appropriate.

   b) Mapping
      i. Investigate what mapping requirements need to be undertaken in accordance with national direction.
      ii. Work with district councils, Council officers, communities and/or commission work based on findings in 2b as required.
      iii. Work with GIS team to develop mapping layers.

3. **Internal workshop(s) to confirm 'size' of review:** This involves the project team and subject matter experts:
   a) Identifying RPS amendments for the purpose of compliance with relevant legislation, national directions and consistency with the *Proposed Coastal Plan for Taranaki*. Also identify those areas from the Council's decisions on the *Proposed Coastal Plan for Taranaki* where the Council have committed to actions to be undertaken through the review of the RPS
   b) Developing an 'issues and options' paper (with recommendations) to be presented to the Policy and Planning Committee for Council's consideration to confirm the scope of the review and identify new issues or themes to be included in the RPS or which require amendment of RPS provisions.

   Identify timeline for remaining methodology steps.

4. **Develop draft RPS provisions:**
   a) **Review of other second generation RPS and e-Plans:** Policy to search and review other councils RPSs and e-Plans to inform best practice in terms of scope plus inter-regional alignment (where appropriate)
   b) **Undertake internal workshops to review and amend RPS provisions:** Policy to lead internal consultation with Council experts by topic/theme to ensure current provisions are 'fit for purpose' and/or identify and amend RPS provisions requiring amending plus any new provisions
   c) **Develop draft revised RPS:** Policy to prepare a revised RPS for targeted consultation (prior to publicly notifying a proposal).

5. **Early engagement:** In conjunction with (4) above, Policy to liaise with tangata whenua to discuss key concepts and assumptions, particularly in relation to issues of significance to iwi in the RPS and the expression of tangata whenua principles and values, including Matauranga Maori and Te Mana o Te Wai. Policy also to engage with district councils and other stakeholders, as appropriate, to discuss key concepts or assumptions of relevance to them.

6. **Legal audit:** Policy to commission a legal review of the draft RPS to ensure legal standing and compliance with relevant legislation.

7. **Prepare Section 32 report:** In conjunction with the above, Policy to prepare Section 32 report setting out the analysis of the benefits and costs of new RPS provisions.

8. **Undertake targeted consultation on a draft RPS:** Policy to present draft RPS to the Policy and Planning Committee for their consideration prior to commencing targeted consultation with tangata whenua, district councils, stakeholders and the wider community on the draft RPS.

Following consultation on the draft RPS, including the receipt of submissions, amendments will be made and a Proposed RPS prepared. Pursuant to Schedule 1 of the RMA, the Proposed RPS will then be publicly notified for submissions.

In addition to the steps identified above, additional tasks associated with the current RPS may be required to be undertaken. Of note, the current RPS is required to be updated to the National Planning Standards structure by 2022. It is unlikely that the Council will have a notified Proposed RPS by this date and so this additional task will need to be factored into the timeframe of the RPS review.

Approval:

The following indicates that approval has been obtained for the project concept:

Project Owner ______________________________

Project Owner

Date ______________________________

Document number: 2424370

Appendix 1 – Relevant RMA provisions

Regional policy statements

59 Purpose of regional policy statements

The purpose of a regional policy statement is to achieve the purpose of the Act by providing an overview of the resource management issues of the region and policies and methods to achieve integrated management of the natural and physical resources of the whole region.

60 Preparation and change of regional policy statements

1) There shall at all times be for each region one regional policy statement prepared by the regional council in the manner set out in Schedule 1.
2) A regional policy statement may be changed in the manner set out in Schedule 1, at the instigation of a Minister of the Crown, the
regional council, or any territorial authority within or partly within the region.

61 Matters to be considered by regional council (policy statements)

1) A regional council must prepare and change its regional policy statement in accordance with—
   a) its functions under section 30; and
   b) the provisions of Part 2; and
   c) its obligation (if any) to prepare an evaluation report in accordance with section 32; and
   d) its obligation to have particular regard to an evaluation report prepared in accordance with section 32; and
   da) a national policy statement, a New Zealand coastal policy statement, and a national planning standard; and
   e) any regulations.
2) In addition to the requirements of section 62(3), when preparing or changing a regional policy statement, the regional council shall
have regard to—
   a) any—
      i) Management plans and strategies prepared under other Acts; and
      ii) *Repealed.*
      iia) relevant entry on the New Zealand Heritage List/Rārangi Kōrero required by the Heritage New Zealand Pouhere Taonga Act 2014; and
      iii) regulations relating to ensuring sustainability, or the conservation, management, or sustainability of fisheries resources (including regulations or bylaws relating to taiapure, mahinga mataitai, or other non-commercial Maori customary fishing); and
      iv) *Repealed.*

      to the extent that their content has a bearing on resource management issues of the region; and
   b) the extent to which the regional policy statement needs to be consistent with the policy statements and plans of adjacent regional councils; and
   c) the extent to which the regional policy statement needs to be consistent with regulations made under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012; and

(2A) When a regional council is preparing or changing a regional policy statement, it must deal with the following documents, if they are lodged with the council, in the manner specified, to the extent that their content has a bearing on the resource management issues of the region:
   a) the council must take into account any relevant planning document recognised by an iwi authority; and
   b) in relation to a planning document prepared by a customary marine title group under section 85 of the Marine and Coastal Area (Takutai Moana) Act 2011, the council must, in accordance with section 93 of that Act,—

i) recognise and provide for the matters in that document, to the extent that they relate to the relevant customary marine
title area; and

ii) take into account the matters in that document, to the extent that they relate to a part of the common marine and coastal area outside the customary marine title area of the relevant group.

3) In preparing or changing any regional policy statement, a regional council must not have regard to trade competition or the effects
of trade competition.

62 Contents of regional policy statements

1) A regional policy statement must state—

a) the significant resource management issues for the region; and

b) the resource management issues of significance to iwi authorities in the region; and

c) the objectives sought to be achieved by the statement; and

d) the policies for those issues and objectives and an explanation of those policies; and

e) the methods (excluding rules) used, or to be used, to implement the policies; and

f) the principal reasons for adopting the objectives, policies, and methods of implementation set out in the statement; and

g) the environmental results anticipated from implementation of those policies and methods; and

h) the processes to be used to deal with issues that cross local authority boundaries, and issues between territorial authorities or between regions; and

i) the local authority responsible in the whole or any part of the region for specifying the objectives, policies, and methods for the control of the use of land—

i) to avoid or mitigate natural hazards or any group of hazards; and

ii) *Repealed*.

iii) to maintain indigenous biological diversity; and

j) the procedures used to monitor the efficiency and effectiveness of the policies or methods contained in the statement; and

k) any other information required for the purpose of the regional council's functions, powers, and duties under this Act.

2) If no responsibilities are specified in the regional policy statement for functions described in subsection (1)(i)(i) or (ii), the regional council retains primary responsibility for the function in subsection (1)(i)(i) and the territorial authorities of the region retain primary responsibility for the function in subsection (1)(i)(ii).

3) A regional policy statement must not be inconsistent with any water conservation order and must give effect to a national policy statement, a New Zealand coastal policy statement, or a national planning standard.

Review

79 Review of policy statements and plans

1) A local authority must commence a review of a provision of any of the following documents it has, if the provision has not been a subject of a proposed policy statement or plan, a review, or a change by the local authority during the previous 10 years:

a) a regional policy statement:

b) a regional plan:

c) a district plan.

2) If, after reviewing the provision, the local authority considers that it requires alteration, the local authority must, in the manner set out in Parts 1, 4, or 5 of Schedule 1 and this Part, propose to alter the provision.

3) If, after reviewing the provision, the local authority considers that it does not require alteration, the local authority must still publicly notify the provision—

a) as if it were a change; and

b) in the manner set out in Parts 1, 4, or 5 of Schedule 1 and this Part.

4) Without limiting subsection (1), a local authority may, at any time, commence a full review of any of the following documents it has:
   a) a regional policy statement:
   b) a regional plan:
   c) a district plan.

5) In carrying out a review under subsection (4), the local authority must review all the sections of, and all the changes to, the policy
statement or plan regardless of when the sections or changes became operative.

6) If, after reviewing the statement or plan under subsection (4), the local authority considers that it requires alteration, the local
authority must alter the statement or plan in the manner set out in Parts 1, 4, or 5 of Schedule 1 and this Part.

7) If, after reviewing the statement or plan under subsection (4), the local authority considers that it does not require alteration, the local authority must still publicly notify the statement or plan—
   a) as if it were a proposed policy statement or plan; and
   b) in the manner set out in Parts 1, 4, or 5 of Schedule 1 and this Part.

8) A provision of a policy statement or plan, or the policy statement or plan, as the case may be, does not cease to be operative because the provision, statement, or plan is due for review or is being reviewed under this section.

9) The obligations on a local authority under this section are in addition to its duty to monitor under section 35.

Schedule 1

2 Preparation of proposed policy statement or plan

1) The preparation of a policy statement or plan shall be commenced by the preparation by the local authority concerned, of a proposed policy statement or plan.

2) A proposed regional coastal plan must be prepared by the regional council concerned in consultation with—
   a) the Minister of Conservation; and
   b) iwi authorities of the region; and
   c) any customary marine title group in the region.

3 Consultation

1) During the preparation of a proposed policy statement or plan, the local authority concerned shall consult—
   a) The Minister for the Environment; and
   b) Those other Ministers of the Crown who may be affected by the policy statement or plan; and
   c) Local authorities who may be so affected; and
   d) The tangata whenua of the area who may be so affected, through iwi authorities … ; and
   e) any customary marine title group in the area.

2) A local authority may consult anyone else during the preparation of a proposed policy statement or plan.

3) Without limiting subclauses (1) and (2), a regional council which is preparing a regional coastal plan shall consult—
   a) The Minister of Conservation generally as to the content of the plan, and with particular respect to those activities to be described as restricted coastal activities in the proposed plan; and
   b) The Minister of Transport in relation to matters to do with navigation and the Minister's functions under Parts 18 to 27 of the Maritime Transport Act 1994; and
   c) The Minister of Fisheries in relation to fisheries management, and the management of aquaculture activities.

4) In consulting persons for the purposes of subclause (2), a local authority must undertake the consultation in accordance with section 82 of the Local Government Act 2002.

3A Consultation in relation to policy statements

1) A triennial agreement entered into under section 15(1) of the Local Government Act 2002 must include an agreement on the consultation process to be used by the affected local authorities in the course of—
   a) preparing a proposed policy statement or a variation to a proposed policy statement; and

b) preparing a change to a policy statement; and
c) reviewing a policy statement.

2) If an agreement on the consultation process required by subclause (1) is not reached by the date prescribed in section 15(1) of the Local Government Act 2002,—
a) Subclause (1) ceases to apply to that triennial agreement; and
b) 1 or more of the affected local authorities—
i) must advise the Minister and every affected local authority as soon as is reasonably practicable after the date prescribed in section 15(1) of the Local Government Act 2002; and
ii) may submit the matter to mediation.

3) If subclause (2) applies, the parts of the triennial agreement other than the part relating to the consultative process referred to in subclause (1) may be confirmed before—
a) an agreement on the consultative process is reached under subclauses (4) and (5)(a); or
b) the Minister makes a binding determination under subclause (5)(b).

4) Mediation must be by a mediator or a mediation process agreed to by the affected local authorities.

5) If the matter is not submitted to mediation or if mediation is unsuccessful, the Minister may either—
a) make an appointment under section 25 for the purpose of determining a consultation process to be used in the course of preparing a proposed policy statement or reviewing a policy statement; or
b) make a binding determination as to the consultation process that must be used.

6) The consultative process must form part of the triennial agreement, whether or not the other parts of the triennial agreement have been confirmed, in the event that—
a) an agreement is reached under subclause (4) or subclause (5)(a) as to a consultative process, as required by subclause (1); or
b) the Minister makes a binding determination under subclause (5)(b).

7) In this clause, affected local authorities means—
a) the regional council of a region; and
b) every territorial authority whose district is wholly or partly in the region of the regional council.

3B Consultation with iwi authorities

For the purposes of clause 3(1)(d), a local authority is to be treated as having consulted with iwi authorities in relation to those whose details are entered in the record kept under section 35A, if the local authority—
a) considers ways in which it may foster the development of their capacity to respond to an invitation to consult;
b) establishes and maintains processes to provide opportunities for those iwi authorities to consult it; and
c) consults with those iwi authorities; and
d) enables those iwi authorities to identify resource management issues of concern to them; and
e) indicates how those issues have been or are to be addressed.

4A Further pre-notification requirements concerning iwi authorities

1) Before notifying a proposed policy statement or plan, a local authority must—
a) provide a copy of the relevant draft proposed policy statement or plan to the iwi authorities consulted under clause 3(1)(d); and
b) have particular regard to any advice received on a draft proposed policy statement or plan from those iwi authorities.

2) When a local authority provides a copy of the relevant draft proposed policy statement or plan in accordance with subclause (1), it must allow adequate time and opportunity for the iwi authorities to consider the draft and provide advice on it.

5 Public notice and provision of document to public bodies

1) A local authority that has prepared a proposed policy statement or plan must—
a) prepare an evaluation report for the proposed policy statement or plan in accordance with section 32 and have particular regard to that report when deciding whether to proceed with the statement or plan; and
b) if the local authority decides to proceed with the proposed policy statement or plan, do one of the following, as appropriate:
i) publicly notify the proposed policy statement or plan:

ii) give limited notification, as provided for in clause 5A.

1A) A territorial authority shall, not earlier than 60 working days before public notification or later than 10 working days after public notification of its plan, either—

a) send a copy of the public notice, and such further information as the territorial authority thinks fit relating to the proposed plan, to every ratepayer for the area of the territorial authority where that person, in the territorial authority's opinion, is likely to be directly affected by the proposed plan; or

b) include the public notice, and such further information as the territorial authority thinks fit relating to the proposed plan, in any publication or circular which is issued or sent to all residential properties and Post Office box addresses located in the affected area—

and shall send a copy of the public notice to any other person who, in the territorial authority's opinion, is directly affected by the plan.

1B) Notwithstanding subclause (1A), a territorial authority shall ensure that notice is given of any requirement or modification of a designation or heritage order under clause 4 to land owners and occupiers who, in the territorial authority's opinion, are likely to be directly affected.

1C) A regional council shall, not earlier than 60 working days before public notification or later than 10 working days after public notification, send a copy of the public notice and such further information as the regional council thinks fit relating to the proposed policy statement or plan to any person who, in the regional council's opinion, is likely to be directly affected by the proposed policy statement or plan.

2) Public notice under subclause (1) shall state—

a) where the proposed policy statement or plan may be inspected; and

b) that any person may make a submission on the proposed policy statement or plan; and

c) the process for public participation in the consideration of the proposed policy statement or plan; and

d) the closing date for submissions; and

e) the address for service of the local authority.

3) The closing date for submissions—

a) shall, in the case of a proposed policy statement or plan, be at least 40 working days after public notification; and

b) shall, in the case of a proposed change or variation to a policy statement or plan, be at least 20 working days after public notification.

4) A local authority shall provide 1 copy of its proposed policy statement or plan without charge to—

a) the Minister for the Environment; and

b) Repealed

c) in the case of a regional coastal plan, the Minister of Conservation and the appropriate regional conservator for the Department of Conservation; and

d) in the case of a district plan, the regional council and adjacent local authorities; and

e) in the case of a policy statement or regional plan, constituent territorial authorities, and adjacent regional councils; and

f) the tangata whenua of the area, through iwi authorities.

g) Repealed

5) A local authority shall make any proposed policy statement or plan prepared by it available in every public library in its area and in every other place in its area that it considers appropriate.

6) The obligation imposed by subclause (5) is in addition to the local authority's obligations under section 35 (records).

6 Making of submissions under clause 5

1) Once a proposed policy statement or plan is publicly notified under clause 5, the persons described in subclauses (2) to (4) may make a submission on it to the relevant local authority.

2) The local authority in its own area may make a submission.

3) Any other person may make a submission but, if the person could gain an advantage in trade competition through the submission, the person's right to make a submission is limited by subclause (4).

4) A person who could gain an advantage in trade competition through the submission may make a submission only if directly affected by an effect of the proposed policy statement or plan that—

a) adversely affects the environment; and

b) does not relate to trade competition or the effects of trade competition.

5) A submission must be in the prescribed form.

7 Public notice of submissions

1) A local authority must give public notice of—
   a) the availability of a summary of decisions requested by persons making submissions on a proposed policy statement or plan; and
   b) where the summary of decisions and the submissions can be inspected; and
   c) the fact that no later than 10 working days after the day on which this public notice is given, the persons described in clause 8(1) may make a further submission on the proposed policy statement or plan; and
   d) the date of the last day for making further submissions (as calculated under paragraph (c)); and
   e) the limitations on the content and form of a further submission.
2) The local authority must serve a copy of the public notice on all persons who made submissions.
3) However, in the case of a submission on a proposed change to a policy statement or plan, if a local authority has given limited notification under clause 5A, it must give notice of the matters listed in subclause (1), as relevant, instead of giving public notice, to—
   a) the persons given limited notification under clause 5A(3); and
   b) the persons provided with a copy of the proposed change under clause 5A(8).

8 Certain persons may make further submissions

1) The following persons may make a further submission, in the prescribed form, on a proposed policy statement or plan to the relevant local authority:
   a) any person representing a relevant aspect of the public interest; and
   b) any person that has an interest in the proposed policy statement or plan greater than the interest that the general public has; and
   c) the local authority itself.

1A) However, in the case of submissions on a proposed change to a policy statement or plan for which limited notification has been given under clause 5A, the only persons (in addition to the relevant local authority) who may make a further submission are—
   a) the persons given limited notification under clause 5A(3); and
   b) the persons given a copy of the proposed change under clause 5A(8).

2) A further submission given under subclause (1) or (1A) must be limited to a matter in support of or in opposition to the relevant submission made under clause 6 or 6A.

8A Service of further submissions

1) A person who makes a further submission under clause 8(1) or (1A) must serve a copy of it on—
   a) the relevant local authority; and
   b) the person who made the submission under clause 6 or 6A to which the further submission relates.
2) The further submission must be served on the person referred to in subclause (1)(b) not later than 5 working days after the day on which the person provides the relevant local authority with the further submission.

8AA Resolution of disputes

1) For the purpose of clarifying or facilitating the resolution of any matter relating to a proposed policy statement or plan, a local authority may, if requested or on its own initiative, invite anyone who has made a submission on the proposed policy statement or plan to meet with the local authority or such other person as the local authority thinks appropriate.
2) A member of the local authority who attends a meeting under subclause (1) is not disqualified from participating in a decision made under clause 10.
3) The local authority may, with the consent of the parties, refer to mediation the issues raised by persons who have made submissions on the proposed plan or policy statement.
4) Mediation under subclause (3) must be conducted by an independent mediator.
5) The chairperson of the meeting must, as soon as practicable after the end of the meeting, prepare a report that—

a) must identify the matters that are agreed between the local authority and the submitters and those that are not; and
b) may identify—
i) the nature of the evidence that must be called at the hearing by the persons who made submissions:
ii) the order in which that evidence is to be heard:
iii) a proposed timetable for the hearing; but
c) does not include evidence that was presented at the meeting on a without prejudice basis.
6) The person who prepared the report must give the report to those persons who attended the meeting and the local authority not later than 5 working days before the hearing.
7) The local authority must have regard to the report in making its decision under clause 10.

8B Hearing by local authority

1) A local authority shall hold a hearing into submissions on its proposed policy statement or plan, and any requirements notified under clause 4, and give at least 10 working days notice of the dates, times, and place of the hearings to—
a) every person who made a submission or further submission, and who requested to be heard (and has not since withdrawn that request); and
b) in the case of a district plan, every authority which made a requirement under clause 4.

8C Hearing not needed

Where submissions are made but no person indicates they wish to be heard, or the request to be heard is withdrawn, the local authority shall consider the submissions along with the other relevant matters, but shall not be required to hold a hearing.

8D Withdrawal of proposed policy statements and plans

1) Where a local authority has initiated the preparation of a policy statement or plan, the local authority may withdraw its proposal to prepare, change, or vary the policy statement or plan at any time—
a) if an appeal has not been made to the Environment Court under clause 14, or the appeal has been withdrawn, before the policy statement or plan is approved by the local authority; or
b) if an appeal has been made to the Environment Court, before the Environment Court hearing commences.
2) The local authority shall give public notice of any withdrawal under subclause (1), including the reasons for the withdrawal.

9 Recommendations and decisions on requirements

1) The territorial authority shall make and notify its recommendation in respect of any provision included in the proposed district plan under clause 4(5) to the appropriate authority in accordance with section 171 or section 191.
2) The territorial authority shall make its decision on provisions included in the proposed district plan under clause 4(6) in accordance with section 168A(3) or section 189A(3), as the case may be.
3) Nothing in this clause shall allow the territorial authority to make a recommendation or decision in respect of any existing designations or heritage orders that are included without modification and on which no submissions are received.

10 Decisions on provisions and matters raised in submissions

1) A local authority must give a decision on the provisions and matters raised in submissions, whether or not a hearing is held on the proposed policy statement or plan concerned.
2) The decision—
a) must include the reasons for accepting or rejecting the submissions and, for that purpose, may address the submissions by grouping them according to—
i) the provisions of the proposed statement or plan to which they relate; or

ii) the matters to which they relate; and

ab) must include a further evaluation of the proposed policy statement or plan undertaken in accordance with section 32AA; and

b) may include—

i) matters relating to any consequential alterations necessary to the proposed statement or plan arising from the submissions; and

ii) any other matter relevant to the proposed statement or plan arising from the submissions.

3) To avoid doubt, the local authority is not required to give a decision that addresses each submission individually.

4) The local authority must—

(aaa)have particular regard to the further evaluation undertaken in accordance with subclause (2)(ab) when making its decision; and

a) give its decision no later than 2 years after notifying the proposed policy statement or plan under clause 5; and

b) publicly notify the decision within the same time.

5) On and from the date the decision is publicly notified, the proposed policy statement or plan is amended in accordance with the decision.

11 Notification of decision

1) At the same time as a local authority publicly notifies a decision under clause 10(4)(b), it must serve, on every person who made a submission on the proposed policy statement or plan concerned,—

a) a copy of the public notice; and

b) a statement of the time within which an appeal may be lodged by the person.

2) Where a decision has been made under clause 9(2), the territorial authority, at the same time as it publicly notifies a decision under clause 10(4)(b), must serve a copy of the public notice on landowners and occupiers who, in the territorial authority's opinion, are directly affected by the decision.

3) If the local authority serves or provides a copy of the public notice under subclause (1) or (2), it must—

a) make a copy of the decision available (whether physically or by electronic means) at all its offices, and all public libraries in the district (if it relates to a district plan) or region (in all other cases); and

b) include with the notice a statement of the places where a copy of the decision is available; and

c) send or provide, on request, a copy of the decision within 3 working days after the request is received.

Appendix 2 – Proposed table of contents for a revised RPS [1]

PART 1 INTRODUCTION AND GENERAL PROVISIONS

INTRODUCTION

- Foreword or mihi
- Contents
- Purpose
- Description of the region

HOW THE POLICY STATEMENT WORKS

- Statutory context (Statutory planning and framework)
- General approach
- Cross boundary matters

INTERPRETATION

- Definitions
- Abbreviations

NATIONAL DIRECTION INSTRUMENTS

- National policy statement and New Zealand Coastal Policy Statement
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TANGATA WHENUA

- Tangata whenua
  - Iwi o Taranaki
  - Ngāti Tama
  - Ngāti Mutunga
  - Ngāti Maru
  - Te Atiawa
  - Taranaki
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PART 2 RESOURCE MANAGEMENT OVERVIEW

- Significant resource management issues for the region
- Resource management issues of significance to iwi authorities in the region

PART 3 DOMAINS AND TOPICS

DOMAINS

- Air
- Coastal environment
  - Coastal environment

[1] Based on the current *Regional Policy Statement for Taranaki 2020* and the structure requirements of the *National Planning Standards 2019*.

Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date	1 September 2020
Subject:	**Parliamentary Commissioner for the Environment report on managing our estuaries**
Approved by:	A D McLay, Director - Resource Management
	M J Nield, Acting Chief Executive
Document:	2562230

Purpose

1. The purpose of this memorandum is to introduce a report prepared by the Parliamentary Commissioner for the Environment (PCE) and released on 11 August 2020, entitled *Managing our estuaries*.

Executive summary

2. On 11 August 2020 the Parliamentary Commissioner for the Environment (PCE) released a report entitled '*Managing our estuaries*'.
3. The report has been presented to members of parliament for their consideration, however, at this time no decisions have been made in relation to adopting any of the PCE's recommendations.
4. Estuaries are significant areas that are important for their social, cultural, historical and ecological values. However, the back and forth flushing of fresh water and marine water means that estuaries can act as a sink for pollution which makes them susceptible to degradation and the impacts of cumulative effects.
5. Accordingly, the PCE looked at the histories of five estuaries as case studies to explore some of the environmental challenges they face and how they are managed.
6. The report found that the problems faced by estuaries are already well known and documented, however, in many cases, effective change has not been achieved and is considered to be due to the low priority that is provided them in legislation.
7. The PCE makes two recommendations:
   a) the mandatory inclusion of estuaries as part of freshwater management units (FMU's) within the NPS-FM; and
   b) robust monitoring of estuaries that supports council decision making.
8. The first recommendation would require that the National Objectives Framework would apply to estuaries and that additional attributes for estuaries be included in Appendix

2A of the NPS-FM. This would result in estuaries having national bottom lines which councils would be required to monitor and report against.

9. The second recommendation would require that the Council adhere to national monitoring and reporting requirements. The PCE recommends that monitoring be nationally standardised, consistent, available, regular, mandatory, include Mātauranga Māori and be independently assessed.
10. If adopted, these recommendations are likely have an impact on the current policy and environmental monitoring frameworks of the Council and how activities between the freshwater and marine domain are managed through the respective RMA Plans.
11. The Council's Estuarine State of the Environment Monitoring (SEM) Programme is set to recommence in the upcoming 2020-2021 summer, however, if the PCE's recommendations are adopted monitoring will likely need to be expanded considerably from its current scope in order to meet the required level of monitoring recommended by the PCE.

Recommendations

That the Taranaki Regional Council:

a) receives this memorandum *'Parliamentary Commissioner for the Environment report on Managing our estuaries'*.

b) notes that monitoring of estuaries under the Council's *Estuarine State of the Environment Monitoring Programme* is set to recommence in the upcoming 2020-2021 summer but may be required to be expanded if the recommendations of the PCE are adopted by the Government.

Background

12. On 11 August 2020, the PCE released his 220 page report titled *Managing our estuaries*. The report arose out growing concern for the health of estuaries around the country and out of recognition of the complexities surrounding estuary management and implementing useful and effective change where required.
13. Estuaries are important environments and play a crucial role in the lifecycles of many freshwater and marine species providing access between the freshwater and marine domains. Estuaries also provide habitats to many of New Zealand's taonga species and significant indigenous biodiversity, including various estuarine plant, shellfish, wader bird and fish species. Estuaries may also contain other values whereby they provide important natural spaces that are particularly valued by communities for their recreational, traditional and cultural values.
14. Historically, many settlements around the country were strategically located near estuaries due to the benefits they offered early communities (both Māori and European). Māori also retain cultural and spiritual relationships with estuaries through whakapapa and traditional practices such as gathering kai and exercising kaitiakitanga.
15. Across the country marked variations between estuaries occur depending on the specifics of each catchment (land use, sediment types, geology and landscapes, flow rates, weather patterns, ecology to name a few) and its relationship with the coast and wider marine environment. In Taranaki there are a number of small estuaries (<500ha) at the mouths of Taranaki's larger rivers. Due to the gradient and geology, the ring plain lacks any extensive estuarine environments; instead, the larger estuaries are

located further north and south. These estuaries are well flushed, with a high freshwater input/area ratio and relatively little diversity in the way of intertidal and subtidal habitats.

16. Given the value and recognised pressures estuaries are under nationally, the PCE resolved to undertake a project to determine the main blocks to improving estuarine health across the country.
17. Accordingly, the PCE looked at the histories of five estuaries as case studies to explore some of the environmental challenges they face and how they are managed. These were:
    - New River Estuary (Invercargill city);
    - Pelorus Sound/Te Hoiere (Havelock);
    - Tauranga Harbour (Tauranga city, Mount Maunganui, Katikati, Bowentown);
    - Te Awarua-o-Porirua Harbour (Porirua city, Whitby, Pāuatahanui); and
    - Whāingaroa Harbour (Raglan).
18. Of note, the report acknowledged that those estuaries used in the case studies are not representative of estuaries across the country. However, the five case studies illustrate the complexities associated with estuarine management.
19. The freshwater/marine relationship, with back and forth flushing of waters, means that estuaries are particularly susceptible to trapping and accumulating pollution that have origins higher up in the catchment. Therefore, what enters an estuary may have an origin hundreds of kilometres away. As noted in the PCE's report, activities such as forest clearance, intensive farming practices and discharges associated with growing populations continue to increase, estuaries become more and more vulnerable to cumulative effects. As a result, one third of estuaries around New Zealand are at high risk of damage from cumulative pressures.
20. The case studies build a picture of the issues faced by estuaries across the country depending on the activities that are occurring within the catchment. Accordingly, the report:
    - looks at the overarching legislative framework for managing estuaries as well as the many non-statutory management options in place around the country;
    - considers the future implications of climate change from both an environmental and legislative perspective and the limitations and implications expected.
21. Set out below is a brief summary of key findings from the report.

Key findings

22. One of the finding of the PCE report is that the problems faced by estuaries are already well known and documented. For example, there is a good understanding that cumulative effects of activities higher up in the catchment can lead to increased degradation over time. Other activities that are known to have a negative effect include (but are not limited to) activities such as land reclamation, placement and management of landfills, hardening of banks, point source discharges, nutrient leaching, fishing and aquaculture activities, deforestation and increased sedimentation.
23. Despite a generally high level of understanding and accumulating evidence of deterioration in estuaries, not to mention efforts by many different parties to improve outcomes, the report states that, in many cases, effective change has not been achieved.

The report considers that improving outcomes for estuaries has largely failed due to the low priority that is provided them in legislation.

24. According to the PCE, the national policy framework for the management of estuaries creates an inherent disconnect between estuaries and those activities that contribute to cumulative effects that take place higher up in the catchment. The key issue being that the RMA, and other legislative tools designed to control these pressures, effectively divide the environment in ways that cut estuaries off from the landscapes of which they are a part.

25. Under the RMA, there are two main policy statements that have an effect on the health and management of estuaries. These are the *New Zealand Coastal Policy Statement* (NZCPS) and the *National Policy Statement for Freshwater Management* (NPS-FM) and the various regional plans that sit under them (primarily freshwater and coastal plans).

26. As noted by the PCE, currently the main legislative tool for management of estuaries is the NZCPS, which includes estuaries as part of the coastal environment.[1] The coastal environment boundary represents the extent to which coastal influences and processes are significant and have an effect onto the terrestrial environment. Typically, the lower reaches of estuaries are identified as being part of the coastal marine area (based on historical and locally agreed extents that were not determined with estuarine environment drivers and extents in mind) and activities are regulated under coastal plans. The other (further inland) reaches of the estuary are therefore managed under other RMA planning mechanisms such as freshwater plans.

27. The NPS-FM gives direction for the management of freshwater systems (including rivers, lakes, and freshwater wetlands) but not for estuaries. Instead, the NPS-FM recognise estuaries as part of the 'receiving environment' and therefore not a freshwater environment. The PCE suggests that a consequence of this approach is that estuaries extending into the freshwater domain have no special recognition or treatment, and are only required to be dealt with as an integrated management matter.

28. The PCE concludes that the high-level approach adopted in the NPS-FM, coupled with the unclear delineation of the estuarine environment between different legislative documents, does not provide the framework for decisive action that estuaries need. The report states that the inability for estuary managers to impose management on the upstream environment is one of the biggest challenges facing estuarine environments[2].

PCE recommendations

29. Based upon his findings, the PCE recommends:
    - the mandatory inclusion of estuaries as part of freshwater management units (FMU's) within the NPS-FM; and
    - robust monitoring of estuaries that supports council decision making.

30. The main driver for addressing estuaries in the NPS-FM (rather than the NZCPS) and designating them as a FMU is that the National Objectives Framework would then apply. This would have significant implications for regional councils (see discussion below). This approach aligns more closely with the concept of 'ki uta ki tai' or the mountains to the sea integrated management approach that is adopted in the NPSFM.

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[1] *NZCPS Policy 1(2)(c).*
[2] *Page 62, PCE report.*

31. Robust monitoring by councils is also recommended to provide a national baseline from which stressors can be identified and monitored over time. The PCE recommends that monitoring be nationally standardised, consistent, available, regular, mandatory, include Mātauranga Māori and be independently assessed. This would apply to the monitoring of FMU's within the NPS-FM 2020, and to pressures that cumulatively impact on estuaries.

32. In order to achieve these recommendations, the PCE notes that the NPS-FM would need to be amended to include references to estuaries. He has provided some suggested wording in his report that reads as follows:

- Amend Subpart 2 National Objectives Framework 3.8(2) – p.15 to read:

  Every water body and every estuary in the region must be located within at least one FMU

- Amend Clause 1.4 Interpretation (1) – p.6 to read:

  FMU, or freshwater management unit, means all or any part of a water body or water bodies, and their related catchments (including any estuary), that a regional council determines under clause 3.8 is an appropriate unit for freshwater management and accounting purposes

- Amend Appendix 1A 4 Mahinga kai – p.37 to read:

  Mahinga kai generally refers to freshwater and marine species that have traditionally been used as food, tools or other resources

- Include meaningful attributes for estuaries to Appendix 2A (attributes requiring limits on resource use) of the NPS-FM.

- Require robust monitoring that supports decision making.

Implications for Taranaki

33. The PCE's report has been presented to members of parliament for their consideration. The Government will now consider the report but at this point in time has not made any decisions in relation to adopting any of the PCE's recommendations. Noting that the NPS-FM has only just been gazetted by the Government (5 August 2020) they may be reticent to make too many significant changes to the NPS-FM so soon.

34. Notwithstanding that, officers have undertaken a preliminary analysis of the PCE's recommendations should they be adopted and note the following.

35. First, including estuaries within FMU's under the NPS-FM would require that the Council to manage estuaries through the future *Natural Resources Plan* (in draft) as well as the Coastal Plan. To ensure NOF limits can apply to the whole estuary, the Council may also have to redefine the extent of the coastal marine area (which is the legislative boundary between the freshwater domain and coastal domain for regulatory planning purposes). The advantage of this would be that it would avoid regulatory management of estuaries being split across different plans. However, the disadvantage of this is that it is re-ligating coastal issues that have already been settled through a long and comprehensive planning process (noting that the Proposed Coastal Plan is in the latter stages of a lengthy statutory review).

36. Second, the PCE's recommendation that attributes for estuaries be included in Appendix 2A of the NPS-FM would require significant additional resourcing so that the Council can comply with national monitoring and reporting requirements. Currently, the NPS-FM set out water quality standards and requirements for rivers and lakes, including national bottom lines for 22 water quality attributes, including periphyton, ammonia,

nitrate, dissolved oxygen, suspended fine sediment, E. coli, cyanobacteria, phytoplankton, total nitrogen and total phosphorus.

37. Third, the Council's Estuarine State of the Environment Monitoring (SEM) Programme is set to recommence in the upcoming 2020-2021 summer, after being discontinued for review in 2013.

38. The *Estuarine Vulnerability Assessment*[3] (EVA), that was carried out in the summer of 2019, helped to inform the redesign of the Council's SEM Programme. This piece of work provided a baseline assessment which identified the estuaries that were most vulnerable to two key estuarine stressors; nutrients and sediment. The Council now intends to monitor the 'at risk' estuaries, following the recommendations laid out in the EVA, which generally align with the *National Estuarine Monitoring Protocol* (NEMP) and the estuarine monitoring regimes undertaken elsewhere in the country, but reflect the specific characteristics of the region's estuaries.

39. In light of the PCE's recommendations, the Council's SEM Programme will be critical for gathering detailed information necessary to understand the attributes and overall state of the major estuaries in Taranaki. However, this monitoring will likely need to be expanded from its current scope in order to meet the required level of monitoring recommended by the PCE.

40. The current SEM Programme, as outlined in the NEMP, focuses on monitoring intertidal habitat quality. This is because estuarine sediments are not only an important habitat, they are considered to be a sink for contaminants and thus an indicator for pollution issues. In addition to this, monitoring of estuarine water quality will also be necessary in order to inform 'ki uta ki tai' (mountains to sea) integrated management.

41. Monitoring of estuarine water quality will gather the necessary evidence to demonstrate how catchment processes are affecting estuaries, by having both estuary input and habitat quality information. Rigorous science is essential for illustrating cause and effect, which is needed for guiding management decisions.

Decision-making considerations

42. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

43. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

44. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks

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[3] *Document 2409900: Taranaki Estuarine Vulnerability Assessment consultation report*

including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

45. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

46. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

47. A 'frequently asked questions' document is attached to this memorandum. A copy of the full report can be found on the PCE's website at https://www.pce.parliament.nz/publications/managing-our-estuaries

Document 2566258: Parliamentary Commission for the Environment - FAQs Managing Our Estuaries

Parliamentary Commissioner for the Environment
Te Kaitiaki Taiao a Te Whare Pāremata

Managing our estuaries

Frequently asked questions

What is this report about?

Since the first arrival of Polynesians on these shores, estuaries have been popular places to live near, and have served as magnets for outdoor recreation. But the health of these ecosystems has long been degraded by human activities. Estuaries receive and accumulate large amounts of whatever is emptied into them. Yet they fall between the cracks of our siloed management.

This report uses five estuaries as case studies to illustrate some of the environmental challenges they face, and how they are managed. The report identifies two points of leverage that could be employed to help overcome these issues. It also warns that climate change is an overarching pressure that will make today's problems even worse.

Why did the Commissioner decide to undertake this investigation?

Estuaries have been neglected compared to many other parts of the environment. There is no environmental policy dedicated to managing estuaries and they tend to be a low priority in the legislation that does apply to them.

It became clear through the investigation that issues crippling estuaries are already well documented, but action to address them has often stalled. The Commissioner decided to undertake this investigation in the hope that he could provide estuary managers with a way forward.

Are the problems really that bad?

Estuaries act as waste traps for pollution carried downstream by rivers and entering their waters from ports and coastal communities. Rather than diluting pollutants, estuaries allow them to accumulate. Yesterday's pollution can come back to bite us today.

Centuries of forest clearance have swollen the sediment loads entering our waterways, while in recent decades, intensive farming practices have resulted in unprecedented nitrogen levels flowing downstream. Population growth and the associated discharge of treated and untreated sewage and stormwater from houses and industry have led to further sedimentation and pollution.

A third of Aotearoa New Zealand's estuaries are at very high risk of damage from cumulative pressures, with some like New River Estuary and Te Hoiere/Pelorus Sound already showing signs of serious health issues.

What were the main findings?

Managing estuaries is about managing the pressures that cumulatively affect them. Yet the Resource Management Act 1991 and other legislative tools designed to control these pressures divide the environment up in ways that cut estuaries off from the landscapes of which they are part. The result can mean overlapping rules that are difficult to implement.

Rather than this piecemeal approach, estuaries require a robust management framework that treats estuaries and their catchments as a single identity. The investigation found that the best way to do this is to include estuaries as part of the freshwater management units within the National Policy Statement for Freshwater Management 2020, as many of the pressures that impact on estuaries arrive via the freshwater systems that feed them.

The report concludes that we must invest more in gathering high-quality data about estuaries and the sources of pollution and sedimentation that damage them, so that any management decisions we make are well informed, evidence based and enduring.

What's so special about estuaries? Why should I care about protecting mudflats?

Our estuaries are very special places. They are transitional zones where freshwater meets saltwater and new ecosystems form. They act as a nursery for many freshwater and marine animals – a permanent home for some, and a temporary resting place for others. They are also where we work, live, play and mahinga kai.

However, many of our estuaries are suffering from human pressures. For example, due to faecal contamination at New River Estuary, kaimoana is now collected with caution and waka ama groups practise tipping drills in local swimming pools rather than put their heads underwater in the river.

Why are estuaries falling through the cracks?

Estuary management is not about managing the body of water itself but managing the activities that affect it. That means considering all the activities that cumulatively impact on estuaries – regardless of where they are located – in an integrated way and with climate change in mind.

Estuaries do fall under the domain of the New Zealand Coastal Policy Statement, and local government can use it to make regional plans that include estuary protection. But it has no mandate to manage many of the activities in a catchment that affect the health of estuaries, and does not establish a bespoke management regime for them.

The National Policy Statement for Freshwater Management 2020 is attempting integrated management across entire catchments, and requires councils to set clear limits to deal with pollutants and undertake rigorous monitoring. However, it mainly focuses on freshwater like lakes and rivers. Estuaries can, but don't have to be, treated the same way. Once again, this leaves estuaries stuck in the complicated and somewhat murky legal territory between land and sea.

Can mātauranga Māori help us better manage our estuaries?

Estuaries are not currently managed using Māori concepts such as tikanga or mātauranga, and legislation that does include them prioritises them inconsistently.

Consultation with Māori revealed that the struggle for integrated landscape management is a very Pākehā problem – in te ao Māori, the landscape and the people within it are inseparable. Many hapū and iwi seek a return to an environmental management approach that encompasses all environments and activities, ki uta ki tai, which is starting to gain traction in the wider community.

What does the Commissioner recommend?

The Commissioner recommends that every estuary be included in one or more freshwater management units within the National Policy Statement for Freshwater Management. This would allow estuaries and their pressures to be managed together. Currently, this is voluntary. Two of the report's case study areas (Te Awarua-o-Porirua Harbour and New River Estuary), have already started moves in that direction.

The Commissioner also recommends establishing a robust monitoring system to help local government and communities make informed decisions. Ideally, this would be standardised, independently assessed and include metrics based on mātauranga Māori. This should apply to all the pressures that cumulatively impact on estuaries, as well as to estuaries themselves.

Won't this all change with climate change anyway?

Estuaries are particularly vulnerable to the looming threats of climate change, such as warming seas, ocean acidification, sea level rise, increased storm surges and further pressures coming downstream from land.

Climate change will force the migration of estuaries, and managers will have either to harden estuarine margins or allow them to move. From now on, any decisions made around the management of estuaries must consider the impacts of climate change.

Integrated management and robust monitoring will put us in good stead to make decisions with a long timeframe in mind.

Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date	1 September 2020
Subject:	**Partial review of Pest Management Plan for Taranaki**
Approved by:	S R Hall, Director - Operations
	M J Nield, Acting Chief Executive
Document:	2489804

Purpose

1. The purpose of this memorandum is to seek Members' approval to commence a **partial** review of the *Pest Management Plan for Taranaki 2018* (the Pest Plan). Pursuant to Section 100D of the *Biosecurity Act 1993* (BSA), the review is limited to amending the Pest Plan to include mustelids as new pest species. The review does not otherwise amend the Proposed Plan, except for minor consequential changes as appropriate.
2. Appended to this item is a draft project brief for undertaking the partial review of the Pest Plan.

Executive summary

3. The current Pest Plan became operative on 20 February 2018 following a comprehensive public process under the BSA. This Plan is the 'rulebook' for pest management in the region.
4. Currently, possums are the only animal species declared to be 'pests' in Taranaki and for which land occupiers (in the Self-help Possum Control Programme) must undertake control.
5. However, pursuant the *Taranaki Regional Council Biosecurity Strategy 2018-2038*, since 2018 the Council has been implementing and 'rolling out' the non-regulatory programme *Towards Predator-free Taranaki/ Taranaki Taku Tūranga*. This programme involves the voluntary control of other predator species such as rats and mustelids (ferrets, stoats and weasels).
6. This programme has received widespread public support. However, concerns have been raised around risks posed to the ongoing effectiveness of the programme due to incomplete or *ad hoc* land occupier participation creating 'hotspots' of higher than acceptable mustelid numbers that threaten the sustainability of and public investment in the programme.

7. To protect the sustainability of and public investment in *Towards Predator-free Taranaki / Taranaki Taku Tūranga* programme, an amendment to the current operative Pest Plan is considered necessary.
8. The purpose of the partial review is to prepare and consult on a proposal to amend the current Pest Plan to add mustelids and introduce land occupier rules to support the implementation of *Towards Predator-free Taranaki/ Taranaki Taku Tūranga* programme.
9. Attached is a project brief for undertaking the partial review of the Pest Plan pursuant to Section 100D of the BSA.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum *Partial Review of the Pest Management Plan for Taranaki*;

b) notes the intention to undertake a partial review of the *Pest Management Plan for Taranaki* to include a new sustained control programme for mustelids;

c) notes the review does not otherwise amend, other than inconsequential changes, the operative *Pest Management Plan for Taranaki*; and

d) approves commencing a partial review of the *Pest Management Plan for Taranaki* pursuant to section 100D of the BSA and in accordance with the attached project brief.

Background

10. The current *Pest Management Plan for Taranaki* (the Pest Plan) became operative on 20 February 2018 following a comprehensive public process under the *Biosecurity Act 1993* (BSA).
11. The Pest Plan is Taranaki's 'rulebook' for pest management and identifies 19 pest plant and animal species for which special powers and rules apply. Of note, possums are the only animal species declared to be 'pests' in Taranaki and for which land occupiers (in the Self-help Possum Control Programme) must undertake control.
12. Notwithstanding the above, the Council has a plethora of programmes addressing other invasive animal species. Under the *Taranaki Regional Council Biosecurity Strategy 2018-2038* (which was adopted at the same time), the Council sets out a much wider suite of regulatory and non-regulatory interventions covering all invasive species (not just those declared to be 'pests'). Pursuant to Section 7.2.2 of that Strategy, the Council undertook to:

    "*Investigate public and private interest in landscape predator control to reduce possum, rat, mustelid and feral cat populations on the ring plain*

    Subject to public and private support, develop with other potential partners a landscape predator control programme based upon the Self-help Possum Control Programme

    If appropriate, consider the inclusion of predator control rules as part of a review of the RPMP."
13. In 2018, the Council, in conjunction with Predator Free 2050 Limited, launched the *Towards Predator-free Taranaki/Taranaki Taku Tūranga* programme. This landscape predator control programme is a voluntary initiative that involves Council working with interested land occupiers to undertake regular and sustained predator control.
14. This programme has received widespread public support. However, concerns have been raised around the voluntary nature of the programme and the risks posed to the

ongoing effectiveness of the programme due to incomplete or *ad hoc* land occupier participation creating 'hotspots' of higher than acceptable mustelid numbers that threaten the sustainability of and public investment in the programme.

15. To protect the sustainability of and public investment in *Towards Predator-free Taranaki/Taranaki Taku Tūranga* programme, and amendment to the current operative Pest Plan is necessary.
16. The purpose of the partial review is to introduce predator control rules to support the implementation of Towards Predator-free Taranaki/*Taranaki Taku Tūranga* programme.

Description of the problem

17. Ferrets, stoats, weasels are part of the mustelid family, which is a group of small to medium sized carnivores. Mustelids have large home ranges and are active day and night.
18. Mustelids were introduced in New Zealand in the 1880's in an attempt to manage growing rabbit populations. This introduction had minimal impact on rabbit densities but significant impacts on indigenous biodiversity.
19. Mustelids are opportunistic predators and, even in small numbers, impact on the presence and abundance of native fauna species. Skinks, flightless birds (such as kiwi) and/or birds that nest in holes (e.g. penguins and parakeet) are particularly vulnerable. Mustelids have been implicated in the extinction of some indigenous bird species and as the major cause of decline of many others.
20. Mustelids can also have considerable negative impact on primary production. Mustelids are a threat to poultry farms and carry parasites and toxoplasmosis, which can cause illness in humans and livestock. Ferrets are also a vector (carrier) of bovine tuberculosis.
21. Mustelids are established throughout the Taranaki region. They are present in small densities across most land use and habitat types, including fertile pasture, rough grassland, tussock, scrubland and the fringes of nearby forest (forest fragments).

The changes proposed

22. This project involves undertaking a partial review of the Plan pursuant to Section 100D of the BSA.
23. As Members are aware, since the 1990s, the Council has been achieving effective sustained possum control over large parts of the Taranaki region through the Self-help Possum Control Programme. Since 1995, the Taranaki region has had pest management plans and land occupiers rules requiring the ongoing control of possums following Council undertaking successful possum control across the ring plain and coastal terraces and reducing numbers to very low levels. This approach has been very successful.
24. The purpose of the Pest Plan review is to declare mustelids to be pests and to add a new sustained control programme to the current Plan. It will seek to replicate that approach for mustelids by establishing a regulatory framework for mustelid control that is incrementally 'rolled out' across the region through the *Towards Predator Free Taranaki/ Taranaki Taku Tūranga* programme.
25. Proposed changes to the current operative Pest Plan are minimal and largely comprise of the inclusion of a new chapter that complies with the content requirements of the BSA and which sets out the land occupier rules to support the implementation of *Towards Predator-free Taranaki/ Taranaki Taku Tūranga*.

26. As far as practicable, the proposed sustained control programme for mustelids would replicate the Council's approach for the Self-help Possum Control Programme whereby the Council would:
    - first, identify 'Predator Control Areas' based upon community interest in sustained mustelid control. Community interest would be determined by >75% of land occupiers, covering at least 75% of the land area targeted, agreeing to participate in the programme and undertake long term predator control maintenance;
    - second, undertake initial predator control work within newly identified Predator Control Area; and
    - third, liaise with and work with land occupiers within the Predator Control Areas to maintain mustelid numbers at low levels. This includes monitoring and enforcement of new rules to maintain mustelids at their reduced levels.
27. The Proposal does not otherwise amend the Pest Plan, except for minor consequential changes necessary to update the Plan and note the inclusion of mustelids as new 'pest'.

The Plan review process

28. Attached is a draft project brief setting out project objectives, scope, methodology and indicative timelines.
29. In brief, the project involves a four component parts:
    - First, need to ensure there are appropriate and effective compliance monitoring techniques or powers available to enforce land occupier rules to control mustelids. Council officers are reviewing similar protocols around New Zealand such as those developed by Hawkes Bay Regional Council.
    - Second, develop a draft proposal in accordance with BSA content and consultation requirements. In particular, the draft proposal should:
        - clearly identify proposed amendments to the Plan, including a new sustained control programme for mustelids; and
        - set out the costs and benefits of the new programme as required by sections 70 and 71 BSA and *National Policy Directions for Pest Management*.
    - Third, undertake early (pre-notification) engagement on draft proposal with key affected stakeholders such as Federated Farmers, tangata whenua, district councils and the Ministry for Primary Industries (as per section 72(1) requirements) to discuss draft concepts and assumptions.
    - Fourth, undertake the public plan making process. Pursuant to Section 100D(5) of the BSA, conduct a partial review of the Pest Plan and 'make' an amended Plan. The process for amending the Pest Plan will involve the public notification of a Proposal, submission process (4 weeks), analysis of and reporting on submissions and recommended responses, a hearing of submissions, and public notification of Council’s decisions.
30. Subject to no appeals to the Environment Court, an amended Pest Plan that includes new mustelid rules could be completed and adopted by Christmas or in the early New Year.

Decision-making considerations

31. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

32. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

33. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

34. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

35. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 2338623: Project brief - Partial Pest Plan Review 250220.

Project Concept Brief:

Partial review of the Regional Pest Management Plan for Taranaki: Predator control rules

Project Description

For the Taranaki Regional Council (the Council) to commence a review of the *Pest Management Plan for Taranaki* (2018) pursuant to Section 100D of the *Biosecurity Act 1993* (BSA) for the inclusion of predator control rules to support the implementation of *Towards Predator-free Taranaki* programme.

The review includes the following component parts:

- Pursuant to Section 100D(5) of the BSA, the initiating of the review by a proposal made by Council
- The preparation of a Section 70 and 71 report setting out the analysis of the benefits and costs of new Plan provisions to control mustelids
- The preparation of a proposal that incorporates amendments to the *Pest Management Plan for Taranaki* that include land occupier rules to control mustelids
- The conducting of a partial review of the *Pest Management Plan for Taranaki* pursuant to sections 68 to 78 of the BSA.

Reason(s) for the Project

The funding received from Government owned *Predator Free 2050 Limited* enabled the implementation of *Towards Predator Free Taranaki* project (TPFT).

The project is split into three main work-streams including the inclusion of predator (mustelids and possums) control into existing *Self-help Possum Control Programme*. It is currently non regulatory (i.e. no rules apply) and its success is dependent upon land occupiers (and others) undertaking voluntary predator control.

The current *Pest Management Plan for Taranaki* became operative on 20 February 2018. This Plan is the 'rulebook' for pest management and identifies 19 pest animal and plant species for which rules apply to land occupiers to undertake control. Of note, possums are the only pest animal species for which land occupiers (in the Self-help Possum Control Programme) must undertake control.

Notwithstanding the above, under the *Taranaki Regional Council Biosecurity Strategy 2018-2038* (which was adopted at the same time) the Council sets out a much wider suite of regulatory and non-regulatory interventions covering all invasive species (not just those declared to be 'pests'). Pursuant to Section 7.2.2 of that Strategy the Council undertook to:

Benefits

The project will have the following benefits:

- protects the significant public investment in mustelid control
- promotes coordinated regional control to increase the effectiveness of mustelid control by individuals
- increases certainty and clarity on the ongoing effectiveness of mustelid control.

Document number: 2338623

- Investigate public and private interest in landscape predator control to reduce possum, rat, mustelid and feral cat populations on the ring plain
- Subject to public and private support, develop with other potential partners a landscape predator control programme based upon the Self-help Possum Control Programme
- **If appropriate,** consider **the inclusion of predator control rules as part of a review of the RPMP.**

Since the implementation and roll out of *Towards Predator-free Taranaki* programme, concerns have been raised around risks posed to the effectiveness of the programme due to incomplete or *ad hoc* land occupier participation creating ‘hotspots’ of higher than acceptable mustelid numbers that threaten the sustainability of and public investment in the programme.

For the purposes of this project regulatory predator control is confined to mustelids due to technical limitations and lack of options for compliance monitoring for other predators such as cats and rats.

Key Dates

Forecast Start Date: 1/09/2020
Forecast End Date: 30/12/2020

Resources

People: S Hall, S Ellis, D West, C Spurdle, Hayden Kinraid

In Scope

- Mustelids (Ferrets, Stoats, Weasels)

Out of Scope

- Possums, Cats, Rats

Project Method

This project involves undertaking a partial review of the *Pest Management Plan for Taranaki* (2018) pursuant to Section 100D of the *Biosecurity Act 1993* (BSA) for the inclusion of predator control rules to support the implementation of *Towards Predator-free Taranaki* programme.

Project methodology initially involves establishing a project team to have input and oversee the project. It will comprise S Hall, S Ellis, D West, Toby Shanley and C Spurdle. S Hall will be project owner.

The Project involves the following component parts and milestones:

1. **Develop draft project brief:** Project team to confirm project brief to establish project objectives, scope, methodology and timelines. Estimated completion date – *16 April 2020*.
2. **Review and confirm adequacy of monitoring protocols:** Environment Services (S Ellis, D West and H Kinraid) to liaise with Hawkes Bay Regional Council on their experiences with compliance monitoring for mustelids. Environment Services also to review the *Hawkes Bay Regional Predator Control Technical Protocol (PN 4970)* and

investigate the merits of developing a Taranaki version to underpin potential mustelid rule. Estimated completion date – *8 May 2020*.

3. **Early engagement:** Environment Services and Policy to liaise with Federated Farmers, as the key affected stakeholder, plus tangata whenua, district councils and the Ministry for Primary Industries (as per section 72(1) requirements) to discuss draft concepts and assumptions. Estimated completion date – *29 July 2020*.
4. **Council decision to commence a review:** Policy to prepare memorandum and refer it and the project brief to Policy and Planning Committee to formally commence review. Target date – *1 September 2020*.
5. **Develop draft plan provisions:**
    a. **Review of other Council RPMPs:** Policy to search other councils' RPMPs for examples of predator rules and provide examples to project team.
    b. **Undertake internal workshop(s) to determine preferred rule design:** Policy analyst to lead a short 'pest intervention logic' workshop with project team to discuss rule(s) and preferred options
    c. **Confirm monitoring protocols:** Project team to review and confirm *Taranaki Regional Predator Control Technical Protocol*.
6. **Develop proposal:** Policy to prepare a proposal that sets out amendments to the *Pest Management Plan for Taranaki* and which include land occupier rules to control mustelids. Target date – *13 October 2020*.
7. **Prepare Section 71 report:** Environment Services and Policy to prepare report setting out the analysis of the benefits and costs of new Plan provisions to control mustelids. Target date – *13 October 2020*.
8. **Council decision to publicly notify proposal:** Policy to prepare memorandum and draft proposal referred to Policy and Planning Committee for their consideration. Target date – *13 October 2020*.
9. **Public notification:** To occur after Policy and Planning Committee's recommendations are formally adopted by full Council (*3 November*). Target date – *16 August*.
10. **Undertake public process:** Pursuant to Section 100D(5) of the BSA, conduct a partial review of the Pest Management Plan for Taranaki pursuant to sections 68 to 78 of the BSA. Assuming there are no appeals to the Environment Court, this process will involve the public notification of a Proposal, submission process (*4 weeks from 7 November to 4 December*), analysis of and reporting on submissions and recommended responses, a hearing of submissions, and public notification of Council's decisions.

Revised and amended RPMP to be presented to full Council meeting for adoption on a date to be confirmed.

Approval:

The following indicates that approval has been obtained for the project concept:

Project Owner ______________________________

Project Owner

Date ______________________________

Document number: 2338623

Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date 1 September 2020

Subject: **Feedback on the Proposed Bylaws: the Proposed Navigation Safety Bylaws and the Proposed River Control and Flood Protection Bylaws**

Approved by: A D McLay, Director - Resource Management

M J Nield, Acting Chief Executive

Document: 2561615

Purpose

1. The purpose of this memorandum is to update Members on the public engagement process for the *Proposed Navigation Safety Bylaws for Port Taranaki and its Approaches* and the *Proposed River Control and Flood Protection Bylaws for Taranaki*.

Executive summary

2. On the 24th of July, the Taranaki Regional Council (the Council) publicly notified two proposed bylaws; the *Proposed Navigation Safety Bylaws for Port Taranaki and its Approaches*, and the *Proposed River Control and Flood Protection Bylaws for Taranaki.*
3. Pursuant to section 156 of the *Local Government Act 2002* (LGA), the Council publicly notified the Proposed Bylaws and invited feedback on the bylaws.
4. The Council received three submissions on the Proposed River Control bylaws and one submission on the Proposed Navigation Safety Bylaws.
5. Submissions will be heard by the Council on the 22 September following the ordinary meeting.
6. In the interim, Council officers are preparing officers reports and track changed versions of the Proposed Bylaws to support the hearings.

Recommendations

That the Taranaki Regional Council:

a) receives this memorandum titled *Feedback on the Proposed Bylaws: the Proposed Navigation Safety Bylaws and the Proposed River Control and Flood Protection Bylaws.*

b) notes that a hearing will be held on September 22nd 2020 following the Ordinary Committee Meeting.

Background

7. Members will recall that, on Saturday 24th of July 2020, the Council publicly notified two proposed bylaws: the *Proposed Navigation Safety Bylaws for Port Taranaki and its Approaches*, (Proposed Navigation Bylaws) and the *Proposed River Control and Flood Protection Bylaws for Taranaki* (Proposed River Control Bylaws). Herein, collectively referred to as the 'Proposed Bylaws'.
8. The Council has had bylaws for navigation safety since 1993 and the Proposed Navigation Bylaws will replace current bylaws that have been in place since 2009 while the Proposed River Control Bylaws are newly proposed bylaws to address the protection of Council owned and/or operated assets associated with river control and flood protection.
9. The purpose of navigation safety is to ensure that different users can safely use shared waterways. To this end, the Proposed Navigation Bylaws are considered to be working well and remain appropriate, however, a small number of minor changes were recommended as part of the review. Changes include:
    a) changing the 'water ski access lane' to the 'boat access lane';
    b) vessels to be seaworthy;
    c) increase regulations in the main navigation channel and Port area;
    d) increase requirements for temporary events that involve uplifting of bylaws or restricting access to general public;
    e) introducing requirements for incident reporting; and
    f) removal of redundant bylaw provisions.
10. As with the current bylaws, the Proposed Navigation Bylaws continue to address:
    - reserved areas;
    - moving safety zones; and
    - administrative matters.
11. The purpose of the Proposed River Control Bylaws is to provide the Council with a regulatory mechanism to better protect its flood protection and river control infrastructure, and hydrological equipment. The proposed bylaw addresses this by requiring that activities occurring within or near floodways or defences against water are appropriate by meeting bylaw requirements or by requiring those undertaking the activity to seek authority from the Council.
12. The Proposed River Control Bylaws also addresses matters such as entry onto land and compliance and enforcement for the purpose of the bylaws.

Submission process

13. Under section 156 of the LGA, the Council invited submissions on the Proposed Bylaws over a four-week period. The Council also directly notified New Plymouth District Council, South Taranaki District Council, Iwi and hapū as well as affected land owners and stakeholders of the Proposed Bylaws. Submissions could be made through the completion of an online submission form on the Council website, via email or posting a hard copy to the Council.

14. Council officers were also available over the submission period to answer questions or to provide clarification on matters of concern. A short presentation was also made for the Proposed Navigation Bylaws at the New Plymouth Yacht Club. The presentation set out the legislative framework of navigation safety, explained the need for navigation safety bylaws, introduced the proposed changes and explained the submission process.
15. The submission period concluded at 5pm on Friday 21st August 2020.
16. Three submissions were received on the Proposed River Control Bylaws, from:
    a) Powerco Limited;
    b) New Plymouth District Council; and
    c) John Doorbar (land owner).
17. Late pre-engagement feedback from the Director of Maritime New Zealand that was not able to be considered prior to publicly notifying the Proposed Navigation Bylaws and has been agreed to be treated as a 'submission'. No other submissions have been received.
18. Council officers are currently considering the submissions and will prepare the following documents for each of the Proposed Bylaws:
    - an officers report on submissions (which includes officers recommended relief); and
    - a track-changes version of the Proposed Bylaws showing recommended changes as a result of submissions.
19. A hearing, to consider submissions for each of the Proposed Bylaws, will take place on September 22nd following the regular Ordinary Council meeting.
20. So far, only one submitter has indicated they wish to speak at a hearing.

Decision-making considerations

21. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

22. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

23. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

24. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

25. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Taranaki Regional Council

MEMORANDUM
Policy & Planning

Date	1 September 2020
Subject:	**Climate Change Strategy**
Approved by:	G K Bedford, Director - Environment Quality
	M J Nield, Acting Chief Executive
Document:	2572330

Purpose

1. The purpose of this memorandum is to present for the Committee's consideration, the '*Climate Change Strategy: a strategy to guide the Taranaki Regional Council's climate change response*'. The proposed Strategy is attached to this memorandum. The Executive Audit and Risk Committee at their meeting on 11 August recommended that this Committee, with its district council and iwi representatives, consider the Strategy and report back.

Executive summary

2. The Strategy is intended to provide regional leadership on climate change and a clear focus and strategic direction to the Council for its climate change intentions and priorities. It has been developed as a non-statutory framework for reference in addressing the broad issues around responding appropriately to climate change and its consequences. The Strategy includes an associated detailed Action Plan, setting out how it is intended the Strategy should be given effect to via in-house and outward-facing activities. The Strategy and Action Plan are seen as living documents, given the ongoing changes in the wider regulatory settings, emerging technologies, and opportunities with which the Council has to deal.
3. The purpose of the Climate Change Strategy is to:
   - provide an overarching document to align and coordinate climate change actions across the Council's responsibilities and operations;
   - respond to and raise awareness of climate change throughout the community; and
   - help coordinate collaboration and partnership between councils, central government and the community.
4. The Strategy proposes the following overarching objective:

   '*The Taranaki Regional Council strengthens the ability and willingness of the Taranaki community to adapt to and thrive under climate change risks and opportunities, through cooperation and coordination on climate change action consistent with its statutory functions.*'

5. The Strategy adopts the following principles to which the Council can give effect:
   - Precaution: act now to maximise co-benefits, reducing future risks and costs associated with climate change, and minimise actions which hinder adaptation.
   - Stewardship/Kaitiakitanga: flexible action and climate policies that enable all to do their bit to reduce emissions and enhance resilience.
   - Equity/justice: prioritise action to the most vulnerable communities and sectors.
   - Anticipation: anticipate change and take a long-term perspective, with a clear and consistent pathway to a low carbon future that will provide benefits and certainty for all.
   - Understanding: grow understanding around the potential impacts of climate change and use the best available information and evidence in education, community consultation planning and decision-making.
   - Cooperation: act together in partnership and build relationships across countries, communities, cultures and organisations.
   - Resilience: enhance the resilience and readiness of communities and businesses so they can thrive in the face of change.
   - Lawfulness: act in accordance with the law as provided through legislation and regulation, including seeking amendment to lawful powers when appropriate and justified.
   - Effectiveness: avoid perverse outcomes and unintended consequences while being able to deliver the desired outcomes.
   - Efficiency: avoid duplication of roles, responsibilities and actions.
   - Robustness: ensure that any interventions can endure through financial and political cycles.
6. In essence the Strategy gives a more explicit and all-encompassing recognition of the environmental, social, cultural and economic problems that climate change is generating. Through it, the Council acknowledges the need for action on climate change, noting the need is becoming ever more imperative in the face of growing national and international concern and evident effects. Further action now is necessary to avoid or reduce future risk and to better adapt to an emerging and very different future. The Strategy examines carefully the appropriateness of and the constraints upon possibilities for meaningful Council action.

Recommendations

That the Taranaki Regional Council:

a) receives the memorandum ' *Climate Change Strategy*' and the report '*Climate Change Strategy: a strategy to guide the Taranaki Regional Council's climate change response*'

b) considers and provides appropriate feedback on the Strategy as a non-statutory framework to provide regional leadership on climate change and a clear focus and strategic direction to the Council on its climate change intentions and priorities.

Background

7. The overwhelming consensus of scientific evidence across multiple disciplines is that human induced climate change is occurring and is intensifying. This poses environmental, social, cultural and economic issues across all strata and sectors of society.
8. In order to reduce potential impacts of climate change, mitigation policies to reduce greenhouse gas concentrations in the atmosphere are needed. Secondly, adaptation policies are required to take into account and adjust to the changes we are already seeing and will continue to see, even if global reductions in future emissions can be anticipated.
9. Central government is responsible for developing policy on climate change. The Paris Agreement which came into force in 2016, commits signatory nations (of which New Zealand is one), to limit global warming to below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius.
10. Local government does not yet have an explicit role in mitigating greenhouse gases across their local districts or regions – this is intended to be the role of central government. Local authorities, however, were permitted to have particular regard to the effects of climate change when exercising functions and powers under the *Resource Management Act (*RMA*)*. These provisions remain in force.
11. Territorial authorities have a particularly important role to play through their provision or control of road networks, water supplies, stormwater management, wastewater disposal, building design, urban development patterns, sea level rise adaptation and managed retreat etc.
12. The scope for regional councils to play any meaningful role is much more limited, despite perceptions held by some. However, it is recognised that action on climate change requires a comprehensive, coherent, coordinated and consistent framework across central and local government and all sectors of society, and that the Council can play a leadership role (having regard to the our statutory roles, functions and responsibilities) to provide a focus for climate change action in the region.

Discussion

13. Since the enactment of the RMA, this Council has been actively engaged in the greenhouse gas emissions/climate change space. Throughout the 1990s, the Council required compliance reporting by major GHG-emitting sources, and it routinely prepared reports on regional GHG emissions and sink inventories. The Council ceased preparing the reports when the Government at that time decided that regional councils would have no role in greenhouse gas mitigation. The call-in of the Stratford combined-cycle power station project (for many years, the only intervention by the Government in a consent application) placed the Council at the forefront of climate change awareness and considerations, and on a number of occasion the Council was required to defend in the Environment Court (successfully) its consenting decisions on significant GHG emitting industries.
14. The Committee will be aware that the riparian and hill country re-afforestation programmes are amongst the largest and most successful in the country. The refusal of the Government of the day to recognise their contribution to GHG mitigation has been an ongoing frustration for the Council and the local communities.
15. The local government sector has publicly committed to mitigation and adaptation actions through the *Local Government Leaders' Declaration on Climate Change* (2017) and

the *Local Government Position Statement on Climate Change* (2018). The Chairman of the Taranaki Regional Council is a signatory to the *Local Government Leaders' Declaration on Climate Change*.

16. Stats NZ (the New Zealand Statistics Department) has very recently (July 2020) released regional emissions inventories, that look at changes in emissions (but not sinks) on a region by region basis across New Zealand, for the last decade. This inventory shows that the Taranaki region has had the second biggest reduction in absolute terms, and the biggest reduction in percentage terms, of all regions in the country. The reductions have come about within the mining (hydrocarbon extraction and processing) and electricity (gas-fired thermal power generation) sectors. Emissions from the agricultural sector have remained steady across the decade, reflecting a mature and stable industry with emphasis upon productivity rather than gross output. The inventory shows that despite a significant increase in households in the region, gross household emissions in Taranaki have actually fallen.
17. On the other hand, the inventory shows that on a per person or per dollar of GDP basis, the region has relatively high GHG emissions (reflecting a regional economy based on primary industry and a small regional population).
18. The weaknesses of the NZ Stats approach are that it fails to account for sinks (re-afforestation); it assigns emissions to sources rather than consumers (so the export of Taranaki's outputs to the rest of the nation or internationally are accounted against the region); and it does not acknowledge that the Government of the day excluded regional councils from interventions on emissions.
19. Climate change impact projections for Taranaki model only minor changes in weather and sea level rise, especially against the background of year-by-year variations, other than in the very long term. These changes offer both opportunities for diversification and risk of greater vulnerabilities.
20. Central government is now putting additional GHG emissions and climate change management frameworks in place, including a Climate Change Commission to provide advice. Community expectations around action on climate change are rising. The Council recognises that given the imperative for local, national, and international action, it is appropriate to explicitly consider and define a clear focus and strategic direction for its climate change intentions and priorities.
21. The Strategy examines (section 1.3 and Appendix 1) a range of other plans, strategies, and guidelines (both statutory and non-statutory) to identify opportunities to undertake initiatives. It sets out (section 2.3) our current roles and functions, with the implications of and for climate change.
22. Section 3 sets out the proposed principles by which the Council can weigh up any interventions or actions (see paragraph 5 above), the objectives the Council intends to pursue, and an overarching strategic vision (paragraph 4 above).
23. Specific policies and an Action Plan that delivers on the policies are presented in Sections 3.3-3.4 and 4, and Table 1. The Action Plan sets out a stocktake of actions that are already underway, those proposed for consideration and implementation within the next 5 years, and those for which a staged approach to further evaluation is deemed appropriate.
24. Committee members will note that even since the Strategy was drafted, the world has changed e.g. the government has moved into the space of publishing regional emission

inventories, and covid-19 responses have raised awareness of opportunities for innovation and change.

25. It is therefore envisaged that the Strategy needs to remain an agile living document, to reflect and adjust to a rapidly shifting external environment. Important triggers for review will include improvements in our knowledge and understanding of climate change, market changes such as in the financing and insurance industries, regulatory change, significant and more frequent extreme events, risks of litigation, and public expectations.

Decision-making considerations

26. Part 6 (Planning, decision-making and accountability) of the *Local Government Act 2002* has been considered and documented in the preparation of this agenda item. The recommendations made in this item comply with the decision-making obligations of the *Act*.

Financial considerations—LTP/Annual Plan

27. This memorandum and the associated recommendations are consistent with the Council's adopted Long-Term Plan and estimates. Any financial information included in this memorandum has been prepared in accordance with generally accepted accounting practice.

Policy considerations

28. This memorandum and the associated recommendations are consistent with the policy documents and positions adopted by this Council under various legislative frameworks including, but not restricted to, the *Local Government Act 2002*, the *Resource Management Act 1991* and the *Local Government Official Information and Meetings Act 1987*.

Iwi considerations

29. This memorandum and the associated recommendations are consistent with the Council's policy for the development of Māori capacity to contribute to decision-making processes (schedule 10 of the *Local Government Act 2002*) as outlined in the adopted long-term plan and/or annual plan. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum.

Legal considerations

30. This memorandum and the associated recommendations comply with the appropriate statutory requirements imposed upon the Council.

Appendices/Attachments

Document 2385229: Climate Change Strategy - A strategy to guide the Taranaki Regional Council's climate change response

Climate Change Strategy

A strategy to guide the Taranaki Regional Council's climate change response

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1 Introduction

1.1 Background

A global problem

Climate change is an established global environmental, social, cultural and economic problem. The overwhelming consensus of scientific evidence across multiple disciplines is that human induced climate change is occurring and is intensifying. Its impact will be far reaching and will affect us all in many different and unknown ways over generations to come.

Increasing concentrations of greenhouse gases in the atmosphere from human activity has led to rising global temperatures, melting ice caps, and extremes of weather including more frequent storms and droughts.[1] This is in turn is resulting in rising sea levels, more severe flooding and erosion and risks to people and property including vital infrastructure. Pests and diseases may spread.

At the same time as posing major challenges, however, addressing climate change presents us with many opportunities in transitioning to a low-carbon economy. For example, it creates real opportunities for greater energy security, cleaner air, better water quality and reduced vehicle congestion. Warmer temperatures may also present opportunities for new crops and land uses.[2]

While strong mitigation policies to reduce greenhouse gas concentrations in the atmosphere are needed, adaptation policies are also required to respond to the changes we are already seeing and will continue to see, even with global reductions in future emissions.

New Zealand's role in tackling global climate change

New Zealand's greenhouse gas emissions are about 0.17% of total global emissions. However, despite its small contribution to global emissions, about 25% of global emissions come from small emitters, so that 'collectively, small emitters do matter and a global, concerted effort is needed'.[3]

New Zealand's greenhouse gas emission profile differs markedly from other developed nations. Nearly half of our emissions, (48.1%) are from agriculture, more than any other developed country. The energy sector accounts for 40.7% of which transport, the largest emissions source, has been the greatest contributor to rising emissions. Industrial processes (6.1%) and waste (5.1%) make up the balance.[4]

New Zealand's unique emissions profile presents us with some challenges in tackling global climate change. Rising transport emissions reflect a small and dispersed population in a geographically challenging landscape where mobility by private vehicles is largely unavoidable given current technology and the cost of alternatives. Furthermore, while we have a large proportion of agricultural emissions, it is internationally recognised that our agricultural production efficiency means we generate less emissions per unit of product than agriculture in most other

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[1] https://www.mfe.govt.nz/climate-change/why-climate-change-matters/evidence-climate-change

[2] These benefits may be may be limited by the negative effects of climate change.

[3] New Zealand Productivity Commission, 2018. *Low emissions economy*.

[4] Ministry for the Environment, 2019. *New Zealand's greenhouse gas inventory 1990-2017.*

countries. This is a critical consideration in a world where food security is an ever-growing issue, brought about by increasing populations, loss of productive soils, conflicting demands for land for biofuels production and re-afforestation.

At the same time however, New Zealand has enough forestry to offset just under a third of gross emissions (29.6%) – a high proportion by international standards. New forest plantings provide time for reductions in emissions to be developed but there are also disadvantages in using forests as permanent sinks with risks from fire, disease and other natural events, as well as social impacts from changing land use.

Central government is responsible for developing policy on climate change. The Paris Agreement which came into force in 2016, commits signatory nations (of which New Zealand is one), to limit global warming to below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 degrees Celsius.

In response, the New Zealand Parliament passed the Climate Change (Zero Carbon) Amendment Bill in October 2019 which amended the Climate Change Response Act 2002. The Act commits New Zealand to reducing net emissions of all greenhouse gases (except biogenic methane) to zero by 2050 and reducing emissions of biogenic methane to 24-47% below 2017 levels by 2050, including to 10% below 2017 levels by 2030.

The Act also establishes a system of emissions budgets to act as stepping stones towards the long-term target and establishes an independent Climate Change Commission to provide advice to the Government. It also includes provisions to promote adaptation through the development of a National Adaptation Plan which will be preceded by a Climate Change Risk Assessment Framework.

The main tool in delivering on central government's greenhouse gas targets is the New Zealand Emissions Trading Scheme (NZ ETS). However, the Government is concerned that the NZ ETS is currently not being used to its full potential and has introduced legislation that would significantly improve the operation of the NZ ETS. Other legislative and policy changes will also be required over the coming years.

Local government's role

Local government does not yet have an explicit role in mitigating greenhouse gases across their local districts or regions – this is intended to be the role of central government. An amendment to the Resource Management Act in 2004 prevented regional councils from considering climate change effects when assessing applications for resource consents to discharge to air. Councils, however, were permitted to have particular regard to the effects of climate change when exercising functions and powers under the Act. These provisions remain in force.

However, the Local Government Act 2002 provides that the purpose of local government includes the promotion of the social, economic, environmental and cultural well-being of the community now and in the future.[5] While climate change is not specifically mentioned in the purpose statement, the wording is sufficiently broad to capture it.

Furthermore, many of local government's policies and plans, while prepared to achieve other objectives (for example in resource management or transport) will also have co-benefits for greenhouse gas emissions reductions. There is also a role for local government to reduce

[5] See section 10 of the Local Government Act 2002, for the full description of the purpose of local government.

emissions from its own operations, such as through its vehicle purchasing policies and waste management practices (although central government policies such as the NZ ETS will impact on these).

Much of the responsibility for adaptation to climate change will however, fall on local government through its environmental planning and regulatory role and through its role in providing local infrastructure. Territorial authorities will have a particularly important role to play through their provision or control of road networks, water supplies, stormwater management, wastewater disposal, building design, urban development patterns, sea level rise adaptation and managed retreat etc. However, local councils cannot address these issues by themselves and will require national policy guidance and support from central government, businesses, insurers, the banking industry, community and all parts of society, as well as a wide range of tools (not just regulation) to effectively manage the risks that climate change presents.

The local government sector has publicly committed to mitigation and adaptation actions through the Local Government Position Statement on Climate Change.[6] A Local Government Leaders' Declaration on Climate Change accompanies the position statement.[7]

The Chairman of the Taranaki Regional Council is a signatory to the Local Government Leaders' Declaration on Climate Change.

The Position Statement and Leaders' Declaration commit to local government led action on climate change and to policies that outline what local government requires of central government These include a national campaign to raise awareness of climate change; policy alignment and a clear legislative mandate to address climate change; a decision on fiscal responsibility for adaptation; and co-investment with central government to support low-carbon, climate resilient infrastructure.

Some local authorities have adopted climate change policies, declared 'climate emergencies', prepared greenhouse gas inventories or taken other actions to address climate change.[8]

Working together is vital because action on climate change requires a comprehensive, coherent, coordinated and consistent framework across central and local government and all sectors of society.

However, local government, including the Taranaki Regional Council, recognises that the need for action on climate change is becoming ever more imperative in the face of growing national and international concern. Further action now is necessary to avoid or reduce future risk and to better adapt to an emerging and very different future.

This Strategy will therefore align with the Council's current statutory roles and responsibilities to provide a focus for climate change in the region. It will be reviewed regularly as circumstances change, legislation is amended and policy develops in future.

1.2 Purpose and scope

The purpose of the Taranaki Regional Council's Climate Change Strategy is to:

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[6] Local Government New Zealand, 2018. *Local Government Position Statement on Climate Change.*

[7] Local Government New Zealand, 2017. *Local Government Leaders' Climate Change Declaration.*

[8] Local Government New Zealand records climate change actions of local government.

- provide an overarching document to align and coordinate climate change actions across the Council's responsibilities and operations;
- respond to and raise awareness of climate change throughout the community; and
- help coordinate collaboration and partnership between councils, central government and the community.

The Strategy is intended to provide regional leadership on climate change and a clear focus and strategic direction to the Taranaki Regional Council on its climate change intentions and priorities.

The scope of the Strategy are those actions that fall within the Taranaki Regional Council's current functions, responsibilities and spheres of influence in the Taranaki region. It will help set the platform for other plans and strategies that link with it.

1.3 Planning context

The strategy is a non-statutory document that is designed to complement national policy direction on the one hand and to complement other key statutory and non-statutory Council documents on the other. Community and iwi co-development and collaboration on climate change policy will be a key feature.

National policy direction comes from specific climate change legislation and related policy[9] and the many policy and technical guidance documents that exist at central government level.[10] At the regional level the key statutes that determine what the Council does and how it does it are the Local Government Act 2002, Resource Management Act 1991, Biosecurity Act 1993, Soil Conservation and Rivers Control Act 1941, Land Transport Management Act 2003, Maritime Transport Act 1994, and the Civil Defence Emergency Management Act 2002.

From these statutes come a range of statutory documents and related non-statutory strategies, operational plans and guidelines. These include the Long-Term Plan, Regional Policy Statement, regional plans, a pest management plan, biosecurity and biodiversity strategies, a Civil Defence Emergency Management Group Plan, a Regional Land Transport Plan, the Regional Public Transport Plan, a Walkways and Cycleways Strategy, asset management plans and an infrastructure strategy, among others.

In addition, there are documents that are prepared by other organisations that will influence what the Council does. Included among these are Iwi Management Plans, *Tapuae Roa: Make Way for Taranaki,* Strategy and Action Plan (the regional economic development strategy for Taranaki) and the *Taranaki 2050 Roadmap* (a plan to transition Taranaki to a low-emissions future).

The diagram contained in Appendix 1 shows the connections between the Climate Change Strategy and other key planning documents, as well as the main legislation under which the plans and strategies are produced. It illustrates how the Climate Change Strategy will act as coordinating and integrating mechanism on all climate change issues relevant to the Council.

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[9] This includes National Policy Statements prepared under the Resource Management Act which the Council is required to give effect to.

[10] See for example https://www.mfe.govt.nz/climate-change; https://www.mpi.govt.nz/protection-and-response/environment-and-natural-resources/climate-change-and-the-primary-industries/

2 Regional context

2.1 Greenhouse gas emissions in the Taranaki region

From the early 1990s until the end of that decade, the Taranaki Regional Council prepared annual inventories of greenhouse gas emissions by sector in the Taranaki region. The inventories were reported to the Taranaki Regional Council to keep the Council regularly informed and up-to-date on the status of greenhouse gas emissions in the region while central government worked on its national and international policy response to the issue.

The inventory reports identified the main sources and quantities of greenhouse gas emissions in the region and their relative contributions to the enhanced greenhouse effect. Typically, the reports found that the agricultural sector accounted for approximately 59.9% of total emissions, major industrial facilities 25.6%, and the transport sector 1.7%. Other sectors accounted for 12.8%.[11]

The Council ceased preparing the reports when the Government at that time decided that regional councils would have no role in greenhouse gas mitigation.[12]

The Government has since developed its own policy further and now collects detailed information on greenhouse gas emissions sources.[13] The Council should request that central government make available a regional breakdown of greenhouse gas emissions in the Taranaki region and what mitigation is occurring so that the Council can be kept informed, advocate to central government and show leadership on behalf of its community on climate change. It also makes the Government more transparent and accountable for its policy.

2.2 Climate change risks for Taranaki

Dealing with uncertainty

Projections of climate change and associated risks depend on many different factors, including future greenhouse gas emissions, technological advancements and societal expectations. There is ongoing uncertainty about future global processes and impacts and competing ideas about what should be done, who should do it and who should pay.

There are also limitations in the science and modelling used and the potential for poorly considered interventions to be made that have inequitable, inefficient or inappropriate or unintended economic, social, cultural and environmental consequences.

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[11] Taranaki Regional Council, 2000. *Emissions of Greenhouse gases in Taranaki. Annual report 1998-99.* Internal Report.

[12] See comment under 1.1 Background on Local Government's role in greenhouse gas mitigation

[13] See for example https://www.mfe.govt.nz/publications/climate-change/new-zealands-greenhouse-gas-inventory-1990-2017

All of these aspects involve uncertainty and risk. These risks include not only physical environmental risks associated with climate change, but also legal, insurance, financial and political risks.

The recommended approach for climate change planning and decision-making therefore, is one of risk management in the face of uncertainty. This will involve a dynamic adaptive pathways planning approach (DAPP) to future decision-making.[14]

Projected climate changes for Taranaki

Climate change trends for Taranaki are contained in a 2008 report by NIWA[15] commissioned by the four councils of the region, and more recently on the Ministry for the Environment's website[16].

According to the Ministry for the Environment, temperatures in Taranaki are likely to be 0.7 degrees Celsius to 1.1 degrees Celsius warmer by 2040 compared to 1995 and 3.1 degrees Celsius warmer by 2090. By 2090, Taranaki is projected to have from 5 to 41 extra days where maximum temperatures exceed 25 degrees Celsius. Frosts are likely to become increasing rare in Taranaki by 2090.

Rainfall will vary locally within the region. North Taranaki will become slightly wetter and South Taranaki will become slightly drier. The largest changes will be for particular seasons rather than annually with up to 9% more rainfall in New Plymouth over winter by 2090. According to the most recent projections, Taranaki is not expected to experience a significant change in the frequency of extreme rainy days as a result of climate change.[17]

The NIWA report projects an increase in drought risk with severe droughts projected to at least double by the 2080s under a 'medium-high' scenario in central and southern parts of Taranaki.

The frequency of extremely windy days in Taranaki by 2090 is not likely to change significantly. There may be an increase in westerly wind flow during winter, and north-easterly wind flow during summer.

Some increase in storm intensity, local wind extremes and thunderstorms are likely to occur but future changes in the frequency of storms are likely to be small compared to natural inter-annual variability. The NIWA report projects some higher intensity ex-tropical cyclones may produce larger storm impacts in Taranaki as the 21st century progresses, but maintains that how these cyclones affect New Zealand after they transition to ex-tropical cyclone status remains uncertain.

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[14] See Ministry for the Environment, 2017. *Preparing for coastal change. A summary of coastal hazards and climate change guidance for local government*, for a discussion of the dynamic adaptive pathways planning approach. The approach identifies ways forward (pathways) despite uncertainty, while remaining responsive to change (dynamic) should this be needed.

[15] NIWA, 2008. *Climate Trends, Hazards and Extremes – Taranaki. Synthesis Report.*

[16] https://www.mfe.govt.nz/climate-change/likely-impacts-of-climate-change/how-could-climate-change-affect-my-region/taranaki

[17] Ibid.

In terms of sea level rise, the Ministry for the Environment states that New Zealand tide records show an average rise in relative mean sea level of 1.7mm per year over the 20th century.[18] Globally, the rate of sea level rise has increased and further rise is expected in New Zealand in future. However, sea level rises are not uniform around the world and neither are they consistent around New Zealand's coastline.[19] In the Ministry for the Environment's *Our marine environment 2016* report, data on sea level rise at New Plymouth showed very large variations from year to year with current sea heights somewhat lower than 60 years ago and lower than other sites around New Zealand where long-term monitoring had taken place. Potential increases in storm surges may present a more significant risk in Taranaki.

For Taranaki, climate change impacts are not expected to be as severe as in some other regions of New Zealand.

Key climate change risks

Key climate change risks for Taranaki are as follows.[20]

- **Coastal hazards:** There could be increased risks to coastal roads and coastal communities and infrastructure from coastal erosion and inundation, increased storminess and sea-level rise, threatening vulnerable beaches and low-lying areas.
- **Erosion, landslides and flooding:** More frequent and intense heavy rainfall events are likely to increase the risk of erosion and landslides. Flooding is likely to become more frequent and severe.
- **Drought:** By 2090, the time spent in drought ranges from minimal change to more than double depending on the climate model and emissions scenario considered. More frequent droughts are likely to lead to water shortages, increased demand for irrigation and increased risk of wildfires, as well as increased animal stress, pasture decline and loss of agricultural production.
- **Disease:** Warmer winters may alleviate cold-related illnesses and reduce cold-related deaths, while hotter summers will likely cause heat stress and promote the spread of sub-tropical diseases and their vectors.
- **Biosecurity and biodiversity:** Warmer, wetter conditions could increase the risk of invasive pests and weeds over time. Climate change can adversely affect important ecosystems.
- **Agriculture:** Warmer temperatures, a longer growing season and fewer frosts could provide opportunities to grow new crops. Farmers might benefit from faster growth of pasture and better crop growing conditions and better (more prolonged) use of seasonally-based infrastructure. However, these benefits may be limited by the negative effects of climate change such as prolonged drought or greater frequency and intensity of

[18] Ibid.

[19] See Ministry for the Environment and Stats NZ, 2017. *Our atmosphere and climate 2017*, and Ministry for the Environment and Stats NZ, 2016. *Our marine environment 2016*.

[20] See https://www.mfe.govt.nz/climate-change/likely-impacts-of-climate-change/how-could-climate-change-affect-my-region/taranaki

storms. Competition for water resources may increase, and greater stock losses may be experienced as a result of more extreme events.

2.3 Taranaki Regional Council's current role in addressing climate change

The Taranaki Regional Council has a wide range of roles, responsibilities, functions and powers that relate to the climate change risks outlined above. While these various roles and responsibilities are prescribed by law and undertaken to achieve objectives other than climate change objectives, there are co-benefits for climate change in achieving them.

Some of these functions and responsibilities fall within the scope of mitigation (reduction) of greenhouse gas emissions while others fall within the scope of adaptation to climate change that is already happening. Other functions involve ongoing engagement, awareness and community support on climate change.

Reference has already been made in Section 1.3 (Planning context) to Appendix 1 that shows the linkages between the statutes, policies and plans that the Council works under and the Climate Change Strategy.

Expanding on these statutory responsibilities, the following lists the practical work that the Council undertakes in assisting climate change mitigation and adaptation objectives:

- **Resource management:** managing the effects of the use of freshwater, land, air and the coast through the Regional Policy Statement and regional plans and through the issuing of resource consents, compliance monitoring and enforcement, pollution incidents and response, water shortage management, state of the environment monitoring and resource investigations.
- **Sustainable land management and plant supply:** promoting riparian management and sustainable land use by promoting the fencing and planting of riparian margins and sustainable land use in the hill country through individual property plans and a plant supply programme. These programmes are seeing significant areas of land undergoing land use change to more sustainable uses such as forestry and reversion or planting of native species to address soil loss, land instability, river bank erosion and water quality enhancement.
- **Biosecurity:** regional pest management to minimise the adverse effects of pests on biodiversity, primary production, the regional economy and the environment.
- **Biodiversity:** maintaining and enhancing the indigenous biodiversity of the region.
- **Transport**: regional land transport planning and contracting public transport services across the region. This area of work provides an opportunity to promote alternatives to the use of private motor vehicles such as public transport and walking and cycling and the use of electric vehicles and buses.
- **Hazard management:** supporting within the Taranaki community, an integrated and comprehensive emergency management system including hazard awareness, reducing risk, maintaining readiness and providing response and recovery capabilities.
- **Flood protection and river control:** providing flood control advice, undertaking minor works and managing and maintaining river control schemes to minimise and prevent damage by floods and river erosion.

- **Recreation, culture and heritage:** supporting and developing regional gardens, Puke Ariki regional museum and library and Yarrow Stadium.
- **Regional representation, advocacy and investment management:** this area of work involves maintaining effective and open community representation as an important part of the democratic process; advocating on behalf of the Taranaki community on matters of regional interest; implementing and further developing a programme of information transfer, advice and education on the Council's activities and ensuring that the Council's equity, property and treasury investments are managed efficiently.

The ways in which the Council achieves these various roles takes a number of forms. The Council from time-to-time takes on the roles of an advocate, facilitator, or educator or can take a more direct role of a funder, service provider, monitor or regulator. In many cases the Council will be involved in more than one way in furthering its objectives within the community. This makes the Council well placed to further promote the community's climate change objectives but this must be done in a way that aligns with national policy direction, is consistent with the Council's statutory functions and takes into account community wishes and ability to pay.

3 A strategic approach

3.1 Principles and vision

The Council's Climate Change Strategy is guided by the following seven principles outlined in Local Government New Zealand's *Local Government Leaders' Climate Change Declaration*.[21]

- **Precaution:** act now to maximise co-benefits, reducing future risks and costs associated with climate change and minimise actions which hinder adaptation.
- **Stewardship/Kaitiakitanga:** flexible action and climate policies that enable all to do their bit to reduce emissions and enhance resilience.
- **Equity/justice:** prioritise action to the most vulnerable communities and sectors.
- **Anticipation:** anticipate change and take a long-term perspective, with a clear and consistent pathway to a low carbon future that will provide benefits and certainty for all.
- **Understanding;** grow understanding around the potential impacts of climate change and use the best available information and evidence in education, community consultation planning and decision-making.
- **Cooperation:** act together in partnership and build relationships across countries, communities, cultures and organisations.
- **Resilience:** enhance the resilience and readiness of communities and businesses so they can thrive in the face of change.

The following principles can be added to these.

[21] Op. cit.

- **Lawfulness:** act in accordance with the law as provided through legislation and regulation, including seeking amendment to lawful powers when appropriate and justified.
- **Effective:** avoid perverse outcomes and unintended consequences while being able to deliver the desired outcomes.
- **Efficient:** avoid duplication of roles, responsibilities and actions.
- **Robust:** ensure that any interventions can endure through financial and political cycles.

Applying these principles gives us the following overall strategic vision for the Taranaki Regional Council action on climate change:

> *The Taranaki Regional Council strengthens the ability and willingness of the Taranaki community to adapt to and thrive under climate change risks and opportunities through cooperation and coordination on climate change action consistent with its statutory functions.*

3.2 Objectives

Objectives are statements of a desired outcome. The Strategy has three core objectives that together span the range of areas that the Taranaki Regional Council will focus on to achieve its vision: mitigation, adaptation and community engagement and awareness.

Mitigation involves actions to reduce greenhouse gases in the atmosphere whereas adaptation is responding to the changes we are already seeing and will continue to see, even with reductions in future emissions of greenhouse gases. Community engagement and awareness of both mitigation and adaptation solutions encourages businesses, communities and individuals to adjust their behaviour in ways that reduce emissions and improve resilience.

Mitigation

The overarching objective to relation to mitigation is that:

> *Greenhouse gas emissions are reduced across all Taranaki Regional Council areas of influence, including its own operations, helping to create the conditions for a transition to a smart, innovative, low-carbon regional economy.*

Adaptation

The overarching objective in relation to adaptation is that:

> *Risks from climate-change related impacts are managed and resilience is increased through the application of sound and consistent adaptation planning based on best scientific information.*

Community engagement and awareness

The overarching objective in relation to community engagement and awareness is that:

> *Community awareness of climate change mitigation and adaptation solutions increases and individuals and organisations are better informed about what they can do to contribute to the transition to a low-carbon regional economy.*

3.3 Policies and actions

A policy means a specific statement that guides or directs decision-making. It indicates a commitment to a course of action in working towards an objective.

An action on the other hand, means a specific programme, procedure, technique or action to carry out a policy.

In line with the purpose and scope of this Climate Change Strategy (section 1.2), and consistent with the above objectives, the Taranaki Regional Council's policies and actions on climate change focus on the following two broad areas:

1. Those policies and actions that are **internal** to the organisation; and
2. Those policies and actions that are **external** to the organisation.

Policies and actions that are internal to the organisation are those that focus on building the Council's knowledge, capacity and capability on climate change and which ensure climate change mitigation and adaptation are factored into the Council's internal decision-making processes. This is the Council leading by example.

Policies and actions that are external to the organisation are those that focus on the work we do in the region, engaging with our communities and raising awareness of climate change. This is the Council requiring or encouraging others to take action that will have benefits for climate change.

Presenting the policies and actions in this way enables the translation of the vision and objectives into practical day-to-day initiatives or actions that the Taranaki Regional Council will pursue or consider.

3.4 Implementation

Implementing and resourcing the Action Plan will require careful consideration. Many of the actions proposed reflect the Council's current statutory responsibilities, which are carried out for reasons other than climate change or make good financial sense to do anyway. There are many co-benefits for climate change management and response in undertaking them.

However, if the Council was to significantly expand its existing programmes or introduce new programmes for climate change, the added costs and obligations would fall on the ratepayers of the region, while the Council would still be required to meet the prudent financial and other obligations under the Local Government Act 2002. In many cases, central government funding or funding from other sources would be required to reduce the financial burden on ratepayers.

Adequate and equitable funding to successfully implement the Strategy in the medium to long-term is of fundamental importance.

4 An Action Plan

The policies and associated actions set out in Table 1, constitute the Action Plan under the Taranaki Regional Council's Climate Change Strategy.

5 Review of the Strategy

The Taranaki Regional Council's Climate Change Strategy is a living document. It will be subject to periodic review and will be changed if required. This will provide an opportunity to review progress and to set new or different goals for the Council. [22]

Climate change is an area where ongoing change, not only in the environment but also in our understanding of climate change and how we need to respond to it, will be the norm. It is important that the Council continues with actions that it can manage, that we do not place an unreasonable and unsustainable burden on ratepayers and that we are still able to deliver to the community on the Council's many other roles and responsibilities.

We agree with central government that we must all focus on a 'just transition' where everyone will be enabled to adjust to the new demands being placed on us by a changing climate. This will require agility in the face of uncertainty and a commitment to work together over the long term.

[22] Important triggers for review will include improvements in our knowledge and understanding of climate change, market changes such as in the financing and insurance industries, regulatory change, significant and more frequent extreme events, risks of litigation and public expectations.

Table 1 Taranaki Regional Council Climate Change Strategy: Policies and actions

Internal policies and actions

Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
1. Better understand our carbon footprint as a basis for future action		• Undertake a baseline audit to establish the Council's current carbon footprint and mitigation options	• Consider adopting a net zero carbon target for the Council with timelines and interim carbon reduction targets • Explore all carbon mitigation options for offsetting organisational emissions including tree planting on Council land, land purchase for tree planting and other carbon sinks • Develop a monitoring and reporting system to track progress and inform further action	Mitigation
2. Ensure appropriate and explicit consideration of	• Climate change is recognised in the Council's own internal strategy and planning documents	• Undertake a review of the Council's legal obligations and	• Long-Term plans, Annual Plans and other internal documents are changed to reflect changes in	Mitigation and adaptation

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Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
climate change in the Council's Long-Term Plans, Annual Plans and other internal procedure documents and guidelines	but these will need to be reviewed to ensure climate change is appropriately, robustly and visibly factored into Council decision making	potential liabilities with respect to climate change • Include appropriate climate change policies and actions in the Council's Long-Term Plan and Annual Plans to ensure climate change is considered in all aspects of Council decision making • Review all internal procedures documents, guidelines and templates for Council papers, reports and project plans to ensure appropriate consideration of climate change • Review the Council's current investment portfolio to ensure consistency with climate change objectives • Ensure robust climate change information and science is available to support decisions • Increase the visibility of the Council's climate change work, for example by providing annual updates on key matters	climate change law, policy, science and information	

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Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
3. Reduce our carbon footprint by reducing emissions from : - vehicle usage and corporate travel - waste generation and disposal - energy and electricity use - purchasing and procurement and - general administration	• Continue policy on car pooling • A review of vehicle needs and potential for EVs has been completed • Maintain the Council's Sustainability Group. Waste minimisation, reuse and recycling programmes introduced. Biennial waste audits carried out. Other appropriate initiatives identifed by staff • Reviews into lighting and heating carried out. New energy efficient lighting installed. Lighting, heating and cooling systems to be reviewed as part of accommodation review in 2019/2020	• Review vehicle fleet needs and opportunities for increased fuel efficiency and conversion to EVs as costs and technology allow • Review corporate travel including limits on travel, no-travel options (e.g. web-based meetings), use of offsetting and use of accommodation with complementary environmental policies • Review purchasing and procurement policy to include specific climate change objectives • Review general administrative policies to ensure carbon footprint is reduced as far as possible (e.g. through reviewing use of printers) • Add specific climate change objectives to work of Sustainability Group	• Consider advancements in technology and costs associated with EVs, solar panels, lighting, heating and cooling, and smart technology in all aspects of the Council's work and consider investment in technology taking a whole of life view	Mitigation
4. Staff actively support a low carbon workplace, lifestyle	• Continue with current initiatives (see 3 above)	• Consider implemeting a comprehensive travel plan for staff travelling to work	• Investigate incentives for staff to undertake low carbon actions	Mitigation and adaptation

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Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
and economy and have the capability and capacity to deliver on the Council's climate change goals		• Increase climate change awareness throughout the Council (e.g. through regular Intranet postings and a new climate change webpage on the TRC website) • Develop an education or information pack for staff use (e.g. as part of Council induction) • Ensure staff actively contribute to national and regional direction on climate change through for example, membership of regional and national working groups that drive climate change • Review staff recruitment, training and individual job descriptions, and development programmes to ensure staff have the skills required or have opportunities to learn about and apply new skills and planning techniques relevant to climate change		
5. Establish appropriate governance		• Consider what, if any, changes might be required to the terms of	• Review organisational structure	

Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
arrangements for climate change		reference for Council committees in relation to climate change • Consider the establishment of a senior management position with responsibilities for climate change priortities within the Council • Consider 'low carbon champions' for each department of the Council		

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External policies and actions

<table>
<tr><th rowspan="2">Policies</th><th colspan="3">Actions</th><th rowspan="2">Mitigation, adaption or community engagement</th></tr>
<tr><th>Existing, underway or planned</th><th>Within the next 5 years</th><th>5 years and beyond</th></tr>
<tr><td>6. Progress climate change mitigation and adaptation through existing work programmes</td><td>• Continue all existing work programmes recognising the benefits for climate change mitigation and adaptation, undertake planned or scheduled reviews of policies and stratagies and incorporate explicit and appropriate climate change objectives and policies into existing work programmes
• Include climate change pressure, state and response in the Council's 2020/21 state of the environment report</td><td>• Finalise the Proposed Coastal Plan making appropriate provision for sea level rise, storm surge and other climate induced hazards
• Review the Regional Policy Statement for Taranaki and consider the need for updated climate change policies
• Prepare a Natural Resources Plan with rules and other methods to address climate change issues that are within the Council's jurisdiction
• Review and adapt the Council's Riparian Management Programme, Sustainable Land Management Programme, Biodiversity Programme, biosecurity programmes, wetlands restoration and environmental enhancement grants programme, as necessary and appropriate, to further support mitigation and adaptation to the effects of climate change</td><td>• Investigate the risk of increasing pest numbers and species and effects on work programmes and resources
• Investigate the use of electric buses or low-carbon or alternative fuels on the region's contracted bus services
• Respond to changes in climate change law and policy and amend work programmes as appropriate</td><td>Mitigation, adaptation and community engagement</td></tr>
</table>

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Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
		• Review the current contracted bus fleet and prepare a transport emissions report • Investigate the potential for existing contracted bus services and new public transport technologies to reduce carbon emissions • Consider initiatives for walking and cycling, car pooling and ride sharing, new public transport services, and greater use of rail • Consider the implications of flood risk induced by climate change, on the Council's flood protection schemes and on other river and flood control works in the region • Work through the Regional Solid Waste Management Committee to continually improve waste practices, reduce the generation of waste and increase recycling • Ensure climate change is appropriately considered in the Civil Defence Emergency		

Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
		Management Group Plan for Taranaki • Consider opportunites and priorities for undertaking climate change related research, resource investigations and projects (e.g. update of the Renewable Energy Assessment for the Taranaki region, 2006, or research into the role of soil as a carbon sink at a farm scale in Taranaki) • Work with the Board of Port Taranaki Ltd to align their programmes for reducing emissions with those of the Council		
7. Develop an integrated, coordinated regional response to climate change	• Continue to work through the Mayoral Forum to discuss and develop a regional response to climate change • Continue to promote implementation of the Taranaki 2050 Roadmap and Tapuae Roa • Continue to engage with and advocate to central government	• Develop a region-wide emissions inventory • Undertake an initial region-wide climate change risk assessment based on community and ecological vulnerabilities • Develop region-wide emissions reduction targets	• Prepare climate change policies, plans and strategies in accordanace with central government policy	Mitigation, adaptation and community engagement

Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
	to develop coherent, effective and appropriate national policy on climate change • Continue to work with other agencies to promote resource use and development that is integrated with transport, infrastructure and with well-designed, compact regional form			
8. Work with other agencies to identify and obtain key information relating to climate change and associated risks	• Support region-specific research into climate change impacts and implications where it relates to Council roles and responsibilities and where knowledge gaps exist • Request central government make available a breakdown of greenhouse gas emissions in the Taranaki region and what mitigation is occurring • Share any information and knowledge obtained with the regional community	• Contract appropriate agencies to update climate change projections and risks for the region	• Develop an ongoing climate change monitoring programme to help assess regional climate change threats and vulnerabilites and report the results to the community	Mitigation, adaptation and community engagement

Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
9. Raise awareness of climate change and build an engaged and resilient regional community	• Continue to advocate on behalf of the regional community for action on climate change • Continue to publicise and celebrate climate change and resilience success stories in the region to inspire positive behaviour change • Continue to involve the regional community in decisions on climate change that affect them • Develop and maintain an on-line portal that will allow hill country farmers to access from one site, information on the benefits, costs and returns on investment from planting more trees on hill country properties	• Investigate with others, practical community initiatives to build community understanding of and resilience to climate change (e.g. through Curious Minds projects, Enviroschools initiatives and Envirolink and other projects) • Develop in conjunction with iwi and hapū, specific options of relevance to tangata whenua, for reducing greenhouse gas emissions or adapting to the effects of climate change • Publish up-to-date information on greenhouse gas emissions in the Taranaki region and what mitigatioin is occurring (see action under Policy 7 above) • Identify successful local government examples of adaptation actions and evaluate their suitability for addressing climate risks in the Taranaki region and make the results available to the community	• Develop an on-line platform to serve as an information repository and as a means to connect with the community on climate change responses regionally and nationally	Community engagement, mitigation and adaptation

Policies	Actions			Mitigation, adaption or community engagement
	Existing, underway or planned	Within the next 5 years	5 years and beyond	
		• Encourage and support communities to make their own contributions to combating climate change • Take an active leadership role in fostering public debate and awareness through public fora and other events		

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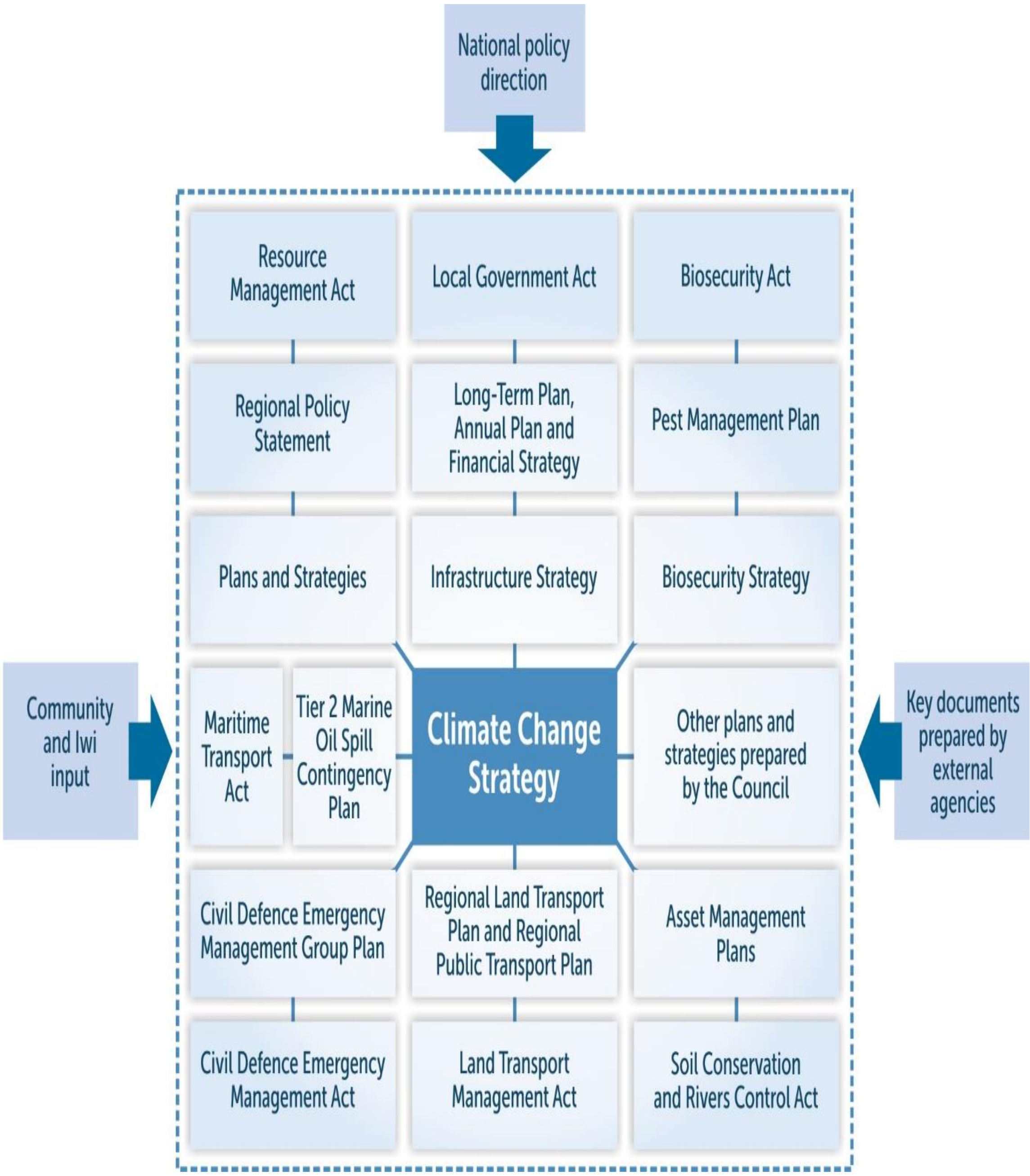
Appendix 1
The relationship between the Taranaki Regional Council's Climate Change Strategy and other key regional planning documents



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Taranaki Regional Council

AGENDA Policy & Planning

Whakataka te hau

Karakia to open and close meetings

Whakataka te hau ki te uru	Cease the winds from the west
Whakataka te hau ki tonga	Cease the winds from the south
Kia mākinakina ki uta	Let the breeze blow over the land
Kia mātaratara ki tai	Let the breeze blow over the ocean
Kia hī ake ana te atakura	Let the red-tipped dawn come with a sharpened air
He tio, he huka, he hauhu	A touch of frost, a promise of glorious day
Tūturu o whiti whakamaua kia tina.	Let there be certainty
Tina!	Secure it!
Hui ē! Tāiki ē!	Draw together! Affirm!

Nau mai e ngā hua

Karakia for kai

Nau mai e ngā hua	Welcome the gifts of food
o te wao	from the sacred forests
o te ngakina	from the cultivated gardens
o te wai tai	from the sea
o te wai Māori	from the fresh waters
Nā Tāne	The food of Tāne
Nā Rongo	of Rongo
Nā Tangaroa	of Tangaroa
Nā Maru	of Maru
Ko Ranginui e tū iho nei	I acknowledge Ranginui above and
Ko Papatūānuku e takoto ake nei	Papatūānuku below
Tūturu o whiti whakamaua kia	Let there be certainty
tina	Secure it!
Tina! Hui e! Taiki e!	Draw together! Affirm!