



AGENDA

Policy & Planning

Tuesday 29 April 2025 10.30am

Policy and Planning Committee

29 April 2025 10:30 AM



Agenda Topic	Page
1. Cover	1
2. Health and Safety message	3
3. Apologies	
4. Confirmation of Policy and Planning Minutes - 18 March 2025	4
5. Freshwater Implementation Update	10
6. Setting Lake Level and Take Limits	14
7. Source Water Management Areas	22
8. Submission on Wastewater Environmental Performance Standards	31
9. Dairy Effluent Management – phase out options	40
10. Emissions Reduction Roadmap	49
11. Our environment 2025 - Tō tātou taiao report	73
12. Replacement of the Resource Management Act	220
13. Karakia to close meeting	229
14. Agenda Authorisation	230



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 43 Cloten Road. 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.



Date: 18 March 2024

Subject: Policy and Planning Committee Minutes – 4 February 2025

Author: M Jones, Governance Administrator

Approved by: A D McLay, Director - Resource Management

Document: TRCID-1492626864-461

Recommendations

That 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, Stratford on Tuesday 4 February 2025
- b) notes the recommendations therein were adopted by the Taranaki Regional Council on Tuesday 18 February 2025

Appendices/Attachments

TRCID-1492626864-248: [Policy and Planning Committee Minutes – 4 February 2025](#)



Date:	18 March 2025	
Venue:	Taranaki Regional Council Boardroom, 47 Cloten Road, Stratford	
Document:	TRCID-1492626864-499	
Present:	C S Williamson	Chairperson
	S W Hughes	
	B J Bigham	zoom
	D M Cram	
	C L Littlewood	zoom (joined meeting at 10.36am)
	N W Walker	ex officio
	D H McIntyre	
	A L Jamieson	
	C Filbee	South Taranaki District Council - zoom
	M Ritai	Iwi Representative
	E Bailey	Iwi Representative - zoom
	P Moeahu	Iwi Representative
	B Haque	New Plymouth District Council
	G Boyde	Stratford District Council
Attending:	S J Ruru	Chief Executive
	A D McLay	Director – Resource Management
	M J Nield	Director – Corporate Services
	A J Matthews	Director – Environment Quality
	D Harrison	Director - Operations
	F Kiddle	Strategy lead
	L Hawkins	Policy Manager
	V McKay	Manager – Environmental Assurance
	M Jones	Governance Administrator
	B Zieltjes	Team Leader – Freshwater and Coastal
	A Northayati	Scientist - Freshwater
	T Gordon	Programme Manager - Freshwater
	J Harvey	Climate Change Coordinator (joined meeting at 11.53am)
	C Woollin	Communications Advisor

One media representative present, joined the meeting at 10.44am.

The meeting opened at 10.30am.

1. Confirmation of Minutes Policy and Planning 4 February 2025

Resolved

That the Taranaki Regional Council:

- a) took as read and confirmed the minutes of the Policy and Planning Committee of the Taranaki Regional Council held on 4 February 2025 at Taranaki Regional Council 47 Cloten Road Stratford
- b) noted the recommendations therein were adopted by the Taranaki Regional Council on Tuesday 18 February 2025.

Boyde/Walker

2. Mana Whenua Engagement Strategic Priorities

- 2.1 S Ruru gave an overview of Mana Whenua engagement for 2025 outlining the key strategic priorities for Taranaki Regional Council.

Resolved

That the Taranaki Regional Council:

- a) received the memorandum titled *Mana whenua engagement strategic priorities*
- b) noted the extensive obligations on Council to provide for mana whenua participation in Council decision-making
- c) noted that the confluence of the Maunga Redress Act, Ngāti Maru JMA, Waitara River Committee, Maniapoto relationship agreement and RMA replacement presents a key strategic opportunity to deepen our partnership with mana whenua and deliver better services for the communities of Taranaki
- d) approved the following strategic priorities for mana whenua engagement over the 2025 calendar year:
 - advancing the Ngāti Maru joint management agreement
 - advancing the establishment of the Waitara River Committee
 - advancing the Maniapoto relationship agreement
 - engaging with Te Tōpuni Kōkōurangi and Te Tōpuni Ngārahu to operationalise provisions in the Maunga Redress Act and explore broader opportunities
 - engaging with iwi and the three district councils to explore governance arrangements for the RMA replacement and development of a potential combined plan that gives effect to existing Treaty settlements
 - continuing to work closely with iwi in the development of the Land and Freshwater Plan and the future of our freshwater science and policy work
- e) determined that this decision be recognised as not significant in terms of section 76 of the Local Government Act 2002
- f) determined that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determined that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Hughes/Cram

3. Government Reform Strategic Priorities

- 3.1 S Ruru set out the landscape of Government reform over 2025, particularly the key strategic priorities for Taranaki Regional Council.

Resolved

That the Taranaki Regional Council:

- a) received the memorandum titled *Government reform strategic priorities*
- b) noted that prioritisation of Council engagement with Government on reform proposals is needed to ensure our limited resources are focused on those proposals that will have the largest impact on Council operations and Taranaki communities
- c) approved the following strategic priorities for Government reform engagement over the 2025 calendar year:
 - national direction proposals under the Resource Management Act 1991, giving priority to freshwater related matters
 - the proposed replacement of the Resource Management Act 1991
 - local government reforms
 - climate change adaptation legislation.
 - directs Council officers to engage with Te Uru Kahika and the three Taranaki territorial authorities to coordinate engagement on the strategic priorities identified above
 - notes Council officers will maintain a watching brief on the proposed Regulatory Standards Bill and any legislation to give effect to the NZ First coalition agreement to review references to the principles of the Treaty of Waitangi in legislation
- d) noted Council will continue to engage on other reform proposals as resources allow and that other groups such as Te Uru Kahika, Taituara and Local Government NZ will likely develop and lodge submissions on behalf of their members
- e) determined that this decision be recognised as not significant in terms of section 76 of the Local Government Act 2002
- f) determined that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determined that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Walker/McIntyre

4. Freshwater Implementation March Update

- 4.1 L Hawkins provided a freshwater Implementation update for February 2025.
- 4.2 Councillor Biggam noted a conflict of interest due to her role with Taumata Arawai.

Resolved

That the Taranaki Regional Council:

- a) received the March 2025 update on the Freshwater Implementation Programme.

Boyde/Walker

5. Land And Freshwater Plan Programme Review

5.1 L Hawkins provided an overview of the programme for development of the Land and Freshwater Plan.

Resolved

That the Taranaki Regional Council:

- a) received the memorandum titled *Land and Freshwater Plan Programme review*
- b) noted that the existing programme endorsed by the Committee in March 2024 is no longer able to be achieved due to the changes in legislation made in October 2024, which prevents councils notifying a freshwater planning instrument before either a new National Policy Statement Freshwater Management in place or 31 December 2025, whichever is sooner
- c) endorsed the approach to pause work on identified National Objectives Framework attributes identified in this memorandum, and to revisit upon further government direction becoming available
- d) endorsed option 1b – continue the development of the Land and Freshwater Plan and associated updates to the Regional Policy Statement so that the programme is ready for Clause 3 consultation in March 2026 in relation to the programme timeline
- e) directed staff to consider any updates provided by the government on the future National Policy Statement Freshwater Management and request appropriate reporting to the committee, including consideration of any necessary changes to the programme in accordance with resolution made above in c
- f) endorsed Option 2a – workshops will be held within Committee and Council meetings and in doing so endorses the Land and Freshwater Plan Governing Style Protocol in relation to engagement with the Policy and Planning Committee and Council on the development of the Land and Freshwater Plan
- g) determined that this decision be recognised as not significant in terms of section 76 of the Local Government Act 2002
- h) determined that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determined that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Bailey/Cram

6. Estimated Reference Condition of Taranaki Lakes

6.1 A Northayati provided an overview of Cawthron Institute's report Estimated reference condition and paleolimnological analysis of Taranaki lakes.

Resolved

That the Taranaki Regional Council:

- a) received the report titled Estimated Reference Condition of Taranaki Lakes
- b) noted the findings therein.

Boyde/Jamieson

7. Te Ura Kahika Adaptation Programme

- 7.1 A Matthews provided an overview of the climate change adaptation work programme co-ordinated across the regional sector by Te Ura Kahika.

Resolved

That the Taranaki Regional Council:

- a) received the memorandum titled *Te Uru Kahika climate adaptation programme*
- b) noted that Te Uru Kahika has established a Climate Adaptation Programme Action Plan to support the sector.

Williamson/Walker

8. Climate Change Strategy Review

- 8.1 A Matthews proposed an approach for a new climate change strategy seeking the endorsement of the committee.

Resolved

That the Taranaki Regional Council:

- a) received the memorandum titled climate change strategy review
- b) noted that the current climate change strategy has been reviewed, and the new climate change strategy will be drafted following completion of the organisational climate change risk assessment
- c) endorsed the proposed approach for drafting the new climate change strategy
- d) determined that this decision be recognised as not significant in terms of section 76 of the Local Government Act 2002
- e) determined that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determined that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Cram/Jamieson

There being no further business the Committee Chairperson, C S Williamson, declared the meeting of the Policy and Planning Committee closed at 12.10pm.

Policy and Planning

Committee Chairperson: _____

C S Williamson



Date: 29 April 2025

Subject: Freshwater Implementation April Update

Author: L Hawkins, Policy Manager

Approved by: A D McLay, Director - Resource Management

Document: TRCID-1492626864-585

Purpose

1. The purpose of this memorandum is to provide a Freshwater Implementation project update.

Executive summary

2. Set out in this memorandum is an update on the progress of implementing the freshwater package from central government. The memorandum focusses on the key tasks undertaken since the previous Committee meeting, and identifies risk associated with the project and achievement of the project timeframes.
3. The attached report focusses on the key streams of work associated with the freshwater package. This being policy development, implementation of Freshwater Farm Plans, and the communications and engagement timeline.

Recommendation

That the Taranaki Regional Council:

- a) receives the April 2025 update of Freshwater Implementation Programme.

Background

4. This memorandum updates on progress in implementing the Freshwater Package. An updated programme of works was presented to the committee in March 2025 and was approved by the Committee. This report provides an overview on the progress of the work programme, specifically focusing on the previous 6 weeks and those ahead. It provides an opportunity for discussions relating to progress and risks identified.

Discussion

5. The attached report (attachment 1) provides a high level overview of the progress made since the last Committee meeting in March 2025, and identifies those tasks to be undertaken in the coming 6 weeks. It also identifies risks associated with the programme, and a copy of the high level engagement strategy.

6. Key discussion points are included in the covering memorandum to draw attention to key areas of work.

Government Direction

7. Since the previous meeting the government has made a number of announcements as it relates to the development of the resource management reform and ultimately the replacement of the Resource Management Act 1991. The detail of these announcements is set out in a separate memorandum for the Committee however, there are some key points that are specifically relevant to freshwater. The release of a new National Policy Statement for Freshwater Discussion document was expected in the first quarter of 2025. Despite the government signaling the pause of a number of areas of national direction, until the new system has been set up, the government has committed to releasing a discussion document for Freshwater direction by the middle of June. There has been some commitment from the government that this consultation will include direction on 're-balancing' Te Mana o Te Wai, water storage and vegetable growing. We also expect that as part of this consultation the government will seek direction on whether they should continue with the body of work relating to freshwater, or whether this should also be paused along with other national direction and the implementation of the new system. Unfortunately uncertainty remains, however there are a number of areas that staff can continue to progress investigations and development of policy options whilst we await further information from the government.

Ongoing policy drafting and engagement

8. At the March 2025 meeting the Committee endorsed an updated programme, supporting staff to continue to work on the development of the draft Land and Freshwater Plan and to work towards Clause 3 notification in March 2026. Progress has continued to be made in developing policy options and drafting sections of the Plan. In particular, and subject to separate papers on the Committee Agenda, is work on developing a suitable framework for managing drinking source water, the phaseout of dairy effluent discharges to water, and an approach to managing lake levels and limits.
9. Further staff have been working closely with, and seeking input and guidance from, the Ngā iwi o Taranaki Freshwater Pou Taiao position on the drafting and general approach of a number of topics including those previously mentioned. Staff have also undertaken an in-depth hui with iwi pou taiao on the framework to manage wetlands. Feedback from this session was still being worked through at the time of preparing this memorandum, but an update will be brought to the Committee for their input at a future meeting.

Freshwater Farm Plans

10. Since the last meeting of the Committee no further updates to direction on Freshwater Farm Plans have been received from the government. However, we do understand an announcement on the regulations will be made soon by the government. Understanding the role of the Freshwater Farm Planning system will be critical to framing key components of the Land and Freshwater Plan.

Appendices/Attachments

TRCID-1492626834-586: [Freshwater Implementation Progress Report April 2025](#)

<h2 style="text-align: center;">Freshwater Implementation Project Report to Policy & Planning Committee</h2> <p style="text-align: center;">April 2025</p>			
	Progress in the last six weeks	Key tasks in the coming six weeks	Risks
National Policy Statement for Freshwater Management	<ul style="list-style-type: none"> Developing draft policy and objectives ready for refinement against expected new NPS-FM direction. Respond to the Wastewater Environmental Performance Standards – consultation closes 24 April 2025 Meetings with Nga iwi o Taranaki Pou Taiao re key policy directions – topics including Source water risk management areas, earthworks, regionally significant wetlands, managing over allocation. Meetings with iwi Pou Taiao re key policy directions – topics including Source water risk management areas, regionally significant wetlands <ul style="list-style-type: none"> Ongoing discussion Meetings with key stakeholder groups to refine policy direction. Progress Science programme: <ul style="list-style-type: none"> Continue existing attribute work 	<ul style="list-style-type: none"> Developing draft policy and objectives ready for refinement against expected new NPS-FM direction Expecting national direction to land in the next 6 weeks – will work on reviewing and responding – expecting consultation before the end of June. Meetings with Nga iwi o Taranaki Pou Taiao re key policy directions – topics including earthworks, contaminated land, water allocation (including over-allocation), beds and structures chapter. Meetings with iwi Pou Taiao re key policy directions – topics including earthworks, water allocation framework and likely ongoing regionally significant wetlands discussions Ongoing discussion Meetings with key stakeholder groups to refine policy direction. Progress Science programme: 	<ul style="list-style-type: none"> Medium risk – Partnership with iwi. Risk that the timeframes, complexity of issues and the need to be working in an agile manner to develop the policy framework will impact on the partnership approach being fostered. Amendments to the Pou Taiao Agreement including the setting up of a steering committee to mitigate this risk. Opportunity to consider amendment to programme to providing more time and opportunity to work through policy drafting. Continue to present progress to the Wai Steering Committee. <i>Also note that the next 6 weeks will likely be focused on central govt direction will also be relevant for iwi.</i> Medium risk – participation in the community engagement is low. Mitigated through continued promotion of process, community meetings switched to being held at various locations, targeted engagement with industry groups to lessen the load on individuals.

	<ul style="list-style-type: none"> ○ Finalise advice of lake levels and allocation framework 	<ul style="list-style-type: none"> ○ Continue existing attribute work 	<ul style="list-style-type: none"> • High risk –change to direction of the NPSFM with the new government. We can mitigate against this risk by maintaining momentum on policy development, keeping abreast of policy announcements from the government, and taking pause when necessary to confirm approach as policy guidance from the government develops.
Freshwater Farm Plans	<ul style="list-style-type: none"> • Status quo – as we await further direction from the Government on likely changes to the Regulations etc. 	<ul style="list-style-type: none"> • Status quo – as we await further direction from the Government on likely changes to the Regulations etc. 	<ul style="list-style-type: none"> • Low risk – potential change to direction of FWFP regulations with the new government. The government has signalled the continuation of the FWFP process and Councils should expect an order in council, as such this is a low risk. The continuation of the programme will mitigate against any pressure to respond to an OIC when released.



Date: 29 April 2025
Subject: Setting Lake Level and Take Limits
Author: L Hawkins, Policy Manager
Approved by: A D McLay, Director - Resource Management
Document: TRCID-1492626864-614

Purpose

1. The purpose of this memorandum is to seek the Committee's support of a preferred framework for managing water quantity in lakes.

Executive Summary

2. Managing water quantity (including in lakes) is one of Taranaki Regional Council's functions under the Resource Management Act 1991 (RMA). The current Regional Freshwater Plan (RWFP) allows the take and use of water from lakes as a permitted activity (up to specified volume and rate limits) and, above those limits, as a consented activity, but there is little guidance on managing the impacts of fluctuations in lakes levels. Further, there is no differentiation between natural lakes and artificial reservoirs created for storage.
3. There is little information about water quantity in Taranaki lakes or its use. There are 23 consents to take water from lakes however, all of these consents relate to man-made lakes constructed by damming rivers or as off-stream storage. This paper outlines the options considered, and proposes a pragmatic framework for managing water in lakes that reflects the different types of lakes in Taranaki and their use.

Recommendations

That Taranaki Regional Council:

- a) receives the memorandum titled – Setting take levels and take limits
- b) supports the recommended approach to managing the quantity of water in lakes set out in this paper
- c) notes that staff will engage with iwi Pou Taiao as part of the next phase of work, including discussions with the Wai Steering Group
- d) determines that this decision be recognised as not significant in terms of section 76 of the Local Government Act 2002
- e) determines that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

Statutory requirements

4. Under the Resource Management Act 1991 (RMA), regional councils are responsible for controlling the quantity, level, and flow of water in any water body (including lakes), including by setting any maximum or minimum levels or flows of water, and controlling the range, or rate of change, or levels or flows of water.¹ This is reiterated in the National Policy Statement for Freshwater Management 2020 (NPSFM) which requires regional councils to set environmental flows and levels, and take limits, for water bodies (including lakes).²
5. The Government has announced plans to replace the RMA with two Acts: a Planning Act and a Natural Environment Act. Under the latter, regional councils will continue to be responsible for managing fresh water and for developing environmental limits to protect the natural environment, including for fresh water.

Current approach in Taranaki

6. The Regional Freshwater Plan for Taranaki 2001 (RFP) manages the taking and use of surface water. It sets out that freshwater ecosystems can be significantly affected by changes in water quantity, as reduced flows or water levels can lead to a reduction in water depth, velocity, wetted area and waste dilution capacity, all of which can affect aquatic ecosystems.³
7. The RFP sets out objectives, policies, and rules to address this issue, such as setting minimum flows for some rivers. There are currently no minimum or maximum levels, or allocation limits, prescribed in the RFP for lakes. The taking and use of surface water (including from lakes) is permitted up to a volume of 50 cubic metres per day per certificate of title, and a rate of take of 1.5 litres per second (except for temporary takes where the rate of take may be up to 5 litres per second for no more than 30 minutes).⁴ The permitted activity rule also includes a condition about how much of the instantaneous flow can be taken, which does not apply to lakes.
8. The taking and use of surface water above the permitted activity thresholds is a discretionary activity, unless it is from a catchment identified in Policy 6.1.1 where the taking and use of water is prohibited. A review of the topographical maps of these catchments as contained in the RFP did not identify any lakes that would be subject to the prohibited activity rule.

Issues

9. The key issues are:
 - a. There is no existing framework in Taranaki for managing the quantity of water in lakes
 - b. There is little to no information on the levels and quantity of water in lakes.

Discussion

10. A technical memorandum by Council's science team provides advice on the setting of levels and take limits for lakes. This includes a collation of existing information on lakes and associated water use in the

¹ Section 30(1)(e), RMA.

² Clause 3.16, NPSFM.

³ Section 6.1, Regional Freshwater Plan for Taranaki.

⁴ Rule 15, Regional Freshwater Plan for Taranaki

region to determine whether the development of regional limits on lake levels and abstraction would be appropriate and included future considerations and recommendations for policy development.

11. The technical advice is summarised in the following sections:

- a. An overview of lakes in Taranaki
- b. Current takes from lakes
- c. Considerations for policy development.

Overview of lakes in the region

12. The technical advice primarily relies on the Freshwater Ecosystems New Zealand (FENZ) geo-database, which provides information on lakes with an open water area of at least one hectare in size. The most recent update to this geo-database was in 2024. There are currently 94 lakes listed in the Taranaki region. More than three quarters of the lakes in the region are small lakes classified as having an open water area of between one and five hectares. Only two lakes are recorded as having an open water area of greater than 30 hectares.
13. In addition, there are a number of lakes in the region with an open water area of less than one hectare which are not identified by FENZ, but still fall within the broad definition of 'lake' under the RMA.⁵ These water bodies are more likely to be classified as wetlands rather than lakes where they are naturally occurring, and the provisions of the National Environmental Standards for Freshwater (NES-F) would prevail over any regional rules. The provisions of the NES-F would not apply to small man-made lakes or reservoirs, of which there are many in the region.
14. Spatially, the majority of lakes in Taranaki are within the southern area of the region, with approximately two thirds located within the Southern Hill Country and Coastal Terrace FMUs. Of the remaining lakes, two-thirds are in the Volcanic Ringplain FMU, and the remaining FMUs contain just a handful of lakes.
15. There are a variety of types of lakes found in the region however, not all lakes recorded in FENZ have been classified by geomorphic class. [Table 1](#) below sets out the geomorphic classifications included in the 2024 FENZ update, and the number of lakes and total water area attributed to each classification. While there are a range of artificial lake classifications identified, a total of 50 lakes include artificial as part of their classification, leaving only 44 identified natural lakes in the region.

Table 1: Number of lakes and total area of water per geomorphic classification

Geomorphic classification	Number of lakes	Total lake area (ha)
AC - Artificial - Constructed	7	17.1
AD - Artificial - Dam / reservoir	36	671.5 (549 ha is Lake Rotorangi)
(A)D - Artificial - Dam / reservoir*	1	2.5
ADR - Artificial - Dam + Riverine	3	8.6
AM - Artificial - Mine	2	4.9
L - Landslide	14	84.7
P - Phytogenic*	1	1.3
R - Riverine	7	11.6
RAD - Riverine + Artificial - Dam	1	10.9
RL - Riverine + Landslide	2	9.7
V - Volcanic	1	1.2
W - Wind	19	99.9

⁵ Section 2, RMA, defines a lake as *a body of freshwater almost entirely surrounded by land*

Total	94	924.0
-------	----	-------

* Geomorphic classification is highly uncertain

16. The recent updates to the FENZ geo-database have resulted in a far larger proportion of lakes in Taranaki being classified as 'artificial', which encompasses both dammed and off-stream reservoirs.

Current takes from lakes

17. Out of a total of 119 consents to take and use surface water in Taranaki, 23 authorise the taking and use of water from lakes. None of these are from natural lakes, with all takes either from reservoirs (i.e., those controlled by dams) or artificial reservoirs (i.e. off-stream storage). [Table 2](#) below summarises current consents. All five takes from a 'named lake' are from reservoirs created through damming or diversion.

Table 2: Consents to take and use water from lakes, by lake category and use of water

Lake category	Hydroelectric generation	Municipal water supply	Irrigation	Other
Named lakes (with damming or diversion)	4	1	-	-
Unnamed lakes / reservoirs (with damming or diversion)	-	-	9	1
Unnamed lakes / reservoirs (no damming or diversion)	-	-	4	4

18. In addition to consented takes, there may be permitted takes from lakes which Council does not hold any information on. This could be estimated using livestock numbers and water consumption, where lakes are surrounded by farmland, or by assuming each adjoining property utilises the permitted volume under the RFWP however, given the level of assumption required, it is unlikely that there would be any particular benefit from undertaking this work.

Key considerations for policy development

19. The technical advice concludes that given the limited information currently available for the majority of lakes in Taranaki, it would be difficult to develop robust regional limits on lake levels and water abstraction. It would be more appropriate for lake-specific levels and limits to be determined following a detailed investigation as part of a resource consent application process. This could be achieved with a permitted rule pathway for minor takes that are currently already provided for, with everything else triggering a higher activity status.
20. The technical advice set out the following recommendations to be incorporated into the policy approach developed for the proposed plan:
- Consider developing a schedule of lakes for inclusion in the plan to delineate between relevant size classes and wetland classifications to accompany plan provisions as needed
 - Consider lake geomorphology class (or similar) to differentiate policy and rule provisions between natural lakes, controlled lakes, and off-line reservoirs
 - Develop a revised permitted take limit for lakes akin to that being developed for rivers and streams, and a consenting pathway where the permitted limits would be exceeded
 - Develop a guidance note to support plan users to gather information and carry out robust assessments of environmental effects that will enable appropriate limits to be set
 - Continue to gather information through state of the environment monitoring, research and investigations to build knowledge regarding lake levels, inflows and outflows in Taranaki.

Options

21. The following options were considered but discounted:
 - a. Adopting a single region-wide approach to managing water quantity in lakes: This option was discounted because it would not be appropriate to manage all lakes (including artificial reservoirs) in the same way. Fluctuations in water levels will have different impacts depending on the size, geomorphology, and use of any lake
 - b. Setting individual lake levels and take limits for each lake: There is not sufficient information to do this for any lakes in the region, and gathering the necessary information would be cost prohibitive.
22. Staff consider a pragmatic approach should be taken and therefore recommend a two-step approach for managing water quantity in lakes:
 - a. Step 1: Classification of lakes
 - b. Step 2: Management approach for each lake classification.

Step 1: Classification of lakes

23. There are a wide range of lake types in Taranaki that vary between FMU. Given the minimal number of takes from lakes, staff consider it is appropriate to manage lake levels and take limits based on classifications that are informed by the hydrological modification and uses of lakes, as follows:
 - a. **Controlled lakes:** These are in-stream lakes that have been created by damming a river or stream and have their inflows and outflows controlled by dams or weirs. These lakes are currently managed by consents for the damming of water and may have bespoke flow and/or level regimes specified in consent conditions to address the connection between lake levels and river flows (for example, requiring a residual flow to be maintained downstream of the dam)
 - b. **Off-stream reservoirs:** These are artificial reservoirs that have been constructed on land (i.e. off-stream) where the water has been taken from another surface water body and stored in the reservoir. Despite their artificial nature, they are captured by the RMA definition of 'lake'
 - c. **Natural lakes:** All other lakes that do not fall under either of the above categories. For simplicity, this category would not differentiate between different geomorphic classifications or sizes of lakes.
24. Rather than setting levels for all lakes within the region, using the above categories would enable lakes to be managed in a manner which is appropriate for the type of lake, and enable a reliance on the limits and levels contained within existing consents, where appropriate. The management approach for each lake category is set out below.

Step 2: Management approach for each lake classification

25. Staff propose to manage each lake classification in different ways to ensure that the values of these water bodies are maintained without resulting in unnecessarily onerous consenting requirements.

Controlled lakes

26. Controlled lakes occur as a result of damming and are often associated with hydroelectricity generation and/or storage. Lake levels can be altered by releasing water downstream. Under the RFWP, damming requires resource consent. Those consents generally include conditions that set bespoke flow and/or level regimes to provide for the connection between the lake and the downstream river environment. This allows for a site-specific approach to be taken.
27. The proposed approach for managing controlled lakes is:
 - a. Lake levels will not be prescribed in the proposed plan but may be specified in a resource consent for the damming or diversion of water, particularly as it relates to managing downstream flows.

For example, maintaining a residual flow downstream of a dam will determine how much water is stored behind the dam (and therefore the levels of that lake)

- b. Water from controlled lakes can be taken and used as a permitted activity up to the permitted volume and rate of take, above which consent would be required
- c. Specific policy direction will provide guidance on any values to be protected.

Off-stream reservoirs

- 28. Off-stream reservoirs are lakes or ponds that have been constructed on land, usually for the purpose of water storage. The levels of these reservoirs are determined by the inflow of water taken from another surface body and the outflow of this water either as a result of being taken and used (i.e., for irrigation) or as a discharge back to surface water (i.e. an overflow mechanism). The inflows are assessed as part of the consent to take surface water from somewhere else and any discharge back into surface water is managed as a discharge. Any additional levels or limits for the water in the off-stream reservoir between these points would be double counting of water.
- 29. The proposed approach for managing constructed lakes is:
 - a. Lake levels are not required to be set as the water taken from a river would need to comply with environmental and minimum flows set for that river and any outflows back to surface water would be managed as a discharge
 - b. Because the water in an off-stream reservoir has already been accounted for in the allocation regime of the river or stream the water is sourced from, takes from off-stream reservoirs would be permitted with no restrictions on the volume or rate of water taken, provided the take has been approved by the owner/operator of the reservoir.

Natural lakes

- 30. Natural lakes are sensitive to changes in water level, which can result in adverse effects on water quality and ecology of lake areas and their connected environments such as marginal wetlands and other tributaries. There is currently not enough information to set specific levels and limits for natural lakes in the region, therefore staff consider it is more efficient and appropriate to apply a conservative policy and rule framework to discourage the taking and use of water from lakes. This is unlikely to have a significant impact on existing users because there are currently no consented takes from natural lakes.
- 31. The proposed approach for managing natural lakes is:
 - a. Takes from natural lakes can occur as a permitted activity, subject to restrictions on the volume or rate of water taken⁶
 - b. Takes from natural lakes which exceed the permitted volume and/or rate will require consent and may include conditions requiring particular lake levels, inflows, or outflows to be maintained
 - c. Specific policy direction will provide guidance on the values to be protected and the level of investigation required to demonstrate that the effects from the taking of water from a natural lake will be no more than minor.

Significance

- 32. The proposals in this paper may affect the 23 existing resource consents for taking and using water from lakes, and may affect any taking and use that is currently occurring as a permitted activity. Further, water quantity and lakes may be a matter of general public interest. However, at this stage the

⁶ Whether the existing permitted activity volumes and rates are appropriate for all natural lakes, regardless of size, is yet to be determined and will be addressed in a separate paper on these takes.

proposals do not hold any legal weight and will not until they are formally incorporated into a new regional plan which is publicly notified. The process for developing a new plan requires multiple rounds of public consultation as well as targeted consultation with statutory bodies and iwi authorities. The Significance and Engagement Policy will be implemented when the proposals are formally incorporated into a regulatory framework in the future.

Financial considerations—LTP/Annual Plan

33. 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

34. 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*.

Climate change considerations

35. There are climate change impacts to consider in relation to this item. Technical advice from the Science team indicates there is likely to be a decrease in the mean annual low flow of most rivers and streams in the region by 2050, with large decreases likely by 2100. Total yearly rainfall is expected to remain roughly the same, but the region is expected to get longer dry periods and heavier, more intense rainfall events.
36. If it becomes more difficult to access water from rivers and streams, which have traditionally been the favoured sources in Taranaki, water users may look to explore alternative options, such as taking water from lakes or storing water. The proposals in this paper will assist with managing any adverse effects of increased use of lakes, and enable the storing of water.

Iwi considerations

37. 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.
38. The content of this paper was discussed with the Freshwater Pou Taiaio from Ngā iwi o Taranaki, further discussions with iwi Pou Taiaio will occur as the policy framework develops, including discussions with the Wai Steering Group.

Community considerations

39. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum. As outlined previously, public consultation will occur in the future once a new regional plan is notified.

Legal considerations

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



Date: 29 April 2025

Subject: **Source Water Management Areas**

Author: J Harvey, Climate Change Coordinator

Approved by: A D McLay, Director - Resource Management and A J Matthews, Director - Environment Quality

Document: TRCID-1492626864-565

Purpose

1. The purpose of this memorandum is to present three options for managing source water risk management areas (SWRMAs) in the development of the Land and Freshwater Plan and seek endorsement of the preferred option.

Executive summary

2. Following the gastroenteritis outbreak in Havelock North in 2016, there has been a renewed focus in central and local government on ensuring that drinking water sources are safe for consumption.
3. The Water Services Act 2021 (the Act) requires that all drinking water suppliers prepare and implement source water risk management plans and that local authorities, including regional councils, contribute to the development of these plans and undertake actions to address any risks.
4. To ensure the Council is meeting legislative requirements to contribute to source water risk management plans, and support a consistent approach across the region, Pattle Delamore Partners Ltd (PDP) was commissioned to delineate source water risk management areas (SWRMAs) for drinking water supplies providing water to more than 500 people across the region.
5. These areas were mapped following the Ministry for the Environment (MfE) guidelines detailed in Delineating Source Water Risk Management Areas 2023 and SWRMAs have now been delineated for the 11 largest drinking water supplies identified across the region, all of which are supplied by the regions district councils. The results of this assessment were presented to Council in an agenda memorandum titled *Source Water Risk Management Areas for Municipal Drinking Water Supplies* on 11 June 2024.
6. The operative Regional Freshwater Plan for Taranaki (the Plan) allows for some activities that could present a risk, to a drinking water supply including:
 - Takes and diversion of water¹
 - Structures and works in beds and streams²
 - Earthworks³

¹ Section 14 – Resource Management Act 1991

² Section 13 – Resource Management Act 1991

³ Section 9 – Resource Management Act 1991

- Discharges to water and discharges to land⁴.
7. Three options are provided for consideration. These options explore alternative ways for managing SWRMAs. Option 1 is to maintain the status quo approach in the operative Freshwater Regional Plan; Option 2 is to utilise delineated source water risk management areas; and Option 3 is to develop a policy driven approach. These options are set out in further detail in the body of this report. Option 2 is the preferred option as this option follows the Ministry of Environment guidelines to provide appropriate protection of SWRMAs and is likely to be the preferred approach for Taranaki's district councils.

Recommendations

That the Taranaki Regional Council:

- a) receives the memorandum titled *Source Water Management Areas*
- b) endorses the policy approach in Option 2 – delineated source water risk management areas and instructs staff to continue to develop a detailed policy framework within this option
- c) determines that this decision be recognised not significant in terms of section 76 of the Local Government Act 2002
- d) determines that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

8. Taranaki's freshwater resources provide drinking water for its residents. Following the gastroenteritis outbreak in Havelock North in 2016, there has been a renewed focus in central and local government on ensuring that drinking water sources are safe for consumption. The operative Regional Freshwater Plan (the operative Plan) contains little direction on managing risks to sources of drinking water and has not yet been amended to give effect to the National Environmental Standards for Sources of Human Drinking Water Regulations (NES-DW) 2007.

The Water Services Act 2021

9. The Water Services Act 2021 (the Act) requires that all drinking water suppliers prepare and implement source water risk management plans that have been based on the scale, complexity, and risk to the drinking water supply. Local authorities, including regional councils, contribute to the development of these plans by providing information on land use activities; sources of contamination; known risks and hazards to the source water; and the results of any source water quality monitoring. It also requires that the Council as a local authority undertake actions to address any risks, as documented in a source water risk management plan or otherwise agreed with the supplier in writing. In addition, the Council and the territorial authorities are required to provide and publish information about source water quality and quantity and to assess the effectiveness of any interventions to manage risks and hazards to source water within the region⁵.

⁴ Section 15 – Resource Management Act 1991

⁵ *Water Services act 2021 Section 46 Regional councils to publish information about source water*

The Resource Management Act 1991

10. The Resource Management Act 1991 (the RMA) section 104 ensures that resource consent applications related to activities near or involving drinking water sources (e.g., water extraction, discharges, or land development) take into account both the direct and cumulative impacts on water quality and availability. Section 104 also requires the Council to have regard to any relevant provisions in other related legislation.
11. To ensure the Council is meeting legislative requirements, and support a consistent approach across the region, Pattle Delamore Partners Ltd (PDP) was commissioned to delineate Source Water Risk Management Areas (SWRMAs) for Taranaki drinking water supplies providing water to more than 500 people. These areas were mapped following the Ministry for the Environment (MfE) guidelines detailed in Delineating Source Water Risk Management Areas 2023, which were also prepared by PDP. In 2024 this work was completed, and SWRMAs have now been delineated for the 11 largest drinking water supplies identified across the region, all of which are supplied by the regions district councils.
12. Each SWRMA was established based on its proximity to the drinking water supply and the associated potential risks and is based on the MfE (2023) guidelines. There are three distinct SWRMAs for groundwater supplies and three distinct SWRMAs for surface water supplies as follows:
 - Groundwater
 - SWRMA 1 area within 5m radius of the wellhead.
 - SWRMA 2 area within one year travel time radius of the wellhead.
 - SWRMA 3 the whole surface water catchment area.
 - Surface water
 - SWRMA 1
 - River and riverbed - 1000m upstream, 100m downstream and 5m landward from the intake point.
 - Lake and lakebed – 500m radius and 5m landward from the edge of the lakebed.
 - SWRMA 2 area within eight hours travel time upstream and 100m landward of the riverbed from the intake.
 - SWRMA 3 the whole surface water catchment upstream and 100m downstream of the intake.

Issues

13. Legislation requires an improvement in the management of New Zealand's drinking water source water. With the initial delineation of SWMRAs now complete, the next step is to decide if and how these risk areas are utilised within the framework of our proposed Land and Freshwater Plan, or if an alternative approach is required.

Discussion

14. The operative Plan allows for some activities that could present a risk to occur within proximity to a drinking water supply, as follows.

Freshwater Plan Activity Classification

Permitted activities

15. Some rules do require a setback distance from a bore, well, spring or surface water body which does provide a buffer from the activity, although these buffers are generic distances and not based on risk. As such, existing permitted activity rules allow for the following activities within proximity to a drinking water supply:
- small discharges directly to water, or into or onto land where the discharge may enter water
 - minor earthworks
 - the construction and maintenance of structures in or close to a waterbody
 - small takes of water from either surface water bodies or groundwater
 - land drainage
 - damming and diversion of water
 - the use of river and lake beds.
16. As there is no requirement to report permitted activities, it is prudent to assume that there are permitted activities, including permitted discharges occurring within proximity to some drinking water supplies.

Consented activities

17. There are also some controlled activities that facilitate the discharge of contaminants to water or into or onto land, where it may enter water, and other activities that can occur either in or in close proximity to waterways. Controlled activities must be consented if the applicant can meet the requirements of the conditions of that rule, therefore unless the conditions allow for the consideration of a designated drinking water source management zone, consideration of any effects cannot be considered.
18. Restricted discretionary activities have similar requirements to controlled activities, in that consideration can only be applied to any conditions stated. In contrast to a controlled activity, an application for a restricted discretionary activity can be refused.
19. Discretionary activities are generally of less concern than permitted or controlled activities. While discretionary activities often involve higher-risk activities, any identified risks can typically be managed through appropriate consent conditions. If the risks are deemed unacceptable, a consent can be refused, provided the policy direction supports this decision. Additionally, since the operative Plan is outdated and does not specifically address drinking water, consenting officers may use their discretion to impose restrictions based on new information, scientific advancements, or changes in legislation. These restrictions could make it difficult for the application to proceed.

Activity risk to drinking water supplies

20. The types of activities that could present a risk to source water are organised by the relevant section of the RMA and the types of activities covered by that section, as follows.

Section 15

Discharges to water

21. Discharges of contaminants directly to water can present a high risk to surface water supplies. The risk decreases as the level of treatment prior to discharge increases, and the distance from the water supply intake increases. Risks from discharges to water within a surface water catchment are generally greater than in a groundwater catchment, as surface water bodies within the same catchment have an immediate direct connection. The connectivity between surface water and groundwater is more complex and the risks greatly reduce with distance (both vertically and horizontally) between a groundwater take and a surface water body.

Discharges to land

22. Discharges of contaminants to land can range from low to high risk depending on the level of management in place and the volume and concentration of any contaminant. Using the land as the

primary or only treatment option can be problematic if the discharge exceeds the assimilation or treatment capacity of the soil. This can result in contaminants entering the groundwater system where they can become more concentrated over time. Discharges to land occurring near a surface water body can present a heightened risk where there is a connection between shallow groundwater and surface water. If poorly managed, discharges can pond on the land surface and enter receiving surface water via runoff or migration via shallow groundwater.

Section 14

Takes and diversion of water

23. The risks to a drinking water source from a take or a diversion of water are generally low if the activity is well managed. The use of backflow prevention and taking and diverting any water at rates and volumes that will have a negligible impact on the flow of the waterbody, are both effective ways to ensure these risks remain low.
24. Some risks to groundwater could occur if the cumulative drawdown impact of multiple bores pumping simultaneously results in poorer quality groundwater being drawn towards the supply bore. This risk could also extend to a surface water supply, especially in a small catchment, due to a reduction in local water levels if over-abstraction occurs. Lowered water levels in surface water bodies can result in an increase in groundwater to surface water interaction, which could change the quality of the surface water if contaminated groundwater was discharging to the stream. An increase in the concentration of contaminants can also present a risk due to the reduced dilution potential of the waterbody when levels are low. All of which could lead to a supplier needing to undertake additional water treatment. Climate change is expected to result in decreases in MALF in 95% of river reaches which will exacerbate the impacts to waterbodies from any additional takes and the impacts from contaminants that make it into any waterbody.

Section 13

Structures and works in beds and streams

25. The risks to groundwater supplies from the placement of a small structure, like a culvert in a nearby surface waterbody, are generally negligible. Larger scale structures like those relating to a hydro scheme or a significant diversion of water, although far less common, could present a risk if a link between the waterbody and the aquifer is present. The risks to a surface water supply from any works within a stream or riverbed are greater. However, if the risk during installation is well-managed once the activity (for example the installation of the structure) is complete, any remaining risks are very low. Any ongoing maintenance or vegetation disturbance related to a structure does increase the risk again; however, only temporarily and generally any of these potential impacts can be managed.

Section 9

Earthworks

26. The risk to groundwater supplies from nearby earthworks can be high as this activity can expose the aquifer directly to a range of contaminants. As distance from the supply (vertically and horizontally) increases, risks are reduced. The risks to a surface water supply from any earthworks nearby are moderate to low depending on the activity, scale and the controls in place. Only earthworks have been considered under Section 9 as this entails disturbance of the earth by blading, contouring, ripping, moving, removing, placing, replacing, excavation and cutting and filling. These activities may result in sediment and sediment-bound contaminants becoming more easily mobilised, and the removal or damage to the natural barriers that occur above and protect local groundwater resources.

Options

27. As demonstrated above, managing the risk to drinking water source water is complex. The overarching framework that is applied to the detailed rules and activity framework below needs to allow for this complexity to be considered and responded to appropriately.

28. The Council is required to identify and evaluate different options that align with the objectives of source water risk management. To meet this requirement, the options presented respond (in varying degrees) to the expectations of the region's district councils and community as communicated during the recent freshwater consultation process. This included the expectation that the Council take measures to improve (or at a minimum, prevent degradation) of the quality of drinking water supply source water. There are three options, presented below.

Option One: Status quo

29. The Council already has some measures in place to protect freshwater more generally, and some measures to consider known drinking water supplies during the consenting process. However, the operative plan lacks targeted policy direction, placing a significant burden on consenting officers. Presently, this requires each application to be assessed individually and, when necessary, rely on the expertise of nominated internal or external technical experts. This approach includes the use of arbitrary distances that trigger the requirement for a consent, to help control activities between 25-500 m around any known water supplies. It also includes the application of a larger spatial buffer area for consideration around some drinking water supplies, but only those that were registered with the Ministry of Health (MoH) at the time this approach was developed. Drinking water suppliers in the dataset include district councils, Ministry of Education and other various suppliers that were required to register at that time. The data set currently includes 74 supplies, 21 of which are rainfall supplies to the roofs of schools or sports clubs, which are outside the Council's control. Of the remaining 53, there are 21 supplies that are estimated to cater for more than 500 people and 32 smaller supplies of which 22 are sourced from groundwater and 10 from surface water.
30. Option 1 would require significant additional work to meet the expectations of the community and the needs of the regions drinking water suppliers. The catchment areas delineated in the consenting layer are the same for a small supply as a large supply and the data does not capture all registered drinking water supplies. As such, this option does not adequately meet current legislative requirements⁶, which require a more risk-based approach.
31. The management zones are displayed spatially, which provides a level of transparency for both applicants and suppliers. However, without provisions in place to guide applicants and consenting officers on the specific requirements for each zone, it offers a reduced level of certainty for both water suppliers and applicants. However, due to the age of the consenting layer, and limited updates having been undertaken, it is considered to be unlikely to meet legislative requirements. Hence should option one be progressed any gaps in legislative requirements will need to be filled. Including further work to ensure that newly registered supplies are consistently captured. All drinking water supplies must be registered with Taumata Arowai by November 2025 and as such the number of drinking water supplies across the region is expected to grow considerably. In addition to updating the consenting layer, a review of policy provisions will also be required to ensure adequate direction is provided for this framework to operate appropriately in areas of discretion. District councils are unlikely to support this option, as the defined areas do not align with the MfE's recommendations for delineating source water risk management areas.

⁶ RMA S104G Consideration of activities affecting drinking water supply source water

When considering an application for a resource consent, the consent authority must have regard to—

(a) the actual or potential effect of the proposed activity on the source of a drinking water supply that is registered under [section 55](#) of the Water Services Act 2021; and

(b) any risks that the proposed activity may pose to the source of a drinking water supply that are identified in a source water risk management plan prepared in accordance with the requirements of the [Water Services Act 2021](#).

Option Two: Delineated SWRMAs

32. Option 2 provides delineated source water risk management areas (SWRMAs) following the guidance provided by MfE. There are three distinct SWRMAs for groundwater supplies and three distinct SWRMAs for surface water supplies as follows:
 - Groundwater
 - SWRMA 1 area within 5m radius of the wellhead
 - SWRMA 2 area within 1 year travel time radius of the wellhead
 - SWRMA 3 the whole surface water catchment area.
 - Surface water
 - SWRMA 1
 - River and riverbed - 1000 m upstream, 100 m downstream and 5 m landward from the intake point
 - Lake and lakebed – 500 m radius and 5 m landward from the edge of the lakebed.
 - SWRMA 2 area within 8 hours travel time upstream and 100 m landward of the riverbed from the intake
 - SWRMA 3 the whole surface water catchment upstream and 100 m downstream of the intake.
33. The MfE guidance was designed to provide regional councils with a standard approach for the mapping of source water risk areas. It is a change from the current approach as it applies a conservative distance that differs depending on the level of risk and whether the supply is groundwater or surface water.
34. The approach in Option 2 considers risk by calculating the time that a contaminant would take to travel to a water supply. For surface water this is eight hours, and groundwater it is one year. To date, SWRMAs have only been delineated for large supplies that cater for more than 500 people. Each large supply has three separate management areas which could provide a level of flexibility in the approach taken. For example, activities within SWRMA 1 closest to the drinking water supply, which presents the highest risk, could have a higher level of management applied than activities occurring within SWRMA 2 and SWRMA 3. Therefore, a clear policy direction and rules framework could apply to each zone. There could also be some flexibility in relation to the level of management imposed on different activity types applied. To enable an effective transition to this framework, changes to the operative Plan would be required to embed the risk management zones and then apply a suitable policy and rule framework addressing any risk to a supply.
35. Option 2 does not consider smaller supplies but is the most stringent option in relation to large supplies that present a level of risk to the greatest number of people. It is more prescriptive than the current approach, which will reduce the burden on consenting officers and technical staff by providing clearer direction for how activities are dealt with in relation to the risk to large supplies. It would also ensure applicants understand the implications of their proposed activities when they are located close to a large drinking water supply.
36. As this approach does not consider smaller supplies, further work will be required as to how the Council will meet the requirements for smaller supplies under section 104(g) of the RMA and the NPSFM 2020. As with Option 1, some consideration in regard to any new supplies would also be required, as these would have to be delineated following the same methodology. However, as all the large water supplies in the region are managed by district councils, and planning for new supplies typically takes several years, it is unlikely that any new sources will be developed in the short term.
37. This option includes the spatial delineation of management areas which provides a high level of transparency to the community. Option 2 would meet the needs of the region's large drinking water suppliers. To apply the framework effectively significant changes to the operative Plan would be required.

Option 3 – Policy driven

38. Option 3 relies on strong policy direction that enables decision-makers to assess and address risks appropriately and less on delineating spatially the risk areas within the draft Land and Freshwater Plan itself. This approach will depend on the interpretation of policies and rules by both the applicant prior to submission and the consenting officer during the application assessment. It is the most flexible of the three options, allowing for a range of approaches. It could be highly prescriptive, with specific standards and requirements tied to a list of designated supplies, or more flexible, applying provisions based on factors like location, size, source water type, and/or activity type within a defined distance from a supply. Policies could also require that within proximity to a drinking water supply the supplier is considered as an affected party on all applications, or on certain activities that are deemed higher risk, which, although providing another layer of complexity, would provide additional security for the supplier.
39. This option would require changes to the operative Plan and because it relies less on spatial delineation it could appear less transparent than the other approaches. The success of this approach would be heavily dependent on clear and effective policy drafting. While it shares similarities with the current approach, this option would provide stronger direction specifically to drinking water supplies and their source water. Therefore, it would reduce the burden on consenting officers by providing clearer guidance and ensure that applicants understand which activities are or are not permitted near drinking water supplies.
40. Option 3 is likely to meet the expectations of the community and the needs of the regions drinking water suppliers as this approach could be tailored accordingly. This option would also assist consenting officers and applicants by providing clearer direction, during decision making; however, it could also introduce a level of inconsistency by relying significantly on the discretion of the consenting officer.

Preferred approach

41. Of the three proposed approaches, Option 2 is the preferred approach as this utilises source water risk management areas delineated following MfEs recommended methodology. Due to source water risk management areas being displayed spatially, it also provides a high level of transparency for both consenting officers and applicants. For both these reasons it is also likely to be the preferred approach for both drinking water suppliers and the wider community.

Significance

42. This decision is assessed as not significant with regards to the Significance and Engagement Policy. It will have no impact on levels of service, incur more than \$10,000,000 budgeted or \$5,000,000 of unbudgeted expenditure, or involve the transfer of ownership or control of a strategic asset.

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 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.

Climate change considerations

45. Although it is important to consider climate change in all aspects of the management of freshwater the consideration of climate change has not impacted the outcome of this item.

Iwi considerations

46. 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.
47. Similarly, iwi involvement in adopted work programmes has been recognised in the preparation of this memorandum. As part of the wider programme of work required to implement sources water management areas, Ngā Iwi o Taranaki Pou Taiao have been approached to provide feedback on the proposed approaches and have indicated their comfort with the preferred approach. Further feedback will be sought from Pou Taiao and tangata whenua more widely as the framework is developed and further feedback received.

Community considerations

48. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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



Date: 29 April 2025

Subject: Submission on Wastewater Environmental Performance Standards

Author: F Kiddle, Strategy Lead

Approved by: A D McLay, Director - Resource Management

Document: TRCID-1492626864-577

Purpose

1. To seek endorsement of a submission on the Consultation on proposed wastewater environmental performance standards discussion document.

Executive summary

2. Taumata Arowai can issue wastewater environmental performance standards that regional councils must apply in assessing resource consent applications for wastewater treatment facilities.
3. A discussion document on the first set of such standards was released for consultation. It covers standards in four areas. The two most pertinent to Taranaki are discharges to freshwater and the coastal environment, and proposed standards for wastewater overflows and bypasses.
4. A draft submission was circulated to the Policy & Planning Committee members for out of session consideration due to time constraints. The submission canvassed a range of matters. Key concerns were the approach in the standards regarding cumulative effects, a lack of nuance where facilities discharge near identified primary contact sites, and the proposal to make wastewater overflows and bypasses a controlled activity.
5. An updated submission will be tabled at the meeting for retrospective endorsement. The submission had to be lodged by 5:00pm 24 April.

Recommendations

That the Taranaki Regional Council:

- a) receives the memorandum titled *Submission on wastewater environmental performance standards*
- b) notes the draft submission in Attachment 1 as circulated for out-of-session consideration
- c) endorses the updated submission as tabled
- d) determines that this decision be recognised as not significant in terms of section 76 of the Local Government Act 2002
- e) determines that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

6. Taumata Arowai has the ability to issue wastewater environmental performance standards that regional councils must apply in assessing resource consent applications for wastewater treatment facilities owned by councils or the Crown. These provisions are effectively a form of national direction and replace any existing provisions in a regional plan. Regional councils still have the ability to develop bespoke provisions to aspects of a wastewater treatment facility not covered by the standards. For example, discharges to air from a facility. Proposed amendments to the RMA currently underway would also allow Taumata Arowai to issue similar standards for stormwater.
7. The *Consultation on proposed wastewater environmental performance standards discussion document* (discussion document) has now been released for comment. It covers standards in four areas:
 - a. discharges to water for a range of parameters and receiving environments, alongside a tailored standard for small wastewater treatment plants
 - b. discharges to land
 - c. beneficial reuse of biosolids
 - d. arrangements for wastewater network overflows and bypasses of wastewater treatment plants.
8. The standards explicitly do not address some areas, receiving these to be regulated through the existing resource consenting process. These are:
 - a. discharges to air from wastewater treatment plants
 - b. recycled treated wastewater for non-potable use
 - c. contaminants of emerging concern such as endocrine disrupters, PFAS (per- and polyfluoroalkyl substances) and heavy metals
 - d. arrangement for onsite wastewater treatment systems (such as septic tanks) or community owned and operated schemes.
9. Attachment two contains a summary of the discussion document.
10. Submissions closed at 5:00pm on 24 April 2025.

Issues

11. Wastewater treatment facilities can have a significant impact on freshwater quality. Accordingly, the proposed standards would have a significant impact on freshwater management in Taranaki.

Discussion

12. Council officers have undertaken analysis of the proposed discharge to water standards against existing consents. Our findings are that:
 - a. The New Plymouth wastewater treatment plant, which discharges to the open ocean, currently achieves a higher discharge standard than what is proposed. However, the proposed standards include exceptions to determine alternative pathogen limits to protect shellfish health. This could ensure that the current standard of discharge continues.
 - b. The Hāwera wastewater treatment plant, which discharges to the open ocean, would likely meet the proposed standards.
 - c. The Stratford wastewater treatment plant, which discharges to a river with low-moderate dilution, would likely meet some standards but not others. However, there is extra uncertainty as the plant discharges to a hard bottomed stream and guidance for periphyton is yet to be released in this environment.
13. The Waverly, Ōpunake, Manaia, Kaponga and Pātea wastewater treatment plants would likely fall into the 'small' plant category of the standards. Pātea probably fits into the 'estuary' category for the discharge receiving environment. This discharge would likely meet the proposed standards.

14. The draft submission focuses on the discharges to water and provisions regarding overflows and bypasses. These are the most pertinent to the wastewater treatment facilities in Taranaki. The submission canvases a range of points. Key matters are:
 - a. The standard does not provide any flexibility to address cumulative impacts from a wastewater treatment facility in a catchment. This puts the burden of load reduction on to the community, effectively requiring them to subsidize the operation of the wastewater treatment facilities in their catchment. This needs to be addressed to ensure wastewater treatment facilities do their 'fair share'.
 - b. A more nuanced approach is needed where discharges occur in proximity to identified primary contact sites. This is based on concerns around the methodology used to justify the standards in the underlying technical advice.
15. Controlled activity status is not appropriate for the overflow of untreated wastewater into freshwater or the coastal environment. This would undermine the urgency in which such serious issues need to be addressed. Existing tools, including statutory defenses, are already appropriate for dealing with overflows.
16. To meet the submission deadline, the draft submission was circulated to Policy & Planning Committee members out of session for comment. The final submission, as updated based on feedback received and lodged, will be tabled at the Committee meeting for retrospective endorsement.

Options

17. Council can endorse the submission as drafted, endorse the submissions with amendment, or not endorse the submissions. Considering the importance of the issue to Council operations, it is important the Council's voice is heard in the standard development process. Accordingly, endorsing the submission is recommended.

Significance

18. This decision is assessed as not significant with regards to the Significance and Engagement Policy. It will have no impact on levels of service, incur more than \$10,000,000 budgeted or \$5,000,000 of unbudgeted expenditure, or involve the transfer of ownership or control of a strategic asset. More broadly, final decision-making authority rests with the Government.

Financial considerations—LTP/Annual Plan

19. 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

20. 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*.

Climate change considerations

21. There are no climate change impacts to consider in relation to this item.

Iwi considerations

22. 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.

Community considerations

23. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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

Appendices/Attachments

TRCID-1553446934-59: [Draft submission on consultation on proposed wastewater environmental performance standards](#)

TRCID-1553446934-62: [Wastewater environmental performance standards on a page](#)



XX April 2025

Document: Document ID Pending

Taumata Arowai

Level 2, 10 Brandon Street

Wellington 6140

Via email: koroero@taumataarowai.govt.nz

Consultation on proposed wastewater environmental performance standards

1. Thank you for the opportunity to submit on the *Consultation on proposed wastewater environmental performance standards discussion document*. The effective management of wastewater systems is a crucial component of how we collectively manage freshwater resources. Robust systems are necessary to ensure our freshwater is safe for human use and is able to provide for native ecosystems.
2. Taranaki Regional Council (Council) regulates a range of wastewater treatment facilities. These currently discharge into a mix of open ocean and riverine environments. The size of facilities also varies, with a number that would likely be classified as small plants under the proposed standards. With this in mind Council, has focused its comments on the discussion document chapters relating to the discharge to water standard and the management of overflows and bypasses.

Discharge to water standards

3. Council's principal concern is how the proposed standard will impact the management of cumulative effects in an overallocated catchment. The standard is clear that even if there is a significant issue regarding cumulative effects in a catchment, no additional regulatory tools would be available to manage the discharge from any wastewater facilities in that catchment. This shifts the cost burden on to communities including farmers, industry and other individuals to address the overallocation and resulting environmental issues. It effectively requires the wider community to subsidise the operation of the wastewater treatment facilities in their catchment.
4. The Government's intent in the replacement of the Resource Management Act 1991 (RMA) is to impose a more robust regime for managing catchments where environmental limits are breached. Further thought is needed to ensure tools are available to ensure wastewater treatment facilities do their 'fair share' of load reduction in these circumstances.
5. Based on a preliminary assessment of wastewater discharge monitoring data in the Taranaki region, some wastewater treatment plants are likely already exceeding the required level of treatment. In these instances, the standard should require this level of treatment to continue. Allowing wastewater treatment plants to lower their standards of treatment in catchments that fail to meet 'national bottom lines' would be inconsistent and inequitable.
6. Council is also concerned that the current standard would give no ability to provide alternative standards where a facility discharges into an outstanding water body. Where a council has gone through a robust plan making process, there should be the ability to provide alternative standards in these circumstances to protect the waterbody's outstanding characteristics.

7. Council supports the proposed exclusion for discharges to rivers or streams with a very low dilution. However, the discussion document is silent on what happens if the dilution factor of a river changes over the 35-year course of the consent. This is particularly pertinent given the expected impacts of climate change over time. Flexibility is needed to adjust consent conditions in these circumstances. A similar exclusion may also be required for some lakes.
8. Council supports an exclusion from the standard where the discharge point is in proximity to human drinking water abstractions but recommends that the proposed 1,000m upstream threshold for rivers be increased and/or changed. The fast-flowing nature of rivers in Taranaki renders the upstream threshold insufficient. The upstream threshold should be based on travel-time instead. This should also apply to tributaries that discharge to lakes within a 500m radius of an intake. Council has recently completed an assessment of drinking water source protection zones for the Taranaki region and can suggest alternative exclusion zones based on this work.
9. Some of the compliance and monitoring provisions require further elaboration and refinement. These include:
 - The standard should specify the level of lab accreditation and independence needed for monitoring.
 - The standard refers to the use of an annual median. It is not clear if this is by calendar year, financial year, 12 months from granting consent, or a rolling average. Anything except a rolling average could facilitate significant adverse effects for a prolonged period before enforcement action could be taken.
 - We encourage consideration being given to complementing the annual median (or 90th percentile) standard with an additional upper limit that cannot be exceeded. This is to capture large one-off events that cause significant adverse effects.
 - We encourage consideration being given to a standard set of discharge monitoring requirements that also apply to small plants. This would enable regional councils to fulfil their water quality resource accounting responsibilities.
10. A more nuanced approach to developing suitable standards is required when discharges occur in proximity to identified primary contact sites. This could involve a Quantitative Microbial Risk Assessment (like the methodology proposed for discharges in proximity to shellfish gathering areas).
11. This suggestion is based on two concerns. First, we are concerned about a discrepancy between the *E. coli* and enterococci discharge standards and the recreational water quality guidelines¹ they are intended to achieve. The discharge standards are based on the 90th percentile of monitoring results, but the recreational water quality guidelines are based on the 95th percentile. Based on the available information it is not clear if this would result in a significant difference in the final concentration of faecal bacteria in the receiving environment. However, based on the methodology provided, the standards would not achieve Microbiological Assessment Category 'A', as is stated in the technical advice.
12. Second, the recreational water quality guidelines include a caveat that they cannot be directly used to determine water quality criteria for wastewater discharges. This is due to the potential for the relationship between indicators and pathogens to be altered by the treatment process. It is not clear whether this was adequately considered during the development of the proposed wastewater standards.

¹ Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas 2003, prepared by the Ministry for the Environment and Ministry of Health

13. Finally, the discharge to water standard needs to be clear that the proposed exemptions to the standard for discharges entering low dilution receiving environments also apply to small wastewater treatment plants. These small plants can still have a significant impact where they discharge into low flow environments. It is appropriate this be dealt with through a more nuanced consenting pathway.

Overflows and bypasses

14. Council is opposed to the proposal that the overflow of untreated wastewater into freshwater or the coastal environment be a controlled activity. While the proposed conditions are based on best practice for monitoring the proposed provisions would undermine the urgency in-which a council needs to act to resolve overflow issues particularly within the context of a 35-year consent term. Such discharges could lead to significant adverse effects on the environment and public health risks.
15. Currently overflows are assessed on a case-by-case basis against the available statutory defences. Action can also be taken using the RMA's emergency works provisions. Together these provide appropriate pathways for managing what can be very significant events.
16. It is also noted that it is likely controlled activities will be removed as an activity classification as part of the RMA replacement. The provisions in the standard should be future proofed and avoid using a controlled activity status for either overflows or bypasses. For the avoidance of doubt, Council would also consider it inappropriate to allow for a permitted activity pathway.
17. Due to time constraints, this submission has been circulated to the Council Policy & Planning Committee out of session for comment. The submission will be recommended for endorsement at the next meeting on 29 April 2025. Any subsequent comments will be passed on to Taumata Arowai.

Yours faithfully

S J Ruru
Chief Executive

Proposal on-a-page

i The Water Services Authority—Taumata Arowai (the Authority), on behalf of the Minister of Local Government, is consulting on a set of proposed national wastewater environmental performance standards ('wastewater standards') under section 138 of the Water Services Act 2021.

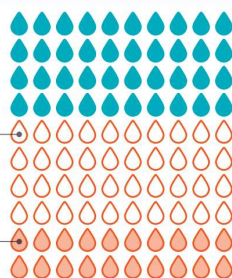
A What is the rationale for change?

A significant proportion of Council and Crown-owned wastewater infrastructure was built 30-40 years ago. These now require upgrades or renewals.

Population growth and urban development also drive the need for infrastructure renewals, with larger communities and housing areas requiring treatment plants and networks with much greater capacity than they currently have.

Around 60% of public wastewater infrastructure will require re consenting in the next decade.

Of this number, 20% of plants are currently operating on expired resource consents.



KEY:
 ● Valid
 ○ Due to expire
 ● Expired

The resource management system can be challenging for network owners and communities across the country.

Resource consents are developed, assessed, and monitored largely on a case-by-case basis. The current process can be lengthy, uncertain, and information intensive as a result.

B What does this package of wastewater standards cover?

The Water Services Act 2021 (the Act) (section 138) enables the Authority to make wastewater standards following public consultation.

Standards only apply to Council and Crown-owned infrastructure, and may include requirements, limits, conditions, or prohibitions related to activities associated with wastewater treatment plants and networks, including:

- **Discharges to land, air or water**
- **Biosolids** and other **by-products** from wastewater
- **Energy use**
- **Waste** introduced by a third party into a wastewater network (such as trade waste).

The initial package of proposed standards covers areas where resource consents are commonly sought for wastewater treatment plants and networks, specifically:



Discharges to water

THIS STANDARD PROPOSES:

- Treatment requirements for the main contaminants discharged from a treatment plant, varying by the risk and sensitivity of the receiving environment.



Discharges to land

THIS STANDARD PROPOSES:

- A framework for identifying suitable land for discharge application, based on a site-specific risk assessment.
- Treatment requirements for nutrients and pathogens discharged to land.



Beneficial reuse of biosolids

THIS STANDARD PROPOSES:

- A grading system for processing biosolids from wastewater treatment plants, with corresponding activity status for how and when biosolids can be reused based on Water NZ guidelines.



Wastewater network overflow and bypass arrangements

THIS STANDARD PROPOSES:

- Risk-based planning, monitoring and reporting requirements for overflows from networks and bypasses of plants.
- All existing overflow points must be consented.

➤ Monitoring and reporting requirements will apply across all the standards.

i Small plant standard (SPS)

The discharge to water standard will impose different treatment requirements for wastewater treatment plants that service very small communities. These plants are significantly different to those that service larger towns and cities. They are usually

oxidation ponds that rely on passive treatment arrangements that require little operation, at isolated sites and often without access to electricity. These small plants often have a minimal impact on the receiving environment because of their small size, particularly in

comparison to contaminants like nutrients from surrounding land. Due to this, no nutrient treatment is proposed as part of the small plant standard, and other treatment requirements are tailored to suit infrastructure of this nature.

Version: 21 Feb 2025

C How will territorial authorities (TAs) and regional councils (RCs) use the standards?

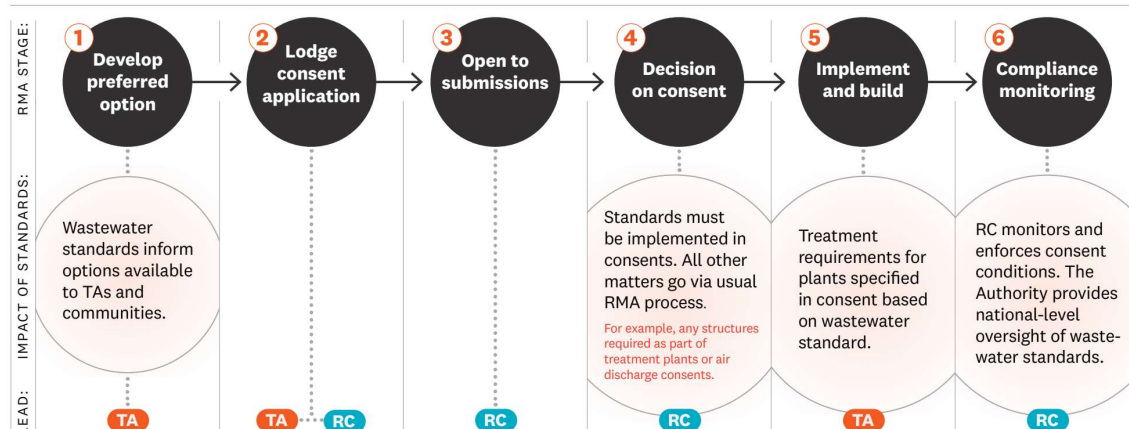
Territorial authorities (TAs) who have wastewater treatment plants due for upgrade or renewal will consult with their communities under the Local Government Act 2002 to determine the best arrangement for their circumstances.

The standards will set treatment requirements based on the type of water body or land the plant discharges to.

These standards will guide councils and communities in making decisions, and in the design, planning, and funding once a decision is made.

Examples of what this might look like:

- Communities and TAs may choose to either:
 - Decommission and replace an old plant with one that discharges to land in the summer, and water in the winter, or
 - Upgrade an existing plant or combine multiple plants into one centralised arrangement.



D What are the expected benefits of the proposed standards?

Wastewater standards will:

- ✓ Support environmental outcomes.
- ✓ Drive cost and time efficiencies.
- ✓ Support owners of networks to better plan and fund infrastructure.
- ✓ Provide clear expectations about treatment quality to communities.

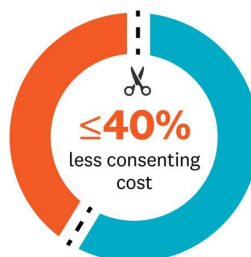
Expected cost efficiencies:

Based on case studies, we expect up to 40% reduction in consenting costs.

This includes cost reductions in staff time, technical and feasibility assessments, legal costs, and consultation/engagement expenses.

Over time, further savings will come from standardising infrastructure and operations

to comply with the proposed wastewater standards.



The standards will provide certainty to TAs, helping them to better:

- Plan
- Design
- Engage with communities
- Fund infrastructure upgrades
- Develop long-term plans

E What was the process to develop the standards?

The Authority developed these proposals using evidence, technical advice, testing.



Review of a range of previous work relating to the area.



Commissioning technical reports into potential areas where standards could be made.



Commissioning case studies of wastewater arrangements to understand the perspectives of iwi/Māori, TAs, and RCs.



Commissioning detailed technical advice into the discharge to water and land standards.



A Technical Review Group made up of TAs, RCs, peak industry bodies, and leading industry professionals.

The goal is to create credible standards that balance:



i The proposed standards do not cover the following matters:

- ✗ Discharges to air from wastewater treatment plants.
- ✗ Recycled treated wastewater for non-potable use.

- ✗ Other contaminants from treatment plants (such as endocrine disruptors, heavy metals, and PFAS).

- ✗ Arrangements for private networks or onsite wastewater treatment systems (such as septic tanks).

Version: 21 Feb 2025



Date: 29 April 2025

Subject: Dairy Effluent Management – phase out options

Author: L Hawkins, Policy Manager

Approved by: A D McLay, Director - Resource Management

Document: TRCID-1492626864-612

Purpose

1. The purpose of this memorandum is to:
 - a. summarise the work undertaken to date on animal effluent discharges to water
 - b. seek Council's support for a preferred option for phasing out remaining discharges.

Executive summary

2. Good progress has been made in reducing the number of treated animal effluent discharges to water over the last 12 years and farmers should be congratulated. But there are 277 resource consents in Taranaki authorising discharges of treated animal effluent directly to water, which expire before 2032. This practice is significantly out of step with industry good practice, and effluent management in the other key dairying regions in New Zealand.
3. This paper outlines five options for phasing out these discharges over time and seeks the Committee's support for Option 2 (staged transition). Under this option, all discharges would be phased out by 2032 but those with consents expiring in the next few years would be able to renew their existing consents for a short duration in order to have sufficient time to plan their transition.

Recommendations

That the Taranaki Regional Council:

- a) receives the memorandum title Dairy effluent management – phase out options
- b) supports the approach to phasing out all remaining discharges of animal effluent to water described in option 2 (paragraphs [32](#) to [35](#))
- c) determines that this decision be recognised as not significant in terms of section 76 of the Local Government Act 2002
- d) determines that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act, determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

4. Animal effluent contains faecal bacteria and nutrients (nitrogen, phosphorus and potassium) which can degrade water quality. *Escherichia coli* (*E. coli*) is bacteria commonly measured to indicate whether water is likely to be carrying pathogens that can make us sick. Freshwater with high levels of *E. coli* presents a higher risk to people, particularly during recreational activities such as swimming.
5. Of the key dairying regions,¹ Taranaki is the only region where discharges of effluent directly to water are still authorised by resource consent. Despite this, approximately 80% of existing discharges are already to land, reflecting the change in industry expectations over the past 12 years and the investments made by farmers in on-farm infrastructure and practices.
6. There are approximately 1522 resource consents authorising discharges of effluent in the region, including 144 for discharges to water and 133 for discharges to water or land (known as dual consents). Dual consents either authorise:
 - a. Discharges to land primarily, with the ability to discharge to water when soil conditions are unsuitable
 - b. Discharges to water and/or land until a specified date, and discharges only to land after that date.
7. These consents all expire before 2032. The number of consents expiring each year is shown in [Table 2](#) below. Geographically, these consents are located across approximately 70 catchments in the region, however approximately half of the consents are in the following catchments: Waitara (41 consents). Waiongana (20), Waiwhakaiho (17), Waingongoro (16), Pātea (15), Kaipokonui (14) and Pungaereere (11).

Table 1: Consent expiry dates

Discharge	Consent expiry date										Total
	2022*	2023*	2024*	2025	2026	2027	2028	2029	2030	2031	
Water	2	3	5	29	24	26	11	22	22	0	144
Land/water	0	0	3	22	23	30	14	18	20	3	133
Total	2	3	8	51	47	56	25	40	42	3	

* Consents have expired but can still be lawfully exercised under the RMA while new applications are processed

8. Discharging effluent to water is significantly out of step with industry good practice. Fonterra has indicated that from mid-2025 it will be taking steps to ensure that all milk collected in the region is from farms discharging solely to land.

Issues

9. There are three key issues:
 - a. Current plan provisions are significantly out of step with industry good practice: In Waikato, Southland, and Horizons, discharges to water are prohibited. In Canterbury, they are non-complying which provides a consenting pathway, but there are no active resource consents for discharges to water. Out of the five main dairying regions, Taranaki is the only region still issuing resource consents (as a controlled activity) for discharges of effluent to water.
 - b. Reductions in the *E. coli* load in many rivers in Taranaki will be required to meet national bottom lines: Nineteen of the region's 22 monitoring sites fall below the national bottom line for *E. coli* and it is estimated that a 50% reduction in *E. coli* loads will be required to meet these. Science work to date indicates that removing all effluent discharges to water would result in a 10%

¹ Waikato, Canterbury, Southland, Otago, and Taranaki.

decrease in the mean annual load of E. coli discharging to the coast via the regions' waterways. Phasing out discharges of effluent to water is also an important part of reducing nutrient levels in water.

- c. Phasing out discharges to water will be difficult for some farms: Some farms have physical constraints that make discharging to land more difficult than other parts of the region. On these farms, the cost of changing to discharging to land may be high and potentially unaffordable for some farmers.

Discussion

Resource consents and new plans

10. When a new regional plan is notified, its rules have legal effect but they do not replace the existing plan immediately. While a new plan goes through the submissions, hearings, and appeals process, both plans must be considered in consent decision-making. The further through the process a new plan gets, the more weight it is given in decision-making, but it does not wholly replace the existing plan until the new plan has been made operative (after any appeals are resolved) and the existing plan is formally withdrawn.
11. Existing resource consents are not immediately affected by new regional plans being notified – consent holders can continue to operate under their current consent until it expires. If a consent expires after a new plan has been notified, but before it becomes operative, then both plans apply.

Consultation feedback

12. Last year, Council consulted on options for phasing out existing discharges of animal effluent to water, summarised in Table 1 below.²

Table 2: Phase-out options

Option	Description	End
No transition	All discharges to water must stop when their current resource consent expires. This would give very little time for some resource consent holders to transition (i.e. those with consents expiring in the next few years) but more time for others (i.e. those with consents not expiring until the 2030s).	2031
Staged transition	All consents expiring before a certain date (e.g. 2028) can be replaced once with a short duration resource consent (i.e. five years). This would give those with early expiry dates similar transition times to those with later expiry dates and would likely speed up the overall phase out.	2031
Individual transition	All consents can be replaced once with a duration based on the individual circumstances of the farm and the upgrades required to shift to a land discharge up to a maximum of 10 years. This would allow for a longer transition period for all current resource consent holders but also delay the improvements to water quality.	2041

13. Most people supported a staged transition. Generally, people who chose this option thought it was fairest to all consent holders. Many people believed that the transition to land discharges had been well-signalled for a long time and that it shouldn't surprise farmers.
14. When filling in the survey, people were asked to describe themselves. They could select one or more options, one of which was "Dairy farming". There was a difference in preferences between respondents:
 - a. for those who chose "Dairy farming", 22 people preferred a staged transition, 19 preferred an individual transition, and 11 preferred no transition

² The consultation document is available from <https://haveyoursay.trc.govt.nz/next-steps-our-freshwater/animal-effluent>

- b. for those who did not choose “Dairy farming”, 37 people preferred a staged approach, eight preferred an individual transition, and 15 preferred no transition
 - c. tangata whenua preferred no transition.
- 15. Fonterra noted that they generally do not support the continued authorisation of treated effluent discharges to water and are working with their suppliers to phase out discharges to water in 2025. Many dairy farmers commented that they had already invested in infrastructure to allow them to discharge effluent to land and that others in the industry needed to do the same. Some people were frustrated that they had already incurred costs to upgrade systems and that other farmers had not. Several people thought that those discharging to water should “get on with it” and move to discharging to land like most farms had already done.
- 16. A number of people, including DairyNZ and Federated Farmers, commented on the variability of individual farm challenges, raising concerns about the cost and practicality of transitioning to land-based discharge, particularly in high-rainfall areas. They highlighted that those farms with major challenges would need more time to explore options. There was concern that for farms with no viable alternative to discharging effluent to water, there would potentially be business closures.
- 17. A small number of people sought to allow some farms to continue discharging to water permanently (i.e. an exemption from the phase-out).

Alternative option: staged + individual

- 18. Some people sought an alternative option to those proposed in the consultation material: a staged transition for most farms, but an individual transition for some farms where phasing out discharges to water will be more difficult. Feedback indicated that financial impacts and practical limitations to discharging to land were the key concerns.
- 19. There were concerns raised that not all land is suitable for discharging effluent. For example, where there is high rainfall, the land is too swampy, the water table is high and there are potential impacts on groundwater, and space limitations (i.e. the amount of land suitable for effluent application).
- 20. Staff were interested in exploring the alternative option of a combination of staged and individual transitions. A meeting with stakeholders was held in December 2024 to discuss:
 - a. what different transition pathways could look like in a plan
 - b. the criteria for determining who would be eligible for an individual transition (i.e. an exemption from the region-wide approach)
 - c. if alternative timeframes are in place for those with an individual transition, what those could or should be.
- 21. In summary, the feedback from this session was that:
 - a. Fonterra strongly opposed providing any long-term transition pathway for farmers discharging to water and indicated they would be requiring suppliers to cease discharging to water from late this year. Staff understand most milk produced in Taranaki is supplied to Fonterra.
 - b. Current discharges to water are not concentrated in one particular area, which would make it difficult to spatially identify an area within which farms could be eligible for an individual transition. Additionally, there are often a combination of different factors on a farm which make it more challenging to discharge to land, rather than the same factors in every case. For these reasons, the general preference was to identify criteria that a consent officer could assess an application against rather than identifying specific areas where an individual transition could be available.
 - c. Key criteria for consideration should include rainfall, slopes, soil types, and number of water bodies on a property. It was noted that rainfall, slopes, and soil types all form part of an assessment of soil risk under the Dairy Effluent Storage Calculator (DESC) and that DairyNZ is

investigating whether alternative risk assessments could be made in Taranaki to reflect the particular climate characteristics of some parts of the region.

- d. There was general agreement that any individual transition should not exceed ten years. If adopted, this would mean the phase-out would be complete in the early 2040s.

National Effluent Advisory Group

22. In February, staff attended a national Effluent Advisory Group meeting focused on sharing current and proposed approaches to managing effluent across all regional councils. Most councils indicated they are either content with their existing provisions or considering minor amendments to better reflect industry good practice (such as using DESC for pond sizing and Engineering NZ practice notes on infrastructure design) or to address specific implementation issues with current provisions.
23. There were some common themes across the councils:
 - a. All councils are considering how freshwater farm plans can be used in their regions, but most indicated they were unlikely to manage effluent solely through farm plans
 - b. A number of councils were concerned about the quality of consent applications prepared, or certification of systems, by people accredited through industry schemes such as the Dairy Effluent Warrant of Fitness programme
 - c. The use of bladders for effluent storage has increased in some regions but current industry practice guides do not have any design standards for these. Some councils have had issues with bladders leaking or exploding, and many noted the temporary nature of bladders due to sludge build-up
 - d. Some councils noted that the climate data used by the DESC has not been updated for some time, and encouraged DairyNZ to prioritise this to ensure soil risk assessments are reflecting recent weather patterns.
24. DairyNZ staff confirmed they are still progressing work to reassess the high risk and low risk soil classification in Taranaki and advised that there are amendments to the Engineering NZ practice note for ponds currently open for public feedback. From discussions with DairyNZ, it appears the Taranaki-specific investigation will be focused in an area identified by Taranaki Catchment Communities known as High Altitude Dairy Environment Solutions (HADES) catchment group area. We are not aware of the timeframes this project is working to.

Options

25. When consultation occurred last year, data from May 2024 showed there were 357 resource consents authorising animal effluent discharges to water or to a combination of land and water. As at January 2025, that number had dropped to 280. Compared to the past decade, the rate of transition appears to have sped up in recent years. With Fonterra indicating a harder line on discharging to water from later in 2025, this rate of transition is likely to continue.
26. Some farms will still find transitioning to land discharge very challenging. Some of these farms may be higher altitude and affected by any changes DairyNZ proposes to the DESC as a result of their current investigations. If that project does consider a different risk profile for those soils is appropriate, the likely result is that more land is considered low risk for effluent application (i.e. potentially more land on farms will be available for discharging effluent compared to current settings).
27. Based on the original options discussed during consultation, and the alternative options proposed by the community, staff consider there are five options for Council to consider:
 - a. Option 1: No transition
 - b. Option 2: Staged transition (preferred)
 - c. Option 3: Staged + Individual transition

- d. Option 4: Individual transition
 - e. Option 5: Allowing some discharges to water
28. Under options 1 to 4, all existing discharges of effluent to water would be phased out. Under option 5, there would be a pathway for some discharges of effluent to water to continue. All discharges to water not in that category would need to be phased out using one of options 1 to 4.
29. These options are discussed in more detail below.

Option 1: No transition

30. As described in [Table 2](#) above, this option was included in consultation last year and would require all discharges to water to cease when their current consent expires. Given some farms may need to fund infrastructure upgrades, this option may be challenging for some farmers. If a new plan is not proposed to be notified for some time, but Council agrees on the framework that should be included in that plan, it may be possible to mitigate the impact of this option by communicating directly with affected consent holders to advise them on future changes. This option was second most popular in consultation feedback, and strongly supported by tangata whenua.
31. Staff do not recommend this option because the debt position of many Taranaki dairy farmers may make funding infrastructure upgrades more challenging. It is important that environmental outcomes are achieved in a way that is sustainable for communities, including financially.

Option 2: Staged transition (preferred)

32. As described in [Table 2](#) above, this option was included in consultation last year and would split existing consents into two groups: those expiring before a certain date, and those expiring after that date. The date would be the middle of the time period between now and the date the last consent is due to expire, so each group would cover the same number of years. The former group would be able to renew their existing consent once for a duration no longer than the latest expiry date of the second group. For example, using current data (as set out in Table 1):
- a. All existing consents authorising discharges to water expire by 2031.
 - b. The overall phase-out time period is between 2025 and 2031 (six years). The middle of this period would be 2028.
 - c. The first group would include all consents expiring between 2025 and 2028. Those consents could be renewed once but only for a period not exceeding 2031.
 - d. The second group would include all consents expiring between 2029 and 2031. Those consents could continue to discharge to water until their consent expires, and after that time they would need to discharge only to land.
33. This option provides additional time for those under greater time pressure because their consents are expiring in the next few years. It will also broadly ensure that all consent holders get a similar amount of time to plan their transition away from discharging to water. However, it does not extend the overall timeframe for phasing out these discharges – all discharges would still be phased out by the end of 2031.
34. Fonterra is planning to phase out discharges to water from their supplier farms more quickly than had previously been anticipated. Staff expect that this will drive an earlier transition than previously expected, including for some of the consents expiring in the coming years.
35. For these reasons, staff recommend this approach. Staff acknowledge that this is not the preferred option of iwi, however given the financial implications for some farmers, it is considered that this option still achieves the desired outcome (i.e. no discharges to water) within a fixed time period, but also acknowledges the impacts on those affected.

Option 3: Staged + individual transition

36. As discussed previously, this option was suggested by a number of people in consultation feedback and explored with stakeholders late in 2024. Under this option:
 - a. The plan would allow for an individual transition based on an assessment of the following factors on a property:
 - i. Annual rainfall
 - ii. Slopes
 - iii. Soil types
 - iv. Number of waterways.
 - b. Applications qualifying for an individual transition could be granted for a period not exceeding ten years, after which time the consent holder would need to discharge to land only
 - c. All other applications (i.e. those not qualifying for an individual transition) would be required to phase out existing discharges to water in accordance with Option 2.
37. This option means there would be discretion for individual consent officers to determine whether an individual transition was available or not, making it difficult to predict how many consents would be eligible. There is a risk that these assessments could result in either very few consent holders being provided an individual pathway or, in contrast, a large number. This option is unlikely to be supported by tangata whenua, who do not support any continuation of discharges to water.
38. While staff appreciate the challenges faced by some farmers, and their need for enough time to fund infrastructure upgrades, Fonterra holds a strong view that these discharges should be phased out much sooner than 10 years and intends to require its suppliers to transition more quickly. Given most dairy farms in Taranaki supply to Fonterra, staff consider this will continue to drive the change to discharging to land in the next few years and that therefore that fewer farms may be in the position of needing an individual transition pathway under the regional plan.

Option 4: Individual transition

39. As described in [Table 2](#) above, this option was included in consultation last year and would provide all consent holders the ability to continue discharging effluent to water for an additional ten years (in addition to the time remaining on their existing consents). Based on current information, this would mean all discharges to water would be phased out by 2041.
40. This was the least popular option included in consultation last year and unlikely to be supported by tangata whenua. Given the level of support for phasing out discharges to water in the feedback received, the lack of support for this option, and the likely speed of transition due to Fonterra's requirements, staff do not consider this option reflects community or industry preferences.

Option 5: Allowing some discharges to water

41. All of the options above assume that, in time, all discharges of effluent to water will be phased out entirely. During consultation, a small number of people sought an alternative option: that most discharges be phased out, but a small number be allowed to continue. The reasons given were largely to do with the difficulty with discharging to land on some farms because of physical and/or financial constraints.
42. Staff do not recommend this option. Discharging effluent to water is not consistent with industry good practice and is not a practice authorised in other dairying regions, nor will it support the direction of travel needed to achieve environmental outcomes. Consultation feedback demonstrated that there is general support for phasing out discharges to water, with those seeking to continue in a minority. This option would not be supported by tangata whenua who wish to see all discharges to water phased out.

Significance

43. The proposals in this paper will affect the existing 277 resource consents authorising discharges of effluent to water to a greater or lesser extent. Discharges of effluent to water are also likely to be a matter of general public interest. However, at this stage the proposals do not have any legal weight and will not until they are formally incorporated into a new regional plan which is publicly notified. The process for developing a new plan requires multiple rounds of public consultation as well as targeted consultation with statutory bodies and iwi authorities. The Significance and Engagement Policy will be implemented when the proposals are formally incorporated into a regulatory framework in the future.

Financial considerations—LTP/Annual Plan

44. 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

45. 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*.

Climate change considerations

46. There are climate change impacts to consider in relation to this item. Technical advice from the Science team indicates there is likely to be a decrease in the mean annual low flow of most rivers and streams in the region by 2050, with large decreases likely by 2100. Generally, the less water there is in a river, the more sensitive it will be to contaminants discharged into it. If discharges of effluent to water are phased out in accordance with Options 1 to 4 of this paper, this will assist with supporting the health of the region's streams by ensuring they can be more resilient to changes in climate.

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.
48. The proposals in this paper have been discussed with the Wai Steering Group as well as with the Freshwater Pou Taiao from Ngā iwi o Taranaki. As outlined above, some options presented are supported by iwi more than others, as policy development continues discussions will be ongoing with pout taiao, iwi and hapu to refine the policy framework.

Community considerations

49. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum.

Legal considerations

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



Date: 29 April 2025

Subject: Emissions Reduction Roadmap

Author: J Harvey, Climate Change Coordinator

Approved by: A Matthews, Director – Environment Quality

Document: TRCID-777834600-109

Purpose

1. The purpose of this memorandum is to seek endorsement of the proposed *Emissions Reduction Roadmap* (the Roadmap) and the approach for the development of an action plan that will detail agreed emission reduction initiatives and their associated timelines.

Executive Summary

2. Taranaki Regional Council (the Council) has prioritised climate change in its Long-term Plan 2024-2034 (LTP). This includes a commitment to reducing its own emissions. This is to be achieved through setting emissions targets and reporting on our progress towards them.
3. The Council commissioned a review of organisation-wide emissions in 2023. The independent review identified that the greatest emissions were produced by vehicles. Vehicle use includes public transport services, those utilised for operational services provided by the Council, as well as staff commuting to and from work.
4. To date, several initiatives have already been launched to minimise the Council's emissions, including the procurement of the first electric fleet vehicle, the first electric bus and the procurement of electricity from Meridian, who only use renewable generation sources, specifically hydropower.
5. To guide Council's efforts, a high-level Roadmap has been developed, providing a visual representation of the proposed pathway toward achieving emissions reduction goals. While the Roadmap outlines the overall direction, it does not include specific goals, timelines, or actions. These details will be presented for endorsement in the Emissions Reduction Action Plan, following internal stakeholder consultation in 2026.

Recommendations

That the Taranaki Regional Council:

- a) receives the memorandum titled *Emissions reduction roadmap*
- b) endorses the proposed Emissions Reduction Roadmap
- c) determines that this decision be recognised as not significant in terms of section 76 of the Local Government Act 2002
- d) determines that it has complied with the decision-making provisions of the Local Government Act 2002 to the extent necessary in relation to this decision; and in accordance with section 79 of the Act,

determines that it does not require further information, further assessment of options or further analysis of costs and benefits, or advantages and disadvantages prior to making a decision on this matter.

Background

6. Climate change is a key area of focus for the Council, with new investment and reporting requirements introduced through the Long-term Plan 2024-2034 (LTP) as set out in Table 1. This includes a commitment to reducing the Council's own emissions; achieved through setting emissions targets and reporting on our progress towards them.

Table 1 Long-term Plan 2024-2034 Performance Measures for climate emissions reduction

Performance measure	Targets		
	Year 1 (2024/25)	Year 2 (2025/26)	Year 3 (2026/27)
Objective: Research and investigations provide solutions that assist community adaptation to climate change and/or decarbonisation of activities. Performance measure: An annual report demonstrates how our actions have assisted to achieve an annual decrease in our carbon emissions and community adaption. We are proposing to do this through setting specific emissions targets and reporting on our progress.	Our Climate Change Strategy and Roadmap is reviewed. An organisational greenhouse gas (GHG) emissions reduction plan is prepared.	Actions identified in the Climate Change Strategy and Roadmap are implemented and publicly reported on.	Actions identified in the Climate Change Strategy and Roadmap are implemented and publicly reported on.

7. Setting and achieving emission reduction targets is crucial for organisations to 'play their part' in meeting New Zealand's legislated target¹ of Net Zero by 2050. Many councils have already commenced their emissions reduction journey. This includes New Plymouth District Council and South Taranaki District Council.
8. In 2023 Tonkin + Taylor was contracted to undertake an initial assessment of the Council's greenhouse gas emissions. This stocktake identified scope 1, 2 and 3 emissions and converted these into CO₂ equivalents (CO₂-eq), a metric measurement used to enable a comparison of various greenhouse gases. Scope 1 refers to direct emissions from sources a company owns or controls, for example fleet vehicles and generators. Scope 2 includes indirect emissions from purchased energy, such as electricity. Scope 3 encompasses all other indirect emissions in the value chain, like the emissions from public transport and the Council's staff commuting to and from work.
9. The greatest source of CO₂-eq emissions was determined to be public transport (1,268 tonnes) the second, third and fourth highest were from the diesel and petrol use in the Council's fleet vehicles and the fuel used by employees commuting to and from work, respectively. A breakdown of calculated estimated emissions as CO₂-eq is provided in Table 2 and presented graphically in Figure 1 below.

Table 2 Taranaki Regional Council emissions in CO₂ equivalent by source during the 2022-2023 period

Source of emissions	CO ₂ equivalents (Tonnes)
Public transport	1,268
Diesel	390
Employee commute	246
Petrol (regular)	225

¹ Climate Change Response Act 2002 Part 1B Subpart 1, 5Q (1)(a) requires all greenhouse gases, other than biogenic methane, to reach net zero by 2050

Source of emissions	CO ₂ equivalents (Tonnes)
Recycling	46
Air travel	35
Natural gas	29
Electricity	29
Accommodation	21
Waste	14
T&D Losses + energy production	6
Road travel	5
WFH	4
LPG	<1
Water	<1

Taranaki Regional Council Emission Sources 2022-2023

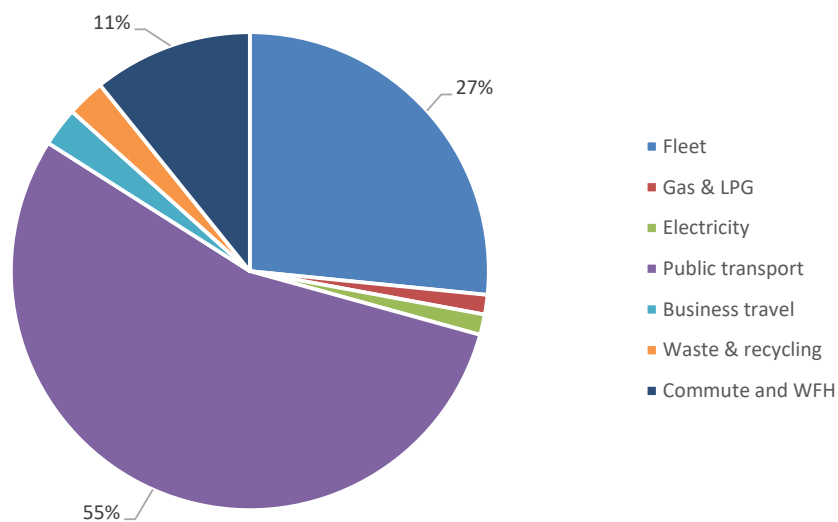


Figure 1 Graphical representation of emissions by source and percentage 2022-2023 financial year.

Issues

- Successful climate change mitigation is the most effective method for reducing the impacts of climate change on communities.

Discussion

- To date there have been limited legislative requirements placed directly on regional councils regarding emissions reduction, therefore most work has been and will continue to be non-regulatory and driven internally by Council staff and regional policy direction. As such, it is necessary to prepare and maintain an emissions reduction action plan that provides direction for the Council as a whole.

12. To date several significant work streams have commenced to meet the needs of the Council to decarbonise. To date this has included:
- Changes in community services such as the inclusion of an electric bus in the public transport network.
 - Changes in the Council's internal functions such as transitioning fleet vehicles to hybrid when practicable, purchasing our first full electric fleet vehicle, undertaking an investigation into the economic benefits of solar power, and procuring electricity supply from Meridian.
 - Establishing an emissions baseline, commissioned and completed in 2024, to provide a baseline for future greenhouse gas emission reduction reporting.
 - Contributing in-kind support through involvement with our rural community to identify ways to reduce CO2 emissions and increase energy resilience across the rural sector.
 - The development of the emissions reduction plan (the Roadmap) that lays out the high level direction for the Council and lays the foundation for the Emissions Reduction Action Plan.

The Roadmap

13. The Roadmap sets out a stepped approach to establishing and achieving the Council's emission reduction goals as follows:

Step 1: Understand our emissions

14. The first step in reducing emissions is to gain a clear understanding of where our emissions come from. This has been completed but will need to be updated regularly.

Step 2: Setting targets and developing actions

15. The next step is to develop an emission reduction action plan that sets targets, and actions to achieve them. Some emissions can be addressed relatively easily by modifying how we do things – such as improving operational efficiencies or encouraging carpooling for daily commutes. Other emissions are more challenging to address. For instance, emissions from diesel-powered four-wheel-drive vehicles used for essential off-road work are harder to tackle due to limited alternative technologies and high associated costs.

Step 3: Monitoring and reporting

16. To ensure the emissions reduction action plan remains relevant over time, it will be regularly monitored and reviewed to reflect advancements in technology, changes in legislation, and other external factors. Where necessary, the plan will be updated to incorporate these developments. Ongoing engagement with Council, iwi/hapū, and other key stakeholders will be essential in evaluating progress, exploring outcomes, and shaping future updates to the plan.
17. In addition to outlining the steps needed to achieve our long-term, organisation-wide emission reduction goals, the roadmap also highlights several key principles:
- **Collaboration:** Starting with a focus on internal coordination and expanding to include wider regional partnerships, as our communities begin their own emissions reduction journeys.
 - **Transparency and Accountability:** Regular monitoring and reporting of progress to ensure we remain accountable to the targets we set.
 - **Early Wins:** Identifying and prioritising achievable actions.
 - **Pragmatism and Flexibility:** Recognising that emissions reduction can be complex and we need to be realistic about what we can achieve.
 - **Co-beneficial Offsetting:** Supporting and promoting carbon offset initiatives that also deliver wider environmental, social, or economic benefits for the region.

- Continuous Learning: Embracing both successes and setbacks and using these insights to adapt and refine the action plan as priorities and circumstances evolve.

Options

18. There are three options available:
 - a) endorse the proposed Roadmap as drafted;
 - b) endorse the Roadmap subject to amendment; or
 - c) reject the Roadmap.
19. Option (a) is recommended. Climate change is a priority issue for Taranaki and the Council – as identified in the LTP. While officers could continue to advance emissions reduction initiatives in line with our LTP commitments in the short-term, an emissions reduction roadmap and action plan endorsed by Council will provide for a more strategic and consistent approach.

Significance

20. This decision is assessed as not significant with regards to the Significance and Engagement Policy. It will have no impact on levels of service, incur more than \$10,000,000 budgeted or \$5,000,000 of unbudgeted expenditure, or involve the transfer of ownership or control of a strategic asset.

Financial considerations—LTP/Annual Plan

21. 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. The actions outlined in this memorandum and the emissions reduction roadmap provided are consistent with the LTP 2024-2034, including the Year 1 Performance Target to prepare an organisational greenhouse gas (GHG) emissions reduction plan.

Policy considerations

22. 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*.

Climate change considerations

23. This item will have a significant influence on the future climate change direction for the Council. It is part of the work stream already approved through the LTP. The Roadmap provides high level direction designed to help the Council meet its emissions reduction requirements.

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.

Community considerations

25. This memorandum and the associated recommendations have considered the views of the community, interested and affected parties and those views have been recognised in the preparation of this memorandum. The Roadmap and proposed action plan have been designed to meet the requirements of our community to respond to these.

Legal considerations

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

Appendices/Attachments

TRCID-1492626864-576 [GHG emissions inventory: summary report](#)

TRCID-1492626864-569 [Emissions reduction roadmap](#)



GHG emissions inventory

Summary report

Prepared for
Taranaki Regional Council
Prepared by
Tonkin & Taylor Ltd
Date
March 2024
Job Number
1091031 v2.0



**Together we create and
sustain a better world**
www.tonkintaylor.co.nz

DOCUMENT control

Title: GHG emissions inventory					
Date	Version	Description	Prepared by:	Reviewed by:	Authorised by:
15/12/23	1.0	Draft GHG emissions inventory summary report	E W Peter	M Karlik-Neale	
28/3/2024	2.0	Final GHG emissions inventory	E W Peter	M Karlik-Neale	Markus Benter-Lynch

Distribution:

Taranaki Regional Council

1 electronic copy

Tonkin & Taylor Ltd (FILE)

1 electronic copy

Table of contents

Executive Summary	1
1 Introduction and context	1
1.1 Organisation description	1
1.2 Reporting period and frequency of reporting	2
1.3 Verification	2
2 Organisational boundary	2
3 Operational boundary	2
3.1 Significance and materiality	4
3.2 Data quality and associated uncertainty	4
3.3 Summary of emission source exclusions and data gaps	5
4 Quantified GHG emissions inventory	6
4.1 Methodology	6
4.2 Data collection and quantification	6
4.3 GHG emissions profile	7
4.3.1 Scope 1 emissions by gas type	9
4.4 GWP calculation and source	9
5 Glossary	9
6 Applicability	11

Appendix A

Executive Summary

This emissions inventory was prepared for Taranaki Regional Council (TRC) for the 2022/2023 financial year ending in June 2023.

Table.1: Executive summary

Organisational background	Name: Taranaki Regional Council (TRC) Contact person: Victoria McKay Contact email: victoria.mckay@trc.govt.nz Area of business: Taranaki, New Zealand Full Time Equivalent (FTE): 256 Business description: TRC is the regional council serving the community in the Taranaki region.	
Reporting period	1 July 2022 – 31 June 2023	
Organisational boundary (operational control approach)	This inventory covers TRC's operational activities except Taranaki Port and Yarrow Stadium.	
Operational boundary	The following Scope 1 and 2 emissions are included in the boundary: <ul style="list-style-type: none"> • Scope 1 (Direct) <ul style="list-style-type: none"> – Generators and garden equipment (stationary combustion) – Fleet fuel (mobile combustion) – Natural gas (stationary combustion) – LPG (gas bottles) • Scope 2 (indirect electricity) <ul style="list-style-type: none"> – Electricity 	
High Level Estimates for Scope 3	<ul style="list-style-type: none"> • Scope 3 (indirect) – initial estimate only <ul style="list-style-type: none"> – Operation of public transport – Water use – Transmission & distribution losses – Production and distribution of fuel – Waste – Business travel – Employee commute – Working from home 	
Exclusions	Scope 1: <ul style="list-style-type: none"> • Wood burner(s) – de minimis • Fugitive emissions (refrigerants) – lack of data 	Scope 3: <ul style="list-style-type: none"> • Purchased goods and services (except public transport & water) • Capital goods. • Disposal of waste water • Investments (Port, Yarrow Stadium)
Emissions	Total Scope 1 & 2: 672.99 tCO ₂ e Total Estimated Scope 1-3: 2,317.5 tCO ₂ e	
Emissions intensity	Scope 1 & 2: 2.63 tCO ₂ e/FTE Scope 1-3: 9.05 tCO ₂ e/FTE	

1 Introduction and context

This report is the inaugural greenhouse gas (GHG) emissions inventory report for Taranaki Regional Council (TRC) for Scope 1 and 2 only. Some Scope 3 emissions have also been estimated based on available data. Those estimates are provided as context for Scope 1 and 2 emissions.

This report was prepared by TRC and Tonkin & Taylor Ltd (T+T) in conformance with the “Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard” (GHG Protocol) (WRI, 2004). The GHG Protocol is a widely accepted methodology for organisational carbon accounting, and is aligned with ISO 14064 (2018). The information contained in the report is based on data provided by TRC as outlined in the carbon inventory spreadsheet. As such, T+T does not accept any liability in relation to the completeness or accuracy of any information contained in the report.

This report:

- Relates to TRC’s GHG emissions.
- Endeavours to use primary data wherever possible, especially for major emissions sources. Where primary data is not available, a consistent and conservative approach to estimating emissions was used.
- Reflects TRC’s commitment to better understand and ultimately reduce its GHG emissions.
- Excludes specific targets and target setting.

1.1 Organisation description

TRC is the regional council serving the community in the Taranaki region. TRC defines its purpose as “TRC is to enable democratic local decision-making and action by, and on behalf of communities and to promote the social, economic, environmental and cultural well-being of communities in the present and for the future”¹. TRC’s functions, responsibilities and activities are listed in [Table 1.1](#).

Table 1.1: TRC’s functions, responsibility and activities²

Group of Activity	Activities within each group
Resource management	Resource management planning Consent processing and administration Compliance monitoring programmes Pollution incidents and response State of the environment monitoring Resource investigations and projects Sustainable land management plans and plant supply programme Waitara River Catchment (New Plymouth District Council (Waitara Lands) Act 2008 Enhancement grants
Biosecurity and biodiversity	Biosecurity and biodiversity planning Biosecurity/pest management Biodiversity
Transport	Regional land transport planning Passenger transport

¹ [TARANAKI-REGIONAL-COUNCIL-Local-Governance-Statement-2022-2025.DOCX \(live.com\)](#)

² [TARANAKI-REGIONAL-COUNCIL-Local-Governance-Statement-2022-2025.DOCX \(live.com\)](#)

Group of Activity	Activities within each group
Hazard management	Harbour management Civil defence emergency management Flood management and general river control River control schemes
Recreation, culture and heritage	Regional gardens Puke Ariki Yarrow Stadium
Regional representation, advocacy and investment management	Investment management Community engagement Advocacy and response Governance

1.2 Reporting period and frequency of reporting

This report covers the reporting period 01 July 2022 to 31 June 2023 (FY22/23). Audience and dissemination policy.

This report is intended for internal purposes, namely, to help TRC to identify and reduce its GHG emissions. As such the report is intended for internal distribution only.

1.3 Verification

The GHG emissions inventory and the GHG emissions inventory report have not been independently verified.

2 Organisational boundary

The organisational boundary identifies which TRC operations are included or excluded from the GHG emissions inventory. Emissions from operations within the boundary are consolidated to determine the total emissions for the reporting period. *The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (GHG Protocol) and ISO 14064-1 (2018) identifies two consolidation methods:

- **Operational control approach:** Under this approach, an organisation accounts for 100% of the GHG emissions from operations over which it has control. Control can be defined as either financial or operational.
- **Equity share approach:** Whereby an organisation only includes GHG emissions for the portion of the facilities and business that the organisation owns.

TRC utilises the operational control approach to set its GHG emissions inventory. This method considers all emissions sources that TRC has control over, which enables the implementation of management actions for these sources.

TRC's organisational boundary does not include Taranaki Port and Yarrow Stadium.

3 Operational boundary

The operational boundary identifies which activities, and their associated emissions sources are included in the GHG emissions inventory. The GHG Protocol categorises emissions as follows:

- **Direct Emissions (Scope 1)** are those resulting from sources that are owned or controlled by the company including stationary energy sources and vehicles owned by the company.
- **Indirect Emissions (Scope 2)** are associated with emissions from the generation of purchased electricity consumed by the company.
- **Indirect Emissions (Scope 3)** are from sources not owned or controlled by the company. This scope is an optional reporting category under the GHG Protocol that accounts for all other indirect emissions.

GHG emissions sources were identified in accordance with the requirements of the GHG Protocol and ISO 14064-1 (2018) and classified into the scopes and categories shown in [Table 3.1](#).

Table 3.1: GHG emissions categories included in the organisational boundary

Scope	ISO 14064-1 Category	GHG Protocol Category	Emissions sources	Included
Scope 1	Cat. 1 Direct	Stationary combustion	LPG, Natural Gas Diesel and petrol used in stationary assets	Yes
		Stationary combustion	Diesel and petrol used in stationary assets	Incorporated in mobile combustion
		Stationary combustion	Wood burners and other biofuels	No – small amount, currently not measured
		Mobile combustion	Petrol & diesel used in TRC fleet	Yes
		Fugitive emissions	Refrigerants in offices, fridges and vehicles	No – data not readily available
		Process emissions	None identified	
		Land-use change	None identified	
Scope 2	Cat. 2 Imported Energy	Purchased energy	Electricity in owned buildings	Yes
Scope 3	Cat. 4 Product used by the organisation	Cat. 1 Purchased goods and services	Operation of public transport, water	Estimate
			Other purchased goods and services	No – currently not measured
		Cat. 2 Capital goods		No – currently not measured
	Cat. 6 Other sources	Cat. 3 Fuel and energy related activities	Transmission and distribution losses, production and distribution of fuels	Estimate
	Cat. 3 Transportation	Category 4 Upstream transportation and distribution	None identified	
	Cat. 6 Other sources	Cat. 5 Waste generated in operations	Waste to landfill, recycling	Estimate
			Liquid waste	No – currently not measured

Scope	ISO 14064-1 Category	GHG Protocol Category	Emissions sources	Included
	Cat. 3 Transportation	Cat. 6 Business travel	Road and air travel, accommodation	Estimate
		Cat. 7 Employee commuting	Travel to and from work, working from home	Estimate
	Cat. 6 Other sources	Cat. 8 Upstream leased assets	None identified	
	Cat. 3 Transportation	Cat. 9 Downstream transportation and distribution	None identified	
	Cat. 5 Use of products sold	Cat. 10 Processing of sold products	None identified	
		Cat. 11 Use of sold products	None identified	
		Cat. 12 End of life treatment of sold products	None identified	
	Cat. 6 Other sources	Cat. 13 Downstream leased assets	None identified	
		Cat. 14 Franchises	None identified	
		Cat. 15 Investments	Port, Yarrow Stadium	No – currently not measured

3.1 Significance and materiality

The following factors were considered when assessing if a GHG emissions source is significant:

- Size of the emissions source in relation to total emissions.
- TRC's level of control over the emission source.
- Ability to measure the emissions.
- Industry practice.

3.2 Data quality and associated uncertainty

Wherever possible, TRC used measured data for emission source quantities (for direct emissions) and the measure that relates as close as possible to the point of combustion or emission (e.g. litres of fuel, rather than kilometres travelled). The emissions calculated for scope 1 and scope 2 sources are based on robust and measured input data (M1). Scope 3 emissions were estimated at a high level where the required data was available.

Overall, the emissions calculated are consistent with internationally accepted methodology and guidelines. The overall uncertainty of the results is therefore limited to the uncertainty inherent in the methodology and emissions factors applied.

Data quality is evaluated using the framework presented in [Table 3.2](#) below.

Table 3.2: Data quality

Data management	Data collection		
	Measured	Derived	Estimated
Robust	M1	D1	E1
Satisfactory	M2	D2	E2
Questionable	M3	D3	E3

Table 3.3: Uncertainty and limitations for GHG emission sources included in the inventory

Emission source	Data source	Unit	Data quality	Uncertainty and data limitations
Scope 1				
Petrol use (mobile)	Fleet fuel consumption report from FRODO	L	M1	Assumed that petrol used was regular petrol. Default emissions factor used for petrol.
Diesel use (mobile)	Fleet fuel consumption report from FRODO	L	M1	Default emission factor used for diesel.
Natural gas (stationary)	Consumption report per ICP from Genesis Energy	kWh	M1	Natural gas connected to pipelines (meter reading was provided for two locations).
LPG (gas bottles)	Summary LPG bottles purchased from Genesis Energy	kg	M1	LPG use is minimal – used for BBQ for community and some internal use. Data provided by number and weight of LPG bottles purchased
Scope 2				
Electricity	Consumption report per ICP from Genesis Energy	kWh	M1	The Gatehouse Restaurant and Reception ICP had four meters. Their data was not able to be separated. Data for each month relates to when the invoice is issued rather than consumption for that month. TRC owned housing is not included due to lack of data.

3.3 Summary of emission source exclusions and data gaps

[Table 3.4](#) details the GHG emissions sources that have been identified but excluded from the GHG emissions inventory. These will continue to be assessed further as TRC continues its GHG emissions reporting journey. Scope 3 emissions have been estimated at a high level where possible.

Table 3.4: GHG emission sources excluded from the inventory

Emission source	Justifications
Scope 1	
Fuel use (stationary)	Very small amount from generators (fixed) in the office property (Pukeiti building), and a number of mobile generators and gardening equipment across

Emission source	Justifications
	Taranaki (parks and rec team). The amount was incorporated with diesel and petrol under mobile combustion.
Wood burner(s) and other biofuels	Low ability to measure. Minimal amount used.
Fugitive emissions (refrigerants)	Difficult to measure.

4 Quantified GHG emissions inventory

4.1 Methodology

The GHG emissions inventory has been prepared in accordance with the **World Resource Institute's Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (2004)** (GHG Protocol) and which is aligned with **ISO 14064-1 (2018) Specification with guidance at the organisation level for quantification and reporting of GHG emissions and removals** (ISO 14064-1 (2018)).

In preparing this inventory, the five principles of ISO 14064-1 (2018) were applied:

- **Relevance** – Select the GHG sources, GHG sinks, data and methodologies appropriate to the needs of the intended user.
- **Completeness** – Include all relevant GHG emissions and removals.
- **Consistency** – Enable meaningful comparisons in GHG-related information.
- **Accuracy** – Reduce bias and uncertainties as far as is practicable.
- **Transparency** – Disclose sufficient and appropriate GHG-related information to allow intended users to make decisions with reasonable confidence.

The methodology used in preparing Taranaki Regional Council's organisational GHG inventory is illustrated in [Figure 4.1](#).

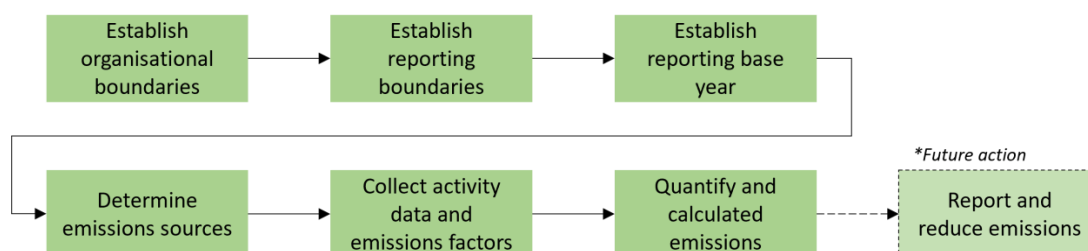


Figure 4.1: ISO 14064-1 (2018) Methodology for Measuring a GHG Inventory

4.2 Data collection and quantification

[Table 4.1](#) provides an overview of how data was collected for each GHG emissions source, the source of the data and assumptions or uncertainties made in calculating GHG emissions. The calculation method used to quantify emissions was the activity data multiplied by the appropriate emission factor: GHG emissions = activity data x emission factor.

GHG emissions factors were generally sourced from New Zealand's Ministry for the Environment.

Table 4.1: Data sources for Taranaki Regional Council's FY22/23 emissions

ISO Category	Source	Unit	Data Source
1) Direct GHG Emissions and removals	Fuel	Litres of Fuel and dollar value	Fuel cards
	Natural gas	TJ	Supplier invoices
2) Indirect GHG emissions from imported energy	Purchased electricity	kWh	Supplier invoices
(3) Indirect GHG emissions from transportation	Business travel – Road travel	Km	Expense report
	Business travel – Air travel	Passenger.km	Expense report
	Accommodation	No. of nights	Expense report
	Employee commute	Days	Staff survey
(4) Indirect GHG emissions from products an organisation uses	Transmission and distribution losses	kWh	Supplier invoices
	Working from home	Days	Staff survey
	Waste	kg	Estimates from TRC
	Water	m ³	Estimates from TRC

4.3 GHG emissions profile

The total Scope 1 and 2 GHG emissions for FY22/23 were estimated at 672.99 tCO₂e (tonnes of carbon dioxide equivalent).

[Table 4.2](#) details TRC's GHG emissions during the reporting period for Scope 1 and 2 including a high-level estimate for Scope 3.

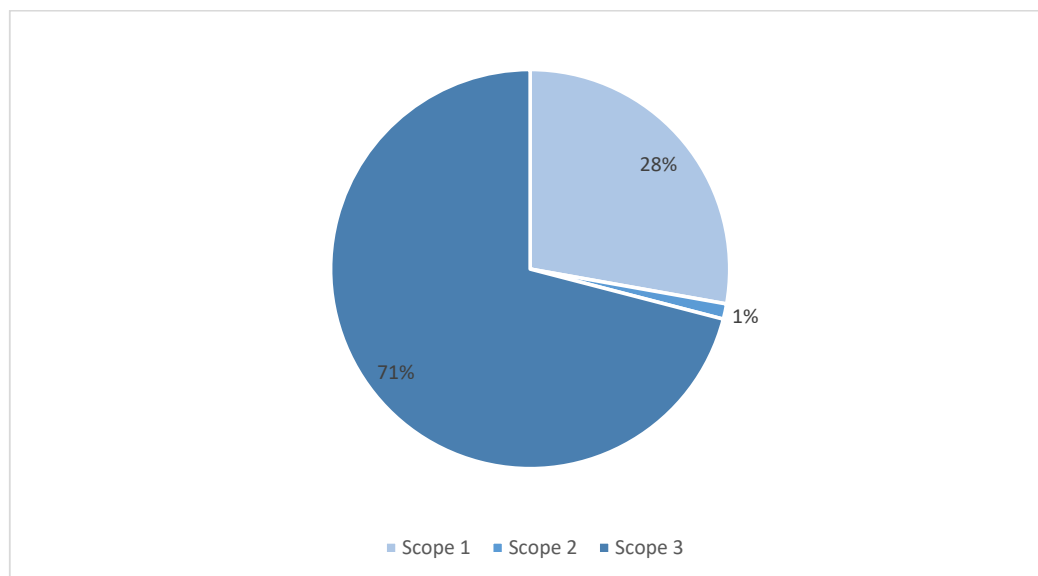


Figure 4.2: Taranaki Regional Council's emissions by scope

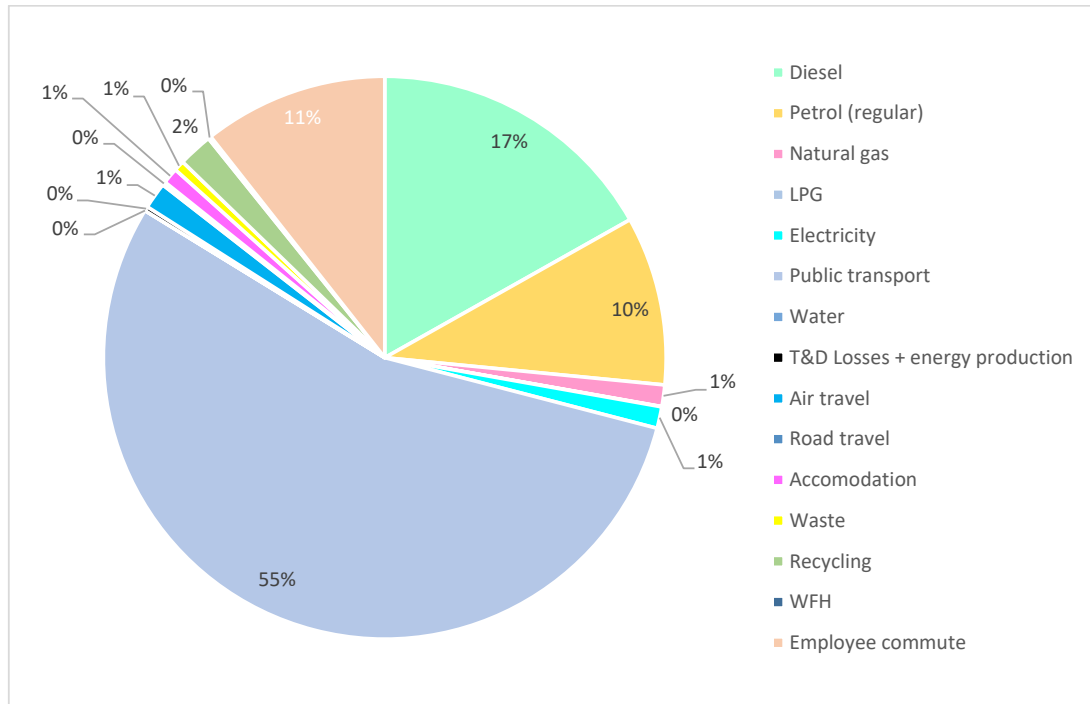


Figure 4.3: Taranaki Regional Council's emissions by source

Table 4.2: Quantified GHG inventory of emissions

Emission Source	Quantity	Unit	Emission Factor (kgCO ₂ e/unit)	tCO ₂ e
Scope 1				
Diesel	143,779	Litres	2.71	390
Petrol (regular)	91,604	Litres	2.46	225
Natural gas	147,757	kWh	0.19	29
LPG	135	kg	2.97	0.4
Scope 2				
Electricity	387,609	kWh	0.07	29
Total Scope 1 & 2				673
Scope 3 (estimate)				
Public transport	467,075	Litres	2.71	1,268
Water	1,346	m ³	0.03	0.042
T&D Losses + energy production				6
Air business travel	44,590	\$	0.79	35
Road business travel	20,169	\$	0.23	5
Accommodation	141,812	\$	0.15	21
Waste	21,000	kg	0.67	14

Emission Source	Quantity	Unit	Emission Factor (kgCO ₂ e/unit)	tCO ₂ e
Recycling	34,183	kg		46
Working from home	10,560	p/day		4
Employee commute				246
Total				2,317

No of employees	256
------------------------	------------

Emissions intensity Scope 1 & 2 (tCO₂e/employee)	2.63
--	-------------

4.3.1 Scope 1 emissions by gas type

ISO 14064-1 (2018) requires that scope 1 emissions are reported separately by gas type. [Table 4.3](#) below shows each Scope 1 emissions source separated into gas types. The vast majority of this is carbon dioxide.

Table 4.3: Taranaki Regional Council's FY22/23 Scope 1 emissions by gas type

Scope 1 activity	tCO ₂ e	tCO ₂	tCH ₄	tN ₂ O	tHFC	tPFC	tSF ₆
Diesel – mobile	390.34	384.34	0.58	5.43	0	0	0
Petrol – mobile	224.90	215.57	2.83	6.50	0	0	0
Gas - stationary	28.81	28.66	0.06	0.01	0	0	0
	0.4091	0.4077	0.0008	0.0002	0	0	0
Total	644.47	628.98	3.47	11.95	0	0	0

4.4 GWP calculation and source

GHG emissions are expressed as kg CO₂-e (Carbon Dioxide equivalent) using the global warming potentials (GWP) from the New Zealand Ministry for the Environment (MfE) 2023. Measuring Emissions: A Guide for Organisations: 2023 Detailed Guide. Breakdown by specific gases can be derived based on data provided in the appropriate chapters in the MfE emissions guide.

5 Glossary

De minimis

Certain activities contribute less than 1 percent of the total of CO₂e emissions. These may be excluded from the GHG inventory, provided that the total of excluded emissions do not exceed a materiality threshold of 5 percent. That is, the total of all excluded emission sources should not exceed 5 percent of the total inventory.

Greenhouse gases (GHG)

Gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. These include:

- Carbon dioxide (CO₂).
- Methane (CH₄).
- Nitrous oxide (N₂O).
- Hydrofluorocarbons (HFCs).

- Perfluorocarbons (PFCs).
- Sulphur hexafluoride (SF₆).

GHG Emissions Scopes:

Scope 1: Direct emissions from sources owned or controlled by reporting entity. For example, diesel generator, coal heating, own vehicle fleet, agriculture.

Scope 2: Indirect emissions generated by purchased energy. For example, electricity, gas.

Scope 3: Indirect emissions that are a consequence of activities undertaken by the reporting organisation or related individual, but not directly controlled by the organisation. For example, flights, freight, non-company vehicles, waste, electricity line distribution and transmission losses.

6 Applicability

This report has been prepared for the exclusive use of our client Taranaki Regional Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:



.....
Elisha Willeam Peter
Sustainability Consultant

Authorised for Tonkin & Taylor Ltd by:



.....
Markus Benter-Lynch
Project Director



.....
Marta Karlik-Neale
Principal Sustainability & Resilience

\\\\ttgroup.local\\corporate\\christchurch\\tt projects\\1091031\\issueddocuments\\trc ghg emissions inventory summary report_final scope 12 final.docx

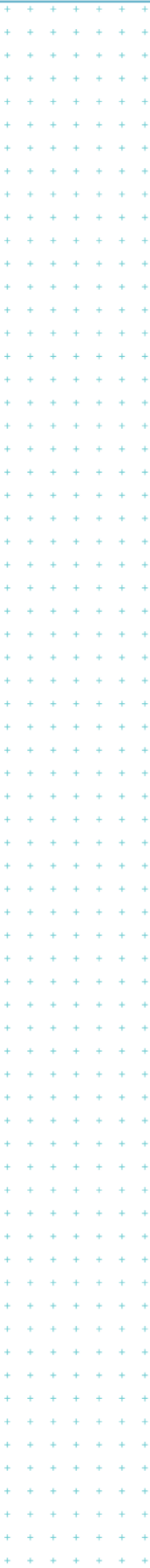
Appendix A Emission Factors

The following GHG emissions factors were used for Scope 1 and 2:

- New Zealand Ministry for the Environment (MfE). 2023. Measuring Emissions: A Guide for Organisations: 2023 Detailed Guide. Wellington.

GHG emission factors for 100% of the electricity are location-based.

The methodology, uncertainty and assumptions used in developing the GHG emissions factors are disclosed within the appropriate chapters in the MfE emissions guide.



www.tonkintaylor.co.nz

EMISSIONS REDUCTION ROADMAP





Date: 29 April 2025

Subject: Our environment 2025 - Tō tātou taiao report

Author: AJ Matthews, Director - Environment Quality

Approved by: AJ Matthews, Director - Environment Quality

Document: TRCID-1492626864-573

Purpose

1. The purpose of this memorandum is to provide an overview of a recently released Ministry for the Environment (MfE) and Stats NZ report: *Our environment 2025 - Tō tātou taiao* and companion documents.

Executive summary

2. Our environment 2025 - Tō tātou taiao is the latest in a three-yearly series of environment reports produced by MfE and Stats NZ under the Environmental Reporting Act 2015.
3. The report provides an overall picture of New Zealand's environment across the marine, freshwater, atmosphere and climate, land, and air domains. A companion document *Our environment, our lives: The stories behind the numbers*, produced by MfE highlights just some of the many initiatives led by communities, iwi and Māori, local government, farmers, businesses and government to drive improvement.
4. The report opens with a discussion on the dynamic and interconnected 'drivers' (or social, cultural, demographic and economic activities) that create pressures on the environment.
5. Data and information are then presented in the report, covering five domains: land, freshwater, marine, air, atmosphere and climate; wrapping up with a discussion on the impacts on people, society and our economy.
6. The report highlights the very real risks to people, communities and places which, should we fail to address them, threaten our livelihoods and quality of life for generations to come. Drawing on a range of data and information sources, it shows how people continue to drive change in our land, water and coasts, and how are affected – in both positive and negative ways - by the changes we cause.
7. It canvases five themes describing the critical knowledge gaps that are holding us back from understanding the drivers and consequences of environmental change as well as effective actions and responses.
8. Many of these gaps are not unique to Aotearoa New Zealand and require further investment in both data collection and analysis to address. It is important to note that these are not new challenges and, while complex to address, they are not insurmountable. Where possible, the Council's science team has been seeking to address some of these gaps and limitations, noting that these challenges cannot and should not sit solely with regional councils to resolve.

9. Council is due to release its own five-yearly environmental synthesis report in 2027. This report presents an opportunity to explore the issues set out in Our environment 2025 - Tō tātou taiao in a Taranaki context, as well as showcase the extensive work undertaken by the Council alongside our community to improve and enhance our natural environment.

Recommendations

That the Taranaki Regional Council:

- a) receives the memorandum *Our environment 2025 - Tō tātou taiao report*
- b) notes the findings and discussion in regard to data gaps and how the Council and wider regional sector is contributing to resolving some of these
- c) notes that the Council is due to publish its next regional state of environment synthesis report in 2027.

Background

10. Our environment 2025 - Tō tātou taiao is the latest three-yearly synthesis report produced by MfE and Stats NZ under the Environmental Reporting Act 2015.
11. The report provides an overall picture of New Zealand's environment across the marine, freshwater, atmosphere and climate, land, and air domains, and is accompanied by supporting documentation including:
 - A [Technical annex](#) with information on the indicators and information sources reported on; and
 - Companion document [Our environment, our lives: The stories behind the numbers](#), produced by MfE, highlights some of the many positive actions New Zealanders are taking to reverse environmental degradation and build greater resilience, whether at community, iwi, business or government level.
12. A range of new and updated indicators include (but are not limited to) land use (livestock numbers and irrigated land), erosion, indigenous terrestrial, freshwater and coastal/marine biodiversity (extinction threat and risk) and waste, groundwater quality, lake health, coastal and estuarine water quality and productivity, fish stocks and associated indicators, climate (sea-surface temperature and marine heatwaves), air (transport emissions and home heating), greenhouse gas emissions and a range of climate indicators.

Discussion

13. The report opens with a discussion of the dynamic and interconnected 'drivers', or social, cultural, demographic and economic activities, that create pressures on the environment. These include international influences, our livelihoods and the economy, population growth and demographic change, individual choices, technology and innovation, and a changing climate. Collectively these pressures lead to both positive and negative outcomes – for our health, for our environment, our economy and infrastructure.
14. Data and information are then presented in the report, covering five domains: land, freshwater, marine, air, atmosphere and climate; wrapping up with a discussion on the impacts on people, society and our economy.

Land

15. Land looks at two important issues. Soil and land use provides insights into how we use and manage the land and the issues this creates for soil erosion, soil health and contamination, and urban greenspaces and land fragmentation. Changes in terrestrial habitats and native species, and how they are threatened by habitat loss and invasive species, is also covered.

16. Land use and management have continued to intensify, putting pressure on soil health, water quality and indigenous biodiversity. While livestock numbers have stabilised following an increase between the 1990's and mid-2010's, intensification has continued with expansion in irrigated land between 2002 and 2022 (primarily in Canterbury) and increases in nitrogen fertiliser use.
17. Erosion continues to impact freshwater, with 182 million tonnes of eroded soil entering waterways in 2022. Climate change is expected to increase erosion rates. Soil quality at monitored agricultural sites is not always within target ranges, with 49% of sites below the target range for microporosity (a measure of soil compaction) from 2014-2018, and 63% of soil samples collected between 2001 and 2015 having Olsen P (phosphorus) levels above the target range.
18. New Zealand consistently generates among the highest rates of municipal waste per person in the developed world. Between 2021 and 2023 we sent an average of 688kg of waste per person to landfill, although this is 11% less waste per capita than in 2018 when waste disposal in New Zealand peaked. Contaminated land and emerging contaminants such as microplastics present risks to public health and the environment.
19. Our cities are densifying and expanding, driven by growing populations, and land-use decisions. The urban area grew 15% between 1996 and 2018, with a combination of densification of the urban environment and expansion at urban margins in the decade to 2021. About 14% of New Zealand has been classified as highly productive; the amount of highly productive land converted to urban or residential use increased between from 2% in 2002 to 3% in 2019, and other areas of highly productive land also became more fragmented. The quantity and quality of urban green space is also declining. In some cities, such as Auckland and Hamilton, parks and green belts are failing to keep pace with expansion and densification is resulting in a decline in private green space.
20. Indicator updates for indigenous terrestrial birds and reptiles show a high proportion of species remain threatened with extinction, or at risk of becoming threatened. Updated assessments by the Department of Conservation show most of our indigenous bat and frog species, and almost half of our indigenous terrestrial vascular plant species, remain threatened with extinction or at risk of becoming threatened. Updates also show that of the assessed indigenous terrestrial invertebrate species, a significant proportion remain threatened or at risk. Pests and weeds threaten biodiversity and put vulnerable ecosystems at risk.

Freshwater

21. This section reports on the state of freshwater quality in our groundwater, rivers and lakes, along with the pressures, including agriculture, wastewater and stormwater, which are responsible for the degraded state of many waterways. Evidence on how freshwater quality, land conversion, changes to flows and water courses, pests and climate change are all affecting the state of freshwater habitats and native species is also presented.
22. *Escherichia coli* (*E. coli*) monitoring data show that contamination by faecal pathogens remains the most widespread water quality issue affecting groundwaters. Of 1,007 groundwater monitoring sites, 46% failed to meet the New Zealand drinking water standard for *E. coli* on at least one occasion between 2019 and 2024. This included some public drinking water supplies sourced from bores and springs. Twelve percent of 1,173 groundwater monitoring sites failed to meet the New Zealand drinking water standard for nitrate-nitrogen on at least one occasion between 2019 and 2024. In contrast, non-natural chemicals (such as PFAS) and pesticides do not appear to present a widespread issue.
23. Case studies show mahinga kai is being impacted in receiving environments, with mātauranga observations of species in coastal North Canterbury and Wairoa and Waiau rivers declining in health between 2021 to 2023. Models estimate that 45 percent of the country's total river length was not suitable for activities such as swimming between 2016 and 2020, based on an average *Campylobacter* infection risk of >3%. Trends in *E. coli* in rivers and lakes were a mixed bag with some improving and some degrading.

24. Overall river habitat is generally better than not. Soil loss to waterways is an issue in some parts of New Zealand, with 23% of river length experiencing a moderate to high impact due to suspended sediment.
25. Both rivers and lake ecosystems are showing signs of degradation due to excess nutrient levels. Macroinvertebrate communities in rivers continue to be impacted (25% improving; 56% degrading), with around 55% of rivers impacted by moderate or severe organic pollution or nutrient enrichment. Modelling suggests that 46% of lakes greater than 1 hectare were in poor or very poor health, 34% were in good or very good health. Trends at 34% of lakes were improving, while 45% were degrading. Introduced aquatic fish and plants place pressure on freshwater systems, a recent example being the introduction of gold clam (*Corbicula fluminea*), which has established a breeding population in the Waikato River.
26. A national assessment of river barriers (dams, weirs, culverts, etc) estimates that at least 48% of the national river network is at least partially inaccessible to migratory fish, though a further 36% is yet to be assessed and could also be inaccessible.
27. Urban wastewater and stormwater also impact freshwater, introducing other contaminants such as heavy metals, hydrocarbons, and pathogens, particularly where treatment is insufficient or where wastewater bypasses treatment (i.e. overflows during wet weather events). Plastics, microplastics (less than 5mm diameter), pesticides and other contaminants are all impacting waterbodies across New Zealand.
28. Wetlands continue to be lost. Freshwater wetland area decreased by 1,498 hectares (0.6 percent), between 2012 and 2018. Degradation of remaining wetlands by drainage and adjacent land use has continued, despite these environments providing important benefits and offsetting the impacts of land use by storing carbon, regulating water flow during storms and filtering nutrients and sediment.
29. In 2017, 76% of freshwater indigenous fish and 39% of plants were threatened with extinction or at risk of becoming threatened. In 2021, 68% of freshwater-dependent birds were also at risk/threatened, with 77% having stable populations and 20% with decreasing populations.
30. The report acknowledges the impacts that water use can have on waterbodies would benefit from further analysis of water use across New Zealand (actual versus consented takes) and levels of overallocation.

Marine

31. This section looks at three interconnected issues affecting coastal and marine ecosystem health: the effects of land-based activities on water quality and marine ecosystems, the impacts of fishing practices, and the consequences of climate change for the oceans. It then examines the impacts on indigenous marine species and habitats.
32. In contrast to freshwater, more coastal and estuarine water quality monitoring sites reported improving trends than worsening ones (between 2006 and 2020). This included nutrients (nitrogen and phosphorus) and some sedimentation measures (suspended solids, turbidity). Most coastal regions saw increasing primary productivity trends between 1998 and 2022, while oceanic regions showed mixed trends, with both increases and decreases in primary productivity.
33. Fish stocks reported in 2023 are generally fished within safe limits, although 12% were overfished/depleted. Bycatch data suggests this to continue to place pressure of marine protected species, while bottom trawling has declined across deepwater and inshore fisheries. More than half of our indigenous marine invertebrates remain threatened or at risk.
34. Average sea-surface temperatures have risen since 1982, peaking in 2022 or 2023. Marine heatwaves have become more frequent, intense and longer-lasting in some parts of the ocean around New Zealand. A recent update to sea-level rise projections in 2022 suggests that areas of the country experiencing ongoing downward land movement may face faster sea-level rise than previously reported.

35. Certain land-use and management practices accelerate sediment build-up and nutrient run-off, affecting water quality in marine environments. Although water quality has improved in terms of nutrients in some estuarine and coastal areas, sedimentation is worsening in many places. Plastic waste, which can end up as litter, is accumulating in the ocean and along the coasts. Although fishing pressures have decreased, overfishing, bycatch and trawling continue to deplete some fish stocks, harm protected species and damage the seabed. Climate change exacerbates these issues by driving ocean warming, acidification and sea-level rise. These changes disrupt marine species and ecosystems, and increase their vulnerability to invasive species and human disturbance.

Air

36. This section looks at two key issues. The first relates to air quality and the sources of air pollution. In Aotearoa New Zealand, air quality is generally good compared with many other countries, largely due to prevailing winds. However, increasing urbanisation can mean that more people are at risk of exposure to polluted air. The second key issue in this section is artificial light and its effects on the environment. Artificial light at night is increasing in both extent and brightness, with potential impacts on native species.
37. Concentrations of the air pollutants particulate matter (PM₁₀ and PM_{2.5}), nitrogen dioxide, and sulphur dioxide continue to decrease at most monitoring sites. However, many sites still exceed World Health Organization (WHO) guidelines at times.
38. New data show that burning wood and coal for home heating (which is a major source of particulate matter emissions) continues to decline in favour of heat pumps and electric heaters, although about one-third of homes still rely on burning wood or pellets. Motor vehicle engine and fuel improvements continue to reduce air pollutant emissions from transport, despite increases in our overall vehicle fleet and higher proportion of diesel vehicles on the roads. The number of electric vehicles has grown, nearly doubling from 2022 to 2024. Other contributors to air pollution emissions include agriculture, construction, industry and other human activities. Particulate matter can come from natural sources and is influenced by climate, including wind patterns.
39. In 2014, 97 percent of New Zealand's population lived under light-polluted skies. Between 2012 and 2021, the lit surface area of the country increased from 3.0% to 4.2%, primarily in rural areas. Growing evidence suggests that light pollution affects and disrupts the habits, interactions and navigation of some native species, such as bats, wētā and seabirds however, evidence in New Zealand is currently limited.

Atmosphere and Climate

40. This section looks at our emissions and how our activities are contributing to an increase in concentrations of greenhouse gases in the atmosphere. It then focuses on our changing climate and how this is affecting the environment.
41. The 2024 update of New Zealand's greenhouse gas inventory shows that in 2022 our total gross emissions were at their lowest since 1999, but still higher than in 1990. Carbon sequestered by land use, land-use change and forestry offset a quarter of our emissions in 2022, compared with 1990 when sequestration by this sector offset about a third of our emissions.
42. Atmospheric concentrations of carbon dioxide, methane and nitrous oxide, measured in the Wellington area, increased in the decade up to 2022.
43. New Zealand's average air temperature continues to rise, and most monitored areas are experiencing more warm days and higher growing degree days (indicating longer growing seasons). The frequency of medium-term (agricultural) drought is increasing in many places. The south of New Zealand is becoming wetter, and the north and east are becoming drier. Maximum daily rainfall is likely increasing across more areas of the South Island, and likely decreasing across more areas of the North Island, and

extreme wind is likely decreasing across most of New Zealand. These findings are supported by additional new evidence indicating that extreme weather events are becoming more frequent and severe due to climate change from human activities.

44. Evidence continues to grow that climate change is affecting soil erosion, and increasing the risks of natural hazards. It affects where species live, their habitats, interactions, life cycles and seasonal timing across terrestrial, freshwater and marine ecosystems. This includes creating more favourable conditions for exotic pests and diseases.

Impacts on people, society and the economy

45. The first part of this section looks at how our health and quality of life are connected to the environment. A healthy environment provides clean air, water, food and spaces for recreation, all of which support physical and mental well-being. Conversely, environmental degradation – such as pollution, biodiversity loss and climate change – can harm health. It contributes to respiratory illnesses, heat-related conditions, waterborne diseases, and mental health challenges stemming from the loss of natural spaces or increased environmental stresses.
46. Since 1980, at least 49 drinking water illness outbreaks have been reported in New Zealand. This includes the 2016 campylobacteriosis outbreak in Havelock North, cryptosporidiosis outbreak occurred in Queenstown in September 2023, both of which caused illness and (in the case of Havelock) contributed to at least four deaths. Rural communities face a higher risk of waterborne disease and young children and people living in deprived areas are most at risk.
47. Faecal contamination is also an issue for recreation, with 388 notifiable illness cases campylobacteriosis, 135 of giardiasis, 106 of cryptosporidiosis, 102 of salmonellosis and 138 of *Escherichia coli* infection, for cases where people reported contact with recreational water (river, lake or sea) reported in 2023. Exposure to potentially toxic algae can cause illness in people and dogs however, toxic algae are generally present at low levels across most of New Zealand.
48. In 2019, air pollution was a factor in 3,239 premature deaths, 13,237 hospitalisations, 12,653 cases of childhood asthma and over 1.771 million restricted activity days. The estimated health impacts associated with human-made air pollution (PM_{2.5} and NO₂) increased between 2006 and 2016 due to population growth and rising NO₂ exposure.
49. The impacts of climate change on the risk of disease and mental health are expected to grow. Some population groups will be more affected by climate change health impacts than others, and existing health and social system inequities will be exacerbated by climate change.
50. The second part of this section of the report looks at people's connection to place, which is also intertwined with nature. The environment shapes cultural values, traditions and a sense of identity. It fosters strong bonds between communities and the landscapes they inhabit. Healthy ecosystems sustain these connections, supporting cultural practices and community resilience.
51. Access to urban greenspaces is important to stay connected to nature, supporting mental health by reducing fatigue and stress, improving immune function, lowering blood pressure and providing space for physical activities. It is noted earlier in the report that urban greenspaces are declining. Environmental degradation is affecting people's ability to connect with nature, impacting quality of life in some areas, for example, where there is significant land use change or biodiversity loss, or where air quality or freshwater health is poor. For some Māori, and the foundation of tūrangawaewae (the land base, a place of belonging, standing and identity) this affects connection to whenua.
52. Many important sites and infrastructure for culture and recreation are at risk from flooding, erosion and extreme weather events. Sea-level rise and coastal erosion is impacting low-lying areas, including 420 archaeological sites on public conservation land. Around the country, 191 marae are within 1 kilometre of the coast, and, in the Bay of Plenty alone, 41 urupā are within 1 kilometre. Severe weather has extensively damaged recreational infrastructure and tracks in recent years. For instance, the Queen

Charlotte Track in the Marlborough Sounds was temporarily closed to walkers and mountain bikers for a few months in 2021.

53. The ability to practise and access food-gathering (mahinga kai) and traditional plant medicine (rongoā rākau) is affected by changes to the environment. Decreased or altered river flows, accumulation of sediment and sewage contamination in rivers, and the effects of excess nutrients in estuaries and the ocean can affect the cultural health of mahinga kai sites. Climate change threatens the loss of treasured (taonga) species and resources.
54. The third part looks at how our homes and livelihoods depend on the services provided by nature. Ecosystems play a critical role in food production, water availability and energy generation, creating the foundation for social and economic stability. However, challenges such as biodiversity loss and climate change (including severe weather events) pose risks to our homes and jobs and to the broader natural and built environment that supports them. Building in at-risk areas is making us more vulnerable to climate change. For example, during the 2016/17 fire season, more homes were destroyed than in each of the previous 100 years, and this record was then surpassed in 2020/21. Around 750,000 people and 500,000 buildings, worth more than \$145 billion, are near rivers and in coastal areas already exposed to extreme flooding in New Zealand. The primary sector, Māori economy, fishing and aquaculture, and tourism are all affected by changes in the environment and climate.

Knowledge gaps

55. The report takes a broader approach to gap analysis than previous reports. It identifies opportunities to improve how we understand environmental change more holistically, and how this change impacts people and our quality of life. The report canvases five themes describing the critical knowledge gaps that are holding us back from understanding the drivers and consequences of environmental change as well as effective actions and responses. Many of these gaps are not unique to Aotearoa New Zealand and require further investment in both data collection and analysis to address.
56. **Theme 1: Decoding drivers of change** identifies the need to develop advanced modelling techniques to better identify patterns and feedback processes, pressures and drivers, and predict how various factors (such as economic policies, climate conditions, technological advancements and population growth) interact over time. The need for further research in social sciences (for example psychology, political science, and economics) is also highlighted, along with the need to develop robust scenario-based models to test 'what-if' scenarios and explore possible futures.
57. **Theme 2: Harnessing data to track change** acknowledges the data gaps that persist across air, land and water, preventing deeper understanding of environmental patterns, processes and feedback loops. This highlights the importance of consistent and robust data collection and management, the importance of modelling to address spatial coverage, utilisation of techniques such as satellite imagery and eDNA, and new emerging pollutants. Monitoring and evaluation of policy effectiveness is currently challenging but could be improved through greater standardisation and use of artificial intelligence to cleanse and analyse data. The authors also identify the importance of striking the right balance between providing open access to shared data with privacy and sovereignty protection.
58. **Theme 3: Understanding interactions and cumulative impacts** recognises the interconnection of the different environmental domains. For example, pollution, climate change, invasive species and land-use change combine with and amplify each other's impacts. Addressing this gap requires us to find ways to overcome: (1) the limited availability of data; (2) difficulties in integrating data as well as linking techniques, for example linking land use with water quality to identify cause and effect, and overcome complicating factors such as lag times and legacy effects; and (3) research and models that can link this environmental change to impacts on people. For example, the development of climate adaptation strategies would benefit from better understanding of the interdependencies among climate, urban infrastructure (including services), financial services (including banking and insurance) and governance systems.

59. **Theme 4: Mātauranga Māori and place-based knowledge** does not separate the environment into domains, nor people from it. While there are many examples of mātauranga Māori throughout Aotearoa New Zealand helping us realise our economic potential and understand the cumulative effects of environmental change on individuals, communities and ecosystems more holistically, barriers remain. Opportunities include: addressing how the wider community understands and values mātauranga; finding solutions to address data sovereignty concerns; developing and implementing respectful and appropriate ways to interweave mātauranga Māori with conventional scientific methods to provide richer, more meaningful insights into environmental change and impact on te taiao, people and their quality of life.
60. **Theme 5: Connecting environmental change to quality of life** highlights the currently limited understanding of how environmental change affects people's quality of life, for example mental health support from green spaces, or cultural ties to landscapes. To more inclusively capture the full spectrum of effects on people's relationships with nature, these methods must account for social and cultural differences, and variations across different locations and over time. Equally important is understanding risks and resilience in the face of environmental challenges so that we can better understand trade-offs and develop strategies that not only protect ecosystems and vulnerable populations, but also enhance quality of life in a rapidly changing world.
61. It is important to note that these are not new challenges and, while complex to address, they are not insurmountable. Where possible, the Council's science team has been seeking to address some of these gaps and limitations, noting that these challenges cannot and should not sit solely with regional councils to resolve.
62. One example of continuous improvement is the recent review of our environmental monitoring network, through which we are seeking to improve monitoring site coverage and network representativeness. The ongoing development and roll-out of National Environmental Monitoring Standards (NEMS) ensures that Council's environmental data is collected in a consistent way by regional councils. Through the development of our proposed Land and Freshwater Plan, Council has been building a strong knowledge and evidence base to support policy and plan development and implementation. This has included the development of regional models to help us test management approaches in freshwater systems such as the positive outcomes of our land management and riparian programmes, as well as understand the potential impacts of climate change and how we can adapt to changes that are outside our control. Science and research workstreams are focusing on bridging gaps in our knowledge and understanding, as well as identifying potential solutions. This includes partnering with primary sector, district councils, iwi/hapū and community groups. Projects such as Awatuna Constructed Wetland and Massey University's Catchment Solutions collaborations are just two such examples of Council working with our community and science providers to build resilience and find ways of working that minimise our impact on the environment while supporting the economy and our people.
63. There are however, further opportunities. While there are examples of where Council is working with iwi/hapū to develop a shared understanding of te taiao, Taranaki is yet to fully embrace the breadth of knowledge and mātauranga Māori and its value in understanding and managing our interactions with the environment. This is an area we have committed to working with iwi/hapū to improve through our Long-term Plan 2024-2034 (LTP). To support the evolution of monitoring and reporting, the Council is also driving improvements in our environmental data and information. This includes future-proofing systems and improving processes to increase transparency and access to information, as well as drive efficiencies in knowledge sharing and reporting.
64. The Council is due to release its own five-yearly environmental synthesis report in 2027. This report presents an opportunity to explore the issues set out in Our environment 2025 - Tō tātou taiao in a Taranaki context, as well as showcase the extensive work undertaken by the Council alongside our community to improve and enhance our natural environment.

Appendices/Attachments

TRCID-1672683750-167: [Our environment 2025 - Tō tātou taiao](#)

TRCID-1672683750-181: [Our environment, our lives: The stories behind the numbers](#)



Our environment 2025

Tō tātou taiao

New Zealand's Environmental Reporting Series
Te Kāhui Pūrongo Taiao o Aotearoa



Ministry for the
Environment
Manatū Mō Te Taiao

Stats ^{NZ}
Tatauranga Aotearoa

Crown copyright ©

Unless otherwise stated, this copyright work is licensed for re-use under a [Creative Commons Attribution 4.0 International licence](#). Except for any photographs, in essence, you are free to copy, distribute and adapt the work, as long as you attribute the work to the New Zealand Government and abide by the other licence terms. To view a copy of this licence, visit [Creative Commons Attribution 4.0 International licence](#). To re-use a photograph please seek permission by sending a request to the stated image owner.

Please note that neither the New Zealand Government emblem nor the New Zealand Government logo may be used in any way which infringes any provision of the [Flags, Emblems, and Names Protection Act 1981](#) or would infringe such provision if the relevant use occurred within New Zealand. Attribution to the New Zealand Government should be in written form and not by reproduction of any emblem or the New Zealand Government logo.

If you publish, distribute or otherwise disseminate this work (or any part of it) to the public without adapting it, the following attribution statement should be used:

Source: Ministry for the Environment, Stats NZ, and data providers, and licensed by the Ministry for the Environment and Stats NZ for re-use under the Creative Commons Attribution 4.0 International licence.

If you adapt this work in any way, or include it in a collection, and publish, distribute or otherwise disseminate that adaptation or collection to the public, the following attribution statement should be used:

This work uses material sourced from the Ministry for the Environment, Stats NZ, and data providers, which is licensed by the Ministry for the Environment and Stats NZ for re-use under the Creative Commons Attribution 4.0 International licence.

Where practicable, please hyperlink the name of the Ministry for the Environment or Stats NZ to the Ministry for the Environment or Stats NZ web page that contains, or links to, the source data.

Disclaimer

While all care and diligence has been used in processing, analysing and extracting data and information for this publication, the Ministry for the Environment, Stats NZ, and the data providers give no warranty in relation to the report or data used in the report – including its accuracy, reliability and suitability – and accept no liability whatsoever in relation to any loss, damage, or other costs relating to the use of any part of the report (including any data) or any compilations, derivative works, or modifications of the report (including any data).

Citation

Ministry for the Environment & Stats NZ (2025). *New Zealand's Environmental Reporting Series: Our environment 2025* / Tō tātou taiao Retrieved from environment.govt.nz.

Published in April 2025 by
Ministry for the Environment and Stats NZ

Publication number: ME 1881
ISBN: 978-1-991140-73-9

Cover: Ahipara Bay, Northland.
Photo: Laura Evans, truestock.

Contents

Message to readers	6
Introduction	8
About Our environment 2025	8
Data sources	9
1. Drivers	11
Introduction	11
International influences	11
Livelihoods and the economy	12
Population growth and demographic change	12
Individual choices	12
Technology and innovation	13
Climate change	14
2. Land	15
Introduction	15
New and updated land indicators and evidence since <i>Environment Aotearoa 2022</i>	15
Soil and land use	16
Terrestrial habitats and native species	23
3. Freshwater	27
Introduction	27
New and updated freshwater indicators and evidence since <i>Environment Aotearoa 2022</i>	27
Freshwater quality	28
Freshwater habitats and native species	33
4. Marine	39
Introduction	39
New and updated marine indicators and evidence since <i>Environment Aotearoa 2022</i>	39
Coastal and marine ecosystem health	40
Marine habitats and native species	46
5. Air	49
Introduction	49
New and updated air indicators and evidence since <i>Environment Aotearoa 2022</i>	49
Air quality	50
Artificial light	54

6. Atmosphere and climate	55
Introduction	55
New and updated atmosphere and climate indicators and evidence since <i>Environment Aotearoa 2022</i>	55
Our emissions	56
Our changing climate	60
7. Impacts on people, society and the economy	66
Health and quality of life	66
People and their connection to place	71
Homes and livelihoods	74
8. Knowledge gaps	78
Theme 1: Decoding drivers of change	78
Theme 2: Harnessing data to track change	79
Theme 3: Understanding interactions and cumulative impacts	79
Theme 4: Mātauranga Māori and place-based knowledge	80
Theme 5: Connecting environmental change to quality of life	81
Additional information	82
Environmental indicators	82
Acknowledgements	83
References	85

Figures

Figure 1:	Livestock numbers (beef cattle, dairy cattle, sheep), 1971–2023	21
Figure 2:	Extinction threat to indigenous terrestrial species	24
Figure 3:	Modelled median macroinvertebrate community index scores indicating organic pollution and nutrient enrichment in rivers, 2016–20	31
Figure 4:	Extinction threat status of indigenous freshwater species	38
Figure 5:	Coastal sea-surface temperature annual average anomaly, 1982–2023	45
Figure 6:	Extinction threat to indigenous marine species	47
Figure 7:	Nitrogen dioxide trends by monitoring site, 2016–23	51
Figure 8:	PM _{2.5} trends by monitoring site, 2016–23	52
Figure 9:	Annual gross greenhouse gas emissions by sector, 1990–2022	58
Figure 10:	New Zealand annual average temperature anomaly, 1909–2022	61

Message to readers

If there has been one constant in Aotearoa New Zealand's environment, it is change. Geologically young, our country has been forged out of dramatic tectonic forces, carved by the winds and water of the Roaring Forties, and populated by unique biodiversity that has evolved in isolation. Ever since people arrived on these shores, we have accelerated this change as we cleared land for food and fibre, built our homes and businesses, and developed new ways to power our economy and get around.



This three-yearly report on the state of the environment shows how people continue to drive change in our land, water and coasts. It also describes how we, in turn, are affected by the changes we cause – in both positive and negative ways.

Much of what you'll read here is cause for ongoing attention and concern. The report highlights real risks to people, communities and places which, left unaddressed, threaten our livelihoods and quality of life for generations to come.

However, the report also tells a story of hope.

There is evidence that some negative trends in our environment are stabilising, or reversing, due to choices people have made about how we live, or as a result of specific management interventions.

In the Ministry for the Environment's companion document *Our environment, our lives: The stories behind the numbers* we spotlight some of the important work being led by communities, iwi and Māori, local government, farmers, businesses and government that's bringing about tangible improvements for people and our precious places.

There is no doubt New Zealand, like all places on our planet, has major challenges ahead. These include increased pressures on our environment, communities and economy from extreme storm and weather events driven by the growing impacts of climate change.

We have a great opportunity to draw on evidence and data to build our resilience to those forces and impacts. Armed with this knowledge we can make informed decisions about our lives and businesses, ensuring New Zealand can leverage the potential of being best prepared for the future.

Our environment 2025 is jointly produced by the Ministry for the Environment and Stats NZ. Our teams of analysts and scientists work independently of the government to organise this evidence and provide New Zealand with a benchmark for reporting that is factual, reliable and robust.

We also recognise the contributions of Māori knowledge and practices in guiding our environmental stewardship, and the role and contribution of business and farming communities in gathering and sharing data. Equally vital to this report is the critical expertise and evidence provided by regional councils and the scientific community. Building a comprehensive evidence base requires strong partnerships and collaboration across all sectors and communities to support the collective effort to protect and restore New Zealand's environment.

This vital work helps New Zealanders understand the inseparable connection between people and the built and natural environments on which we depend. It shows us there are things we can do to further improve our economy, nature and lives, and it helps provide us with the evidence needed to know where to put our efforts.



James Palmer
Secretary for the Environment



Mark Sowden
Government Statistician

Introduction

About Our environment 2025

Our environment 2025 is the latest three-yearly state of the environment report produced by the Ministry for the Environment and Stats NZ under the Environmental Reporting Act 2015.

It is known as a synthesis report – it brings together key findings from the regular six-monthly reports that cycle the five domains of **air, freshwater, marine, atmosphere and climate, and land**. The last synthesis report released was *Environment Aotearoa 2022*. Where previous synthesis reports have been named *Environment Aotearoa*, this report has been intentionally named *Our environment 2025* to align with the naming of domain reports (eg, *Our air*, *Our freshwater*).

Our environment 2025 provides a picture of the whole environment and its interconnections, showing how changes to different parts of the environment impact on each other.

The environment includes people. Our lives and livelihoods are intertwined with environmental systems and processes in countless complex ways. Human actions are responsible for driving changes in the state of the environment, and our lives are also affected by those changes.

Effective decision-making about the environment relies on an accurate and accessible knowledge base. The purpose of the report is to provide high-quality information about how and why our environment is changing, and the resulting impacts. Evaluating specific policies and advice on responses to environmental issues is out of scope for environmental reports under the Environmental Reporting Act 2015, and therefore they are not discussed here.

Report structure

In line with the focus on how humans both impact and are impacted by environmental change, the report begins and ends with people.

[Section 1](#) covers **drivers**, exploring how collective decisions made by people in many different areas add up to influence environmental change – from global economic and geopolitical factors to changing demographics, new technologies and our individual choices.

The next five sections cover each of **the five environmental domains**. Each chapter reports on:

- the pressures our choices place on that domain
- how these pressures result in changes to the state of the environment
- the impact of these changes on ecological systems and native species
- new and updated data and evidence since the 2022 report.

Many of the activities that drive changes in our environment begin with how we use and manage **land** ([section 2](#)). Pressures arising from our land-use decisions affect many native species, and flow through into the other domains.

What happens on land flows into **freshwater** ([section 3](#)). Erosion, pollution and run-off affect the water quality of lakes, rivers and groundwater. Although some freshwater bodies are in a reasonably healthy state, this affects the species and ecosystems that depend on them.

Rivers and streams enter the **marine** environment ([section 4](#)). Pollution and sedimentation that reach our coasts and oceans, as well as fishing practices, put coastal and marine habitats under threat. Some of these pressures have decreased in recent years, while others are increasing.

Human actions also drive changes to the **air** ([section 5](#)). Transport, home heating, agriculture and industry lower air quality. While air pollution has been declining in many areas, it can still pose risks to our health.

Changes to the other domains are amplified by changes in the **atmosphere and climate** ([section 6](#)). Rising temperatures and changing weather patterns increase many of the pressures in other parts of the environment, along with the threats to native species and ecosystems.

[Section 7](#) covers **impacts on people, society and the economy** across all domains. It reports on the effects of interconnected changes to the environment on our health, property, places and livelihoods.

The report then outlines some **knowledge gaps** ([section 8](#)) and areas where reporting on the environment could be strengthened. The aim is to improve the knowledge base from which we make decisions about our impacts.

Data sources

The data used in this report came from many sources, including Crown research institutes and central and local government. Further supporting information was provided using a 'body of evidence' approach. This includes peer-reviewed, published literature, and grey literature such as government reports. It also includes Māori knowledge (mātauranga Māori) and observational tools to identify changes in the environment.

All the data, including references to scientific literature, were corroborated and checked for consistency with the original source. The report was produced by a team of analysts and scientists from within and outside the Ministry for the Environment and Stats NZ. It was also reviewed by a panel of independent scientists. The indicators and the most recent updates are on the Stats NZ indicator web pages (see [Environmental indicators](#)). Reports released under the Environmental Reporting Act 2015 are produced independently of government ministers.

More detailed context for the use of some of the data and evidence in this report is provided in [Our environment 2025 Technical annex | Tō tātou taiao Āpitihanga hangarau](#) ('Technical annex'), and hyperlinks to the technical annex are included where this evidence is used.

Our environment

All parts of the environment are connected to each other, and to people.



1. Drivers

Introduction

We depend on the environment to support our basic needs, lifestyle and livelihoods. The environment we rely on includes the ecosystem services that nature provides, such as services that provide clean air and water, pollinate crops and maintain a stable climate. Natural infrastructure (eg. forests, wetlands, soils and rivers) plays a crucial role in maintaining these services. Natural systems not only support agriculture and forestry, but mitigate the impacts of natural disasters and climate change. However, using and modifying the environment to meet our needs can put pressure on nature and its ability to sustain us (IPBES, 2019; see [Our land 2024](#) and [section 7: Impacts on people, society and the economy](#)).

In this context, ‘drivers’ are the social, cultural, demographic and economic activities that create pressures on the environment. These forces can act collectively and at a variety of scales from global to national, local and even individual. Many are dynamic and interconnected, and are evolving in response to changes in society, the economy and the environment (IPBES, 2018).

Global drivers such as geopolitics, international markets and demographics influence the decisions we make locally in different ways, as do our own values. These decisions include how we live and travel and what we buy (IPBES, 2022, 2024a). Along with factors such as population change and new technologies, our decisions combine to either increase or decrease environmental pressures.

International influences

Aotearoa New Zealand operates within a complex and dynamic geopolitical system, where global events drive the political, social, economic and environmental forces that shape our nation. Our economy and way of life rely heavily on international consumer demand for our export products, and for access to vital commodities we cannot produce here. However, global instability – caused by factors such as wars, pandemics and the escalating impacts of climate disruption – poses significant risks to both our economy and our environment.

These destabilising forces affect global markets, which directly influence our export-driven economy (MFAT, 2023a). For instance, international pressures and customer demand drive businesses to calculate and reduce their carbon footprints, as major overseas customers work toward 2030 emission targets (EECA, 2025). Environmental certifications are now essential for maintaining market access and securing premium prices for exports. Losing such certifications could not only lower economic performance but also cause further degradation of the environment by weakening the incentive to use sustainable practices.

The rapid rise of initiatives such as the [Taskforce on Nature-related Financial Disclosures](#) and ‘[nature positive](#)’ strategies highlight the growing importance of nature markets for market access. These changes come with shifts in agricultural lending practices. International lenders often require impact and climate change assessments. These examples show that while some international drivers pose challenges, others foster positive change.

Finally, the growing instability in global geopolitics threatens the viability of international agreements that protect the environment. As the impacts of climate change intensify, the weakening or collapse of these agreements could have significant consequences for the nation’s environmental health, and for collective efforts to address global challenges such as biodiversity loss and carbon emissions.

Livelihoods and the economy

Our overall quality of life and wealth are closely tied to the health of the economy. All of these factors rely on a healthy, productive environment. Resilient and enduring economic growth is essential to improving living standards and quality of life, while looking after the environment on which we depend (Galt & Nees, 2022; MBIE, 2023).

Unlike most developed economies in the Organisation for Economic Co-operation and Development (OECD), New Zealand exports are mostly primary sector products (MPI, 2024a). International demand for primary sector products is strong, and is predicted to continue to rise with ongoing growth in both the global population and wealth, as well as international climate disruptions (FAO, 2024; MPI, 2023a; MPI, 2024a; OECD-FAO, 2023). Tourism also forms a significant part of the export sector (Stats NZ, 2025). The export economy – and our gross domestic product – rely heavily on productive land, available freshwater, oceans and scenic environments (MPI, 2023a; see [Our land 2024](#) and [Our freshwater 2023](#)).

The industries that rely on productive environments, such as agriculture and fishing, can also put pressure on the natural systems that support them. This can lower productivity and degrade the wider environment, giving rise to the effects outlined in [section 7: Impacts on people, society and the economy](#).

Population growth and demographic change

New Zealand's population is growing and ageing. It grew by about 750,000 between 2013 and 2023 (Stats NZ, 2024a, 2024c). Population projections indicate the population of New Zealand has a 90 percent probability of increasing to between 5.55 and 6.65 million by 2048, meaning it is highly likely to grow by at least 400,000 compared with 2022 (Stats NZ, 2022a). In 2023, people aged 65 years and older made up 16.6 percent of the population, up from 14.3 percent in 2013; children under 15 years of age made up 18.7 percent, down from 20.4 percent in 2013 (Stats NZ, nd). These ageing trends are expected to continue over the coming decades (Stats NZ, 2022a).

These changes are major drivers of other demographic trends, such as where we live, work and build. This in turn can have significant implications for the pressures we place on the environment. With more people comes greater demand for land to build on, and for more energy and public infrastructure as towns and cities grow. Depending on how we build, accommodating this growth can displace or degrade – or preserve and restore – the environment and natural infrastructure we depend on (Auckland Council, nd; EHINZ, nd-a; MfE, 2023a; New Zealand Infrastructure Commission, 2024; Public Health Agency, 2022; see [Our land 2024](#)).

Individual choices

The way we live our lives – where we live, what we buy and how we spend our time – ultimately determines how much impact we have on our environment. Some cause-and-effect relationships are immediate and obvious, but many are subtle, only noticeable over the longer term, and can seem far-removed from our daily lives. This complexity can mean that economic, social, cultural and environmental trade-offs from our decisions are not apparent (Acaroglu, 2019; Deloitte, 2023; Gkargkavouzi & Halkos, 2024; Vega, 2024).

Living in a country with a developed economy and high purchasing power, we have significant choice in what we consume (Miller et al, 2017; OECD, 2024; Reserve Bank of New Zealand, nd; Watkins et al, 2021). These choices, such as what we eat and where it comes from, create demands for domestic and imported goods, driving production locally and internationally. These economies and their supply chains can put pressure on the environment. For example, the amount of greenhouse gas emissions associated with imported goods in 2019 was about equal to the emissions we produced here (Stats NZ, 2021a).

Our consumption habits also affect how much waste we generate. New Zealand has one of the highest per capita rates of waste generation in the developed world, though there are inconsistencies in how different countries report this (OECD, 2024). Most waste from households is disposed of in municipal landfills, and the amount going to landfills has stabilised in recent years (MfE, 2024a).

Where we live and work, and how we travel, also drive environmental pressures. A preference for standalone housing and private land, for example, drives the expansion of cities into rural areas (MfE 2023a; PCE, 2023). Vehicle ownership per person in New Zealand is among the highest in the world, with vehicle use contributing to our high per-capita emissions and to global climate change (MfE, 2024c; see [section 5: Air](#)). In 2023, 85 percent of New Zealanders who worked away from home, and 45 percent who studied away from home, commuted in private vehicles (Stats NZ, 2024c).

Technology and innovation

Technology and innovation play a large role in shaping how we understand and respond to environmental change. From data to urban planning and agriculture, innovation drives both positive and negative impacts.

Data tools are transforming how we monitor and manage the environment. Technologies like satellite images, sensors and mapping systems can help track water quality, forest health, or urban growth in real time. In New Zealand these tools could be increasingly used to manage and monitor freshwater, biodiversity and land-use change in more efficient ways (DOC, 2023; Reid & Castka, 2023). Advanced models, machine learning and artificial intelligence can then analyse these data to predict future trends and plan for climate change (AI Forum NZ, 2022; Giupponi et al, 2022). However, it is also important to consider the energy use of these systems and ensure fair access to technologies.

In towns and cities, development can displace or degrade existing natural infrastructure. This reduces ecosystem services and carbon storage, impacting on climate mitigation potential.

However, developing more innovative and green or nature-based infrastructure, such as restoring streams, re-establishing floodplains and preserving or creating wetland ‘sponges’ (eg, Making Space for Water initiatives), can conserve and improve ecosystems (Auckland Council, 2024; PCE, 2023; Tasman District Council, nd; see [Our land 2024](#) and [Our freshwater 2023](#)).

In rural areas, innovation provides a chance to expand and improve the economy, which may either reduce or increase environmental pressures (FAO, nd; MPI, 2017). Improvements in farming methods, irrigation, equipment and wastewater treatment have already increased output while attempting to minimise environmental harm (Ekanayake & Hedley, 2018; Fernandez, 2017; Macintosh et al, 2025; Monaghan et al, 2021). Emerging technologies like low-emission stock feed and resource-efficient crops could minimise agricultural emissions and ensure productivity (Caradus, 2023; Climate Commission, 2021; Driver et al, 2023; NZAGRC, 2021; Roques et al, 2024).

Climate change

Geopolitical forces overseas (including global economic trends) significantly affect climate change in New Zealand, and have given rise to international policies and agreements (eg, the Paris Agreement) to respond to these drivers. Geopolitical tensions and conflicts can also disrupt supply chains, leading to fluctuating energy prices and availability. This in turn affects our energy consumption patterns and emissions (Skilling, 2022; Winkelmann et al, 2019). The economy, largely driven by the primary sector and tourism, contributes to greenhouse gas emissions (see [section 6: Atmosphere and climate](#)). Population growth, particularly in cities, exacerbates these effects by increasing the demand for housing, transport and services (MfE, 2023a; PCE, 2023). As the country's population and economy continue to grow, so does its reliance and impact on the environment, contributing to climate change.

Climate change can amplify drivers and pressures in other environmental domains. For more detail on this complex relationship, see [section 6: Atmosphere and climate](#). Rising temperatures and changing weather patterns give rise to droughts and reduced water availability, increasing tensions over water resources. Extreme weather events, such as cyclones, can disrupt infrastructure, agriculture, tourism and food systems, leading to economic instability. Population displacement due to climate-induced events, such as coastal erosion and flooding, can put extra pressure on people and property (see [section 7: Impacts on people, society and the economy](#)). This interconnectedness means that climate change poses a critical challenge for the environment and economy (IPBES, 2019).

2. Land

Introduction

The land and ecosystems of Aotearoa New Zealand are globally unique and nationally significant. Land offers us resources, and supports our livelihoods and economy, property and places, along with our health and quality of life.

For some Māori, connection to land is through whakapapa (ancestral lineage), placing people in a special relationship as a part of ecosystems (Harmsworth, 2022a; Timoti et al, 2017). These connections are emphasised in Māori language (te reo Māori), where the word 'whenua' means both 'land' and 'placenta' – to give nourishment and sustenance (Harmsworth & Awatere, 2013).

Diverse plants and animals are endemic to New Zealand (found nowhere else in the world). Ecosystems, soils and landscapes also have their own intrinsic value, and conserving our natural spaces is important to the majority of New Zealanders (DOC, 2011).

The activities that drive changes in our environment are often based on land. The choices we make today about how we use the land, and our activities on it, are central to whether we see improvements or deterioration not only on the land, but in downstream freshwater and marine environments, and in the air and atmosphere.

Land-use practices for agriculture, forestry and urban development contribute significantly to declines in freshwater quality and biodiversity. Pollution from excess sediment, nutrients, pathogens and contaminants harm our freshwater and marine ecosystems (see [section 3: Freshwater](#) and [section 4: Marine](#)). Land use and management influence air quality, and are central to mitigating and adapting to climate change (see [section 5: Air](#) and [section 6: Atmosphere and climate](#)).

Actions on land have both immediate and longer-term consequences. We are also still facing the legacy effects of human deforestation. For example, sedimentation (Sabetian et al, 2021), increased vulnerability to invasion by non-native species (Brownstein & Monks, 2024) and extinction debts (Walker et al, 2023) for places and species where ecosystems are now below a threshold level so they cannot recover.

This section looks at two important issues. The first is about **soil and land use**: how we use and manage the land and the issues this creates for soil erosion, soil health and contamination, and urban greenspaces and land fragmentation. The second looks at changes in **terrestrial habitats and native species**, and how they are threatened by habitat loss and invasive species.

For the wider effects, see [section 7: Impacts on people, society and the economy](#).

New and updated land indicators and evidence since *Environment Aotearoa 2022*

Updates to livestock numbers and irrigated land indicators

Since the large increase in intensification of land use between the 1980s and mid-2010s, this trend has stabilised, with small shifts since the last indicator updates. Dairy cattle numbers

have declined since the peak in 2014. However, the area of irrigated agricultural land increased between 2019 and 2022, implying that more intensive farming has continued to expand.

(See [Land use and management has intensified, putting pressure on soil health, water quality, and indigenous biodiversity.](#))

Waste data new to reporting

Data that are new to the environmental reporting series show the large amount of waste that New Zealanders sent to municipal landfills each year between 2021 and 2023, compared with international reporting. Between 2018 and 2023, the household and municipal waste disposed per person stabilised, after increasing between 2012 and 2018.

(See [Waste and contaminants pollute soil and water.](#))

Updated erosion indicators

Indicator updates confirm previous reporting, showing that 5 percent of New Zealand's land is classified as highly erodible, and risks of erosion by landslide remain the most common class of erosion risk. Erosion is likely to further increase in combination with predicted higher-intensity rainfalls due to climate change.

(See [Erosion varies regionally, placing pressure on downstream freshwater and marine environments.](#))

Updated extinction threat indicator: indigenous terrestrial birds and reptiles

Indicator updates for indigenous terrestrial birds and reptiles show a high proportion of species remain threatened with extinction, or at risk of becoming threatened.

(See [Many indigenous terrestrial species are threatened with or at risk of extinction.](#))

Updated national assessments of extinction risk for indigenous bats and frogs, and indigenous terrestrial invertebrates and vascular plants

Updated assessments by the Department of Conservation show most of our indigenous bat and frog species, and almost half of our indigenous terrestrial vascular plant species, remain threatened with extinction or at risk of becoming threatened. Updates also show that of the assessed indigenous terrestrial invertebrate species, a significant proportion remain threatened or at risk.

(See [Many indigenous terrestrial species are threatened with or at risk of extinction.](#))

Soil and land use

Soil is the foundation of all land-based ecosystems, from tussock grasslands and wetlands to forests and agricultural landscapes. Healthy soils support biodiversity, cycle nutrients, filter contaminants and store carbon (Hewitt et al, 2015; Stevenson, 2022). From a mātauranga Māori (Māori knowledge) perspective, soil has an ancestral lineage that we are a part of (Harmsworth, 2022a).

Our activities on land affect soil condition and terrestrial environments, and have a flow-on impact on all other environmental domains. The following subsections outline these aspects of soil and land use:

- **erosion** – how soil erosion is affecting different parts of the environment, and how land use and land cover changes can exacerbate this natural process
- **land use and management** – how these practices affect soil health, and contribute to waste and contamination
- **urban densification** – how this puts a strain on green spaces, while urban expansion and the fragmentation of highly productive land affect its capacity to grow food. The way we manage urban development not only affects the 84 percent of us living in urban areas (Stats NZ, 2024d), but also has significant consequences for communities across the country.

Erosion affects land, freshwater and coastal environments, and is exacerbated by human activities and climate change.

Erosion varies regionally, placing pressure on downstream freshwater and marine environments.

- New Zealand has naturally high rates of erosion, due to geology and climate. However, these rates have increased due to vegetation clearing for agriculture, and climate change-related events (MfE, 2024i).
- An estimated 182 million tonnes of eroded soil entered New Zealand's rivers in 2022. This places pressure on receiving environments downstream (see indicator: [Estimated long-term soil erosion: Data to 2022](#), [section 3: Freshwater](#) and [section 4: Marine](#)).
- In 2022, 5 percent (12,693 square kilometres) of the land was classified as highly erodible. This is land without protective woody vegetation, which is at risk of severe mass-movement erosion. The risk of erosion varies regionally (see indicator: [Highly erodible land: Data to 2022](#) and [Technical annex](#)).
- Climate change exacerbates some degradation processes such as landslides, erosion and sedimentation. Soft rock hill country in both the North and South islands is particularly vulnerable. Climate change is predicted to increase erosion rates, though by how much depends on the future climate scenario. Under a low emissions pathway, regional sediment loads are predicted to increase by 1 to 49 percent across the country by 2090, while a higher emissions pathway could see increases of 18 to 233 percent over this period (Neverman et al, 2023; Smith et al, 2023; see [section 6: Atmosphere and climate](#)).
- Erosion is a significant concern on Māori land, as over 80 percent of it consists of hilly or mountainous terrain. This makes it highly susceptible to major erosion events such as landslides (Awatere et al, 2021).

Forest management practices can both relieve and put pressure on the environment.

- Tree cover reduces the risk of mass-movement erosion on steep slopes, by protecting soils from wind and rain. Tree roots also stabilise soil (Basher, 2013; Li et al, 2019; Phillips et al, 2023; Rey, 2021). How well this protects against erosion depends on the species, type and age of the forest, and on the root growth encouraged by different soil types and local climate (Phillips et al, 2023).
- For example, in Hawke's Bay and the Wairarapa hill country after Cyclone Gabrielle, it was estimated that land covered by indigenous forest had a lower probability of landslides

than with other land cover types. Land under exotic or indigenous forest is less likely to slide than hill-country pastoral land (McMillan et al, 2023).

- How exotic plantation forests are managed can affect erosion risk, especially on steep slopes. Land can be vulnerable to erosion for several years after harvest, as there is no forest canopy and the roots decay over time, reducing protection from mass-movement erosion (Marden et al, 2023; Phillips et al, 2015; 2024).
- The risk of gully erosion is affected by planting density, and how much of the area around water courses is set aside as a buffer. These buffers are freed from the disturbance of planting and harvesting cycles, and are more likely to be permanently stabilised by native riparian cover (Marden & Seymour, 2022).
- Other issues arising from forest management and harvest can include loss of water-regulating functions, including run-off, and adding to the risks of pest invasion (Jones et al, 2023; Messier et al, 2022; NIWA, nd-b).
- The ways that forests are managed and cleared on steep terrain have generally increased the amount of sediment entering rivers (Larned et al, 2020; Marshall et al, 2023).

The area of exotic forest has expanded, mostly due to the conversion of exotic grassland.

- In 2018, about half (about 12,635,000 hectares) of New Zealand was covered with native ecosystems, and about half (about 13,741,000 hectares) was primarily covered with farms, pasture, plantation (exotic) forests and urban land uses (see indicators: [Indigenous land cover](#), [Exotic land cover](#), [Urban land cover](#)).
- Exotic forests covered about 2.1 million hectares in 2018. The area of exotic forest increased by 220,922 hectares (12 percent) between 1996 and 2018 (see indicator: [Exotic land cover](#)). This is mostly on hill- and high-country land (MPI, 2022). Of land cover converted to exotic forest between 1996 and 2018, 75 percent was from exotic grassland (see indicator: [Exotic land cover](#)).
- Plantation forest currently consists of around 90 percent radiata pine, the remainder being Douglas fir, cypress and eucalyptus (MPI, 2023b). Plantations can also comprise native species such as mānuka, which can be used for honey production (Lambie et al, 2021).

Land use and management can affect the productivity of our land, and contribute to pollution through waste and contaminants

Land use and management have intensified, putting pressure on soil health, water quality and indigenous biodiversity.

- Agricultural land use intensified between the 1990s and mid-2010s. This increased the number of livestock and the yields per hectare, and added more fertilisers and irrigation (Manderson, 2020; Wynyard, 2016; see [Environment Aotearoa 2022](#)). Intensification can compromise the health of soils and freshwater (Monaghan et al, 2021; Snelder et al, 2021; see [section 3: Freshwater](#)).
- Much of the intensification is due to a switch from sheep and beef farming to irrigated dairy farming, driven by increasing profitability in the dairy industry (Wynyard, 2016). Dairy cattle numbers nearly doubled from 3.4 million in 1990 to a peak of 6.7 million in 2014. However, the number declined to 5.9 million in 2023 (see indicator: [Livestock numbers: Data to 2023](#) and figure 1).

- The area of irrigated agricultural land nearly doubled between 2002 and 2022, reaching 762,000 hectares, or 5.8 percent of the total farm area. Most of this increase occurred in Canterbury, which had 63 percent of the irrigated land in 2022. More than half of irrigated agricultural land in New Zealand is used for dairy farming (see indicator: [Irrigated land: Data to 2022](#)).
- Sales of nitrogen fertiliser consistently increased between 1991 and 2019, from 62,000 to 452,000 tonnes (a 629 percent increase). Sales of phosphorus increased from 94,000 tonnes in 1991 to a peak of 219,000 tonnes in 2005 (a 133 percent increase). They then dropped to 154,000 tonnes in 2019 (a 30 percent decrease from the peak) (see indicator: [Fertilisers – nitrogen and phosphorus](#)).
- Despite increases in nitrogen fertiliser and irrigation, gains in pasture eaten on dairy farms have slowed since 2001/02. After increasing 1.48 percent per year between 1990/91 and 2001/02, pasture eaten increased 0.26 percent per year between 2002/03 and 2019/20. This is an early indication that extra fertiliser or irrigation is, on average, yielding a smaller increase in grazeable feed (Chapman et al, 2024).
- Agricultural and horticultural intensification, coupled with changes in land use and land cover, contributes to the loss, fragmentation and degradation of indigenous habitats and the species they support (Clarkson, 2022; DOC, 2020).

Soil quality at monitored agricultural sites is not always within target ranges.

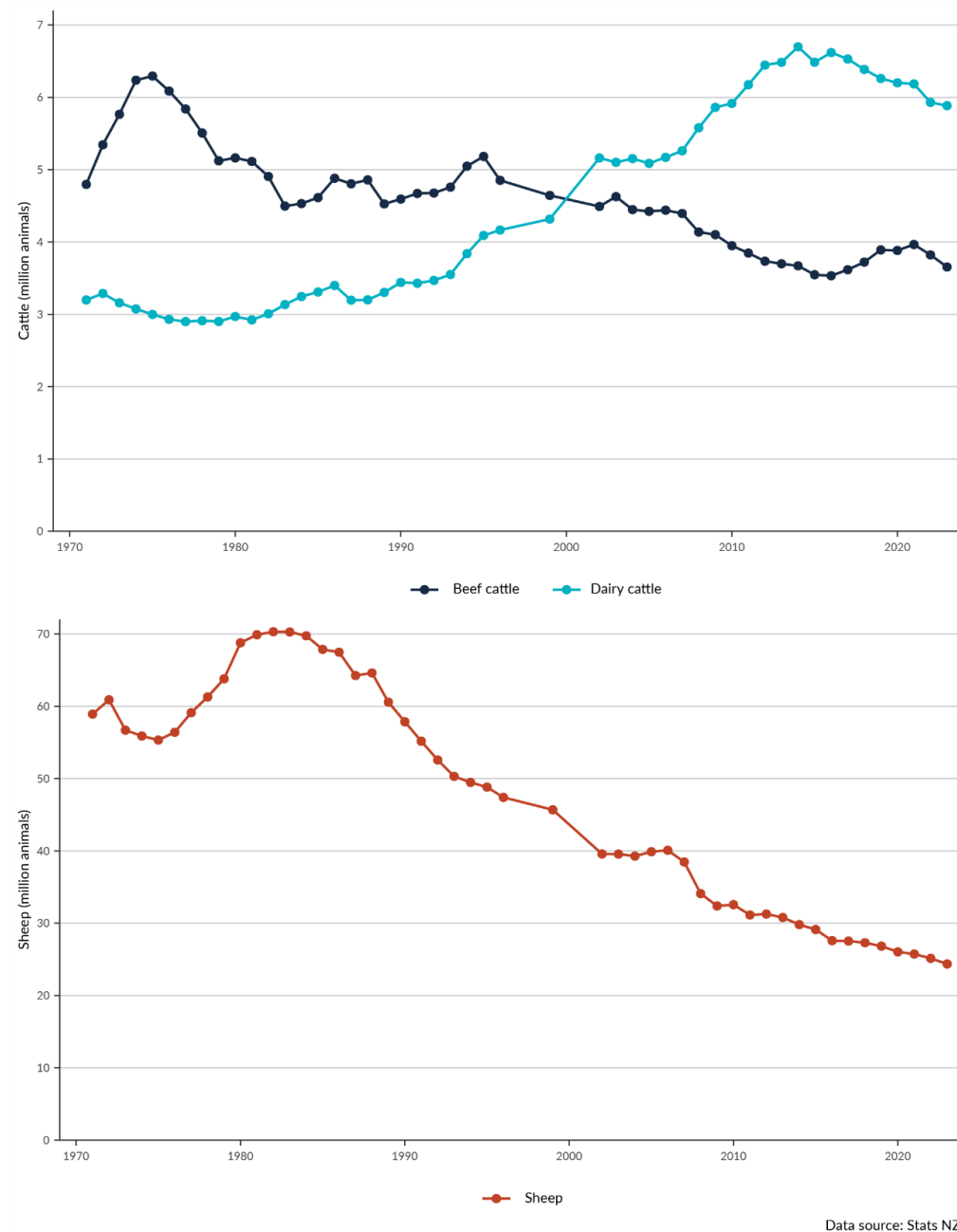
- Soil quality is monitored routinely through seven indicators, with an emphasis on chemical and physical properties across nine land uses. Target ranges are defined for each of the indicators that describe a compromise between optimal crop yield and fewest environmental impacts. Soil quality issues of most concern include compaction (as measured by macroporosity) and elevated phosphorus levels (as measured by Olsen phosphorus) (see indicator: [Soil quality and land use](#) and [Our land 2021](#)).
- Forty-nine percent of sites were below the target range for macroporosity for 2014 to 2018, indicating that compacted soil limited the flow of oxygen and water (see indicator: [Soil quality and land use](#)).
- Sixty-three percent of 450,000 soil samples collected between 2001 and 2015 had Olsen phosphorus levels above the target range. Elevated Olsen phosphorus that washes or leaches into waterways can lower fresh and coastal water quality (McDowell et al, 2020¹).

Waste and contaminants pollute soil and water.

- New Zealand consistently generates among the highest rates of municipal waste per person in the developed world, though there are inconsistencies in how different countries report (OECD, 2024). We sent an average of 688 kilograms of waste per person to municipal landfills each year between 2021 and 2023 (MfE, 2023b). From 2012 through 2018, this average increased 32 percent (570.1 to 755.3 kg per person per year). More recently, it has generally stabilised (with some fluctuation). Landfills received 11 percent less waste per capita in 2023 than the peak in 2018 (MfE, 2023b).

¹ Olsen phosphorus findings are not being reported from the Soil quality and land use indicator. This is due to the discovery of an error, which overreports the number of sites tested above target ranges (see indicator: [Soil quality and land use](#)).

- Much of our waste ends up in landfills. On average, municipal landfills across the country received a total of 3.9 million tonnes of mixed household, commercial and industrial waste each year between 2021 and 2023. Of this material, 9.8 percent was reused, repurposed or recovered (MfE, 2023b).
- Landfills can leak leachate, or liquid containing contaminants. There are controls to contain leachate, but it can still contaminate nearby soil and water, and harm ecosystems and people (MfE, 2004; Siddiqua et al, 2022).
- Chemical contaminants stem from the use of chemicals, including hazardous substances, in industry, agriculture, horticulture and forestry (MfE, 2021a; PCE, 2022). In the 12 months ended 31 June 2023, councils reported that over 45,000 sites had been used for hazardous activities or industries that might cause contamination (MfE, 2024h).
- There is emerging evidence that some New Zealand soils are contaminated with microplastics, although their distribution and effect are uncertain (de Bhowmick et al, 2021; ESR, 2024). Soils receiving applications of biosolids and composts made from municipal waste have a higher risk of contamination (Ruffell et al, 2025). Internationally, it is estimated that soils could currently store more microplastics than surface water in global oceans (Nizzetto et al, 2016; Tremblay et al, 2019; see [section 4: Marine](#)).
- Contaminants from land can be carried to freshwater environments and the ocean directly, via stormwater systems, or in untreated or partially treated wastewater (see [section 3: Freshwater](#)). Also, some of our waste does not make it to landfill and ends up as litter. Plastic is the most common type of litter found on beaches (see [section 4: Marine](#)).

Figure 1: Livestock numbers (beef cattle, dairy cattle, sheep), 1971–2023

Note: The scale for the number of sheep is 10 times that for cattle (see indicator: [Livestock numbers: Data to 2023](#)).

Urban densification places pressure on green spaces, and urban expansion encroaches onto highly productive land

Our cities are densifying and expanding, driven by growing populations, and land-use decisions.

- Population growth has contributed to the outward expansion of towns and cities. The total urban area grew by 15 percent between 1996 and 2018 (see indicator: [Urban land cover](#)).

- There is a trend towards densification in cities. The decade to 2021 saw a rise in the construction of higher-density dwelling types, including townhouses and apartments, mostly through low-rise infill in existing urban areas (PCE, 2023; Stats NZ, 2024b; see [Our land 2024](#)). Meanwhile, towns and cities are also expanding outwards. New subdivisions at the margins are increasingly characterised by larger houses on smaller sections (PCE, 2023).
- Densification helps address the housing supply shortage, can reduce sprawl onto agricultural land and offers opportunities to reduce our transport emissions (PCE, 2023).

Urban development and land fragmentation are decreasing the availability of highly productive land, which can limit options for rural land use.

- Highly productive land is land that is particularly suitable for food production (Curran-Cournane et al, 2021a; see [Technical annex](#)). This land type is particularly important for horticulture. It also has cultural and historical value, as Māori gardening and horticulture (māra kai) sites of significance are often on such land near cities (Harmsworth, 2022b).
- About 14 percent (3,830,000 hectares) of the total land area of New Zealand has been classified as highly productive land (NZLRI, 2021; Rutledge et al, 2010).
- Highly productive land is a finite resource. Converting it to housing is effectively irreversible, which means the amount available can only remain stable or decline (Curran-Cournane et al, 2018, 2021b). Conversions reduce how much of this land is available for farming, and could lead to intensification on the remaining land (Curran-Cournane et al, 2021a; Deloitte, 2018).
- In 2002, 69,920 hectares of highly productive land had an urban or residential land use, and so was unavailable for, or restricted from, use as farmland. In 2019, this area had increased to 107,444 hectares (a 54 percent increase) (see indicator: [Land fragmentation](#)). This is about 3 percent of New Zealand’s highly productive land (NZLRI, 2021; Rutledge et al, 2010).
- During this same period, the remaining highly productive land became slightly more fragmented. There was a 1.9 percent increase in the area occupied by small-sized parcels (parcels of 2 to 8 hectares) and a 1 percent decrease in the area occupied by parcels over 8 hectares (see indicator: [Land fragmentation](#)). Smaller blocks, while still productive, are often shifted out of commercial production over time (Curran-Cournane et al, 2021a; Hart et al, 2013).

The quantity and quality of urban green space is declining.

- Urban green spaces provide important cultural connections for many New Zealanders. Other benefits include reducing stormwater run-off, cleaning the air, lowering ambient temperatures and increasing the diversity of plants and animals that can live in our cities (PCE, 2023).
- Loss of green spaces and their biodiversity can cause a disconnection from our natural heritage, and a loss of cultural identity and sense of place (Blaschke et al, 2024; see [section 7: Impacts on people, society and the economy](#)).
- Our cities are currently well-endowed with green space, though some suburbs are greener than others. Green space in some cities covers more than 30 percent of their area (PCE, 2023). However, it is under increasing pressure from densification and expansion that does not include planned green areas.

- In some cities, such as Auckland and Hamilton, parks and green belts are not keeping pace with expansion. Private green space is also declining, and this trend is accelerating (PCE, 2023).
- Densification can degrade our existing urban green spaces. It can result in the removal of trees, and the disturbance and compaction of soils. This in turn can lead to urban heat islands and increase the risk of flooding (PCE, 2024). Increases in population density mean more people can enjoy nearby public parks and reserves, but this can increase pressure on these areas (PCE, 2023).

Terrestrial habitats and native species

New Zealand has a high number of endemic species – one of the highest totals worldwide – and many are considered treasured (taonga). Culturally important species, including many threatened terrestrial birds and trees, are vulnerable to diseases like kauri dieback and myrtle rust. Human activities on land, pests, diseases and changes to native ecosystems all combine to threaten iconic species. This subsection explores how these pressures are changing species and habitats.

Many land ecosystems and species are under threat

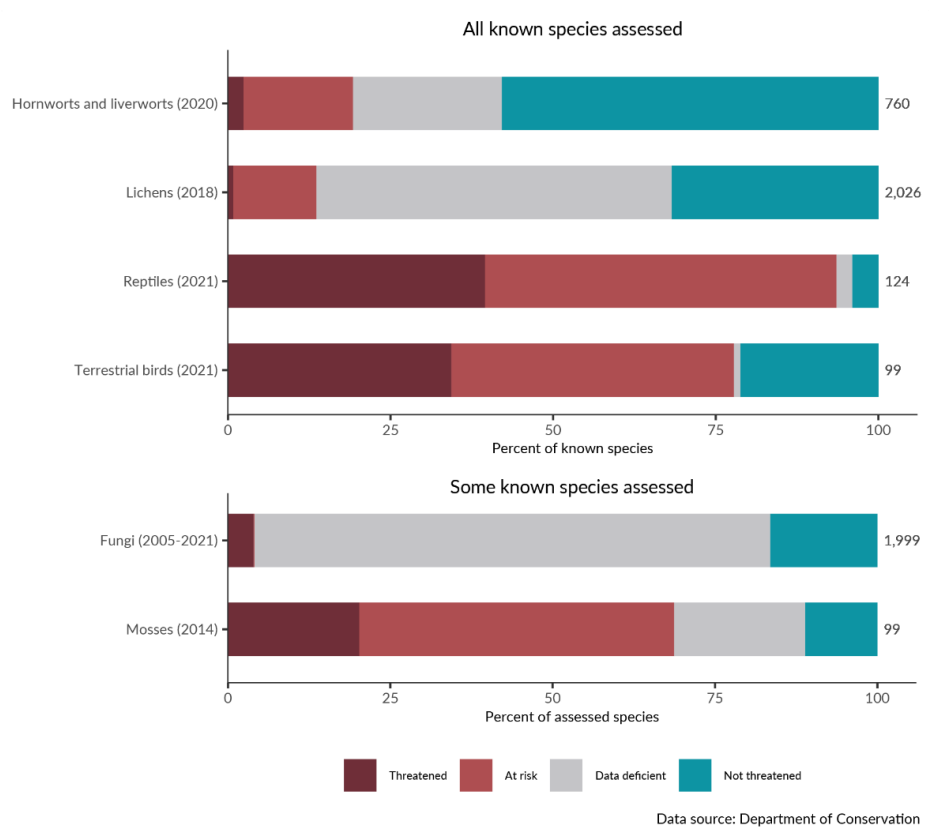
Many indigenous terrestrial species are threatened with extinction or at risk of becoming threatened.

- Pressures on ecosystems from land-use change, pollution, invasive pest species and climate change have individual and cumulative impacts on indigenous species. New Zealand's unique biodiversity has a high proportion of threatened or at-risk species – one of the highest amid the global biodiversity crisis (Bradshaw et al, 2010; IPBES, 2018, 2019; see [section 3: Freshwater](#) and [section 4: Marine](#)).
- In 2021, 94 percent (116 of 124) of indigenous reptile species were threatened with extinction or at risk of becoming threatened (figure 2). Estimated population trends show 72 percent of species have decreasing populations and 5 percent have increasing populations (see indicator: [Extinction threat to indigenous species](#)).
- In 2021, 78 percent (77 of 99) of indigenous terrestrial bird species were threatened with extinction or at risk of becoming threatened (figure 2). Estimated population trends show 22 percent of species have decreasing populations and 21 percent have increasing populations (see indicator: [Extinction threat to indigenous species](#) and [Technical annex](#)).
- In 2023, 48 percent (1,260 of 2,621) of indigenous terrestrial vascular plant species were threatened with extinction or at risk of becoming threatened. Estimated population trends show 18 percent of species have decreasing populations and 1.4 percent increasing (de Lange et al, 2024).
- In 2022, 80 percent (4 of 5) of indigenous bat species were threatened with extinction or at risk of becoming threatened. Estimated population trends show three species have decreasing populations and one species increasing (O'Donnell et al, 2023).
- In 2024, 93 percent (13 of 14) of indigenous frog species were threatened with extinction or at risk of becoming threatened. Estimated population trends show 12 species have decreasing populations and one stable (Burns et al, 2025).
- In 2022, 36 percent (1,433 of 3,961) of assessed terrestrial invertebrate species were threatened with extinction or at risk of becoming threatened. Estimated population trends

show 0.4 percent of assessed species have decreasing populations, 1 percent stable or increasing, and 26 percent stable; the remaining population trends are unavailable² (Andrew et al, 2012; Barker et al, 2021; Buckley et al, 2012; Buckley et al, 2015; Buckley et al, 2016; Heath et al, 2015; Heath et al, 2022; Hoare et al, 2017; Leschen et al, 2012; Mahlfeld et al, 2012; Sirvid et al, 2021; Stringer et al, 2012a; Stringer et al, 2012b; Trewick et al, 2018; Trewick et al, 2022; Walker et al, 2021; Walker et al, 2024a; Ward et al, 2017; Yeates et al, 2012; see [Technical annex](#)).

- The decline in the health and area of ecosystems and their biodiversity reduces the environment’s ability to recover from disturbances, such as those caused by extreme weather events, long-term environmental changes and climate change (Dasgupta, 2021; Key et al, 2022).

Figure 2: Extinction threat to indigenous terrestrial species³



Note: Totals given for species on the right of this figure show the total number of species assessed. Complete assessments are those where all known species in the group have been assessed. Partial assessments are those where not all species in the group have been assessed (see indicator: [Extinction threat to indigenous species](#)).

² Note that only some known species of terrestrial invertebrates have been assessed for extinction threat status and estimated population trends.

³ Note that extinction threat information updated since the Extinction threat to indigenous species indicator update in 2023 has been included in the text and is based on New Zealand Threat Classification System data downloads, as well as older information from the terrestrial invertebrates species group (see [Technical annex](#); NZTCS, 2025). Figure is based only on information available in the indicator (see indicator: [Extinction threat to indigenous species](#)).

Remaining indigenous forest, scrub and tussock provide important habitat for indigenous species, but continue to be lost to other land uses.

- Native land cover includes forests, tussock grasslands and shrublands. Land covered with original or regenerating native vegetation ranges from vast areas of conservation land (mainly in higher, more remote areas) to small, isolated stands of regenerating bush on farms and in cities.
- Before the arrival of humans, native forest covered more than 80 percent of the land (see indicator: [Predicted pre-human vegetation](#)). It now covers less than 30 percent. The area covered with native ecosystems, including forests, decreased by about 88,000 hectares between 1996 and 2018, mainly through conversion to pasture and exotic plantation forestry (see indicator: [Indigenous land cover](#)).
- Lowland native forests are important habitats for a high proportion of threatened native plant species (Walker et al, 2008). Some animals also persist in the remnant native forest in pastoral systems, such as the brown kiwi in the North Island. However, species that need large, connected forest, such as the kōkako, are generally not present in these modified landscapes (Norton et al, 2020).
- Native forest remnants in farmland are vulnerable to exotic plant invasion via creeping edge effects. These effects are increased by spillover of nitrogen and irrigation from agricultural intensification (Brownstein & Monks, 2024). Wetland remnants are also affected by adjacent land use (see [section 3: Freshwater](#)).
- Exotic plantation forests can have positive effects on some native species compared with bare or pastoral land, particularly where native habitat is fragmented. It can protect and connect native ecosystem remnants and provide habitat where no alternative exists (Brockerhoff et al, 2017; Pawson et al, 2010). Threatened and at-risk species found in plantation forests include bats, insect-eating birds such as riroriro (grey warbler), piwakawaka (New Zealand fantail), and kiwi, and a wide variety of invertebrates found in leaf litter layers, soil and wood (Borkin et al, 2011; Marshall et al, 2023; MWLR, 2018; Pawson et al, 2010).

Pests and weeds threaten biodiversity and put vulnerable ecosystems at risk.

- Weeds (plant pests) are introduced exotic plants that are growing in the wild and damaging native ecosystems. Weeds and other pests can reduce biodiversity by outcompeting other species. They can alter habitats, damage ecosystem functions and even increase fire risk (Brandt et al, 2020; Clarkson, 2022; PCE, 2021).
- For some Māori, pests and weeds can disrupt the balance that Papatūānuku (Earth mother) needs to be well, creating a system that no longer provides for life (PCE, 2021).
- There are over 1,800 exotic plant species that can maintain populations in the wild without human assistance (McAlpine & Howell, 2024; PCE, 2021). The number of wild (naturalised) pest plant species is continuing to grow as there are few barriers to naturalisation (Brandt et al, 2020). The North and South islands each have more of these plants than almost any other island in the world, with exotic species making up 44 percent of our vascular plant life (PCE, 2021).
- Weeds pose a threat to endangered ecosystems (Rapson et al, 2023) and are the main hazard to one-third of nationally threatened native plant species (Hulme, 2020; PCE, 2021).

- Wilding conifers are plant pests that spread from plantation forests through natural regeneration or seeding. They are a serious threat to the ecology and biodiversity of many native ecosystems (Edwards et al, 2020; Etherington, 2022; Froude, 2011; MPI, 2023c; Peltzer, 2018). They particularly affect tussock grasslands, rare ecosystems and subalpine habitats, which are all important for supporting biodiversity (MPI, 2014; Peltzer, 2018)
- Around 2 million hectares across the country are thought to be invaded by wilding conifers (Peltzer, 2018), and the area is expanding by around 90,000 hectares a year (MPI, 2023c). Without management, wilding conifers will form dense forests and could invade about 25 percent of land in New Zealand in 30 years (MPI, 2023c).
- Mammalian pests threaten many native birds, reptiles, invertebrates and plants (DOC, 2020). Between 2013 and 2019, possums were the more common pest in woody areas, while for hooved animals (such as deer and goats), mean occupancy (distribution) was around 70 percent in non-woody areas and 85 percent in woody areas (see indicator: [Land pests](#)). Possums and hooved animals have a particularly high impact on growth of some native tree species, as native forests have historically lacked herbivorous mammals (Hawcroft et al, 2024). Pest populations in woody areas are harder to harvest or control (Moloney et al, 2021).
- Introduced pathogens (disease-causing microorganisms) threaten native plants and commercial crops. They include kauri dieback disease, myrtle rust and the kiwifruit vine disease, PSA (*Pseudomonas syringae actinidiae*). Pathogens affect species that are culturally important for many Māori (Clarkson, 2022; Diprose et al, 2022; Royal Society Te Apārangi, 2014).

3. Freshwater

Introduction

Aotearoa New Zealand's freshwater environment supports all aspects of our lives, and we share an intimate connection with it. It is central to our quality of life, supporting the economy, recreation and food-gathering. For many Māori, the freshwater environment is central to customs and protocols (tikanga), knowledge (mātauranga) and traditional food-gathering practices (mahinga kai).

Despite this, freshwater is under pressure from activities on the land and in the water, and from a changing climate. Although some freshwater bodies are in a reasonably healthy state, many have been degraded by the effects of these pressures on water quality and freshwater habitats. Further, most indigenous freshwater fish and freshwater bird species, including some iconic treasured (taonga) species, are either threatened with extinction or at risk of becoming threatened.

Rivers and groundwater act as pathways transporting nutrients, sediments and contaminants from the land to the marine environment. Changes in the quality of freshwater can also affect estuaries and coastal waters (see [section 4: Marine](#)).

This section looks at two key issues.

First, it reports on the state of **freshwater quality** in our groundwater, rivers and lakes. It also summarises the pressures, including agriculture, wastewater and stormwater, which are responsible for the degraded state of many waterways.

It then presents evidence on how freshwater quality, land conversion, changes to flows and water courses, pests and climate change are all affecting the state of **freshwater habitats and native species**.

For the wider effects of the state of freshwater, see [section 7: Impacts on people, society and the economy](#).

New and updated freshwater indicators and evidence since *Environment Aotearoa 2022*

Updated national groundwater quality assessment

New *Escherichia coli* (*E. coli*) monitoring data show that contamination by faecal pathogens remains the most widespread water quality issue affecting groundwaters. Evidence not previously available from water suppliers shows that *E. coli* levels have failed to meet drinking water standards in some samples from aquifers that supply public drinking water.

An assessment of new nitrate-nitrogen monitoring data has strengthened previous assessments of the scale of nitrate impact in groundwaters. It indicates that a significant proportion of groundwaters have accumulated excess nitrate due to human activities, which can compromise drinking water quality and degrade surface water ecosystems. Groundwaters in most parts of the country continue to comply with drinking water standards, but some aquifers are still not safe for supplying drinking water that has not been treated for nitrate.

New monitoring data for pesticides and per- and polyfluoroalkyl substances (PFAS) indicate that they are not widespread in groundwaters, and rarely occur above drinking water standards.

(See [Freshwater quality is mixed. In some water bodies, contaminant levels pose a risk to people and freshwater species, habitats and ecosystems.](#))

New data and modelled findings for national lake health

A new model for lake water quality affirms previous assessments that almost half of the country's lakes are in poor health due to excess nutrients. However, unlike the previous model, it predicts that most of the remaining lakes are in good health, rather than average. This is due to the new model's improved accuracy for lesser-impacted lakes, and does not reflect a measured change in the state of lake environments between assessment periods.

(See [Some river and lake ecosystems are showing signs of degradation from excess nutrient levels.](#))

Updated extinction threat indicator: indigenous freshwater-dependent birds

The indicator update for indigenous freshwater-dependent birds shows most species remain threatened with extinction, or at risk of becoming threatened.

(See [Many indigenous freshwater species are threatened with extinction or at risk of becoming threatened.](#))

Updated national assessment of extinction risk for indigenous freshwater plants

An updated assessment by the Department of Conservation shows a significant proportion of our indigenous freshwater plant species remain threatened with extinction, or at risk of becoming threatened.

(See [Many indigenous freshwater species are threatened with extinction or at risk of becoming threatened.](#))

Freshwater quality

The quality of our freshwater is affected by different human activities. This impacts the health of ecosystems, and our ability to safely connect with the freshwater environment. This subsection looks at the state of groundwater, lakes and rivers, and what it means for drinking and swimming. It also examines the pressures that can degrade them.

Freshwater quality is widely monitored across groundwater, lakes and rivers, and models are used to predict water quality in unmonitored rivers and lakes. Cultural indicators, such as for traditional food-gathering practices (mahinga kai), can show the overall health of freshwater ecosystems. This subsection uses a selection of these measures to assess the extent of freshwater pollution in New Zealand, focusing on faecal pathogens and nutrients. Elevated nitrogen and faecal contamination can make waters unsafe for drinking, and faecal contamination can make them unsafe for recreation. Excess nutrients can degrade freshwater habitats and ecosystems, and harm freshwater species.

Freshwater quality is mixed. In some water bodies, contaminant levels pose a risk to people and freshwater habitats, species and ecosystems

Some of our groundwater is unsafe for drinking.

- *E. coli* is monitored as an indicator of the presence of pathogens associated with animal or human faeces, especially *Campylobacter*. Consuming faecal pathogens in drinking water can make people ill (see [section 7: Impacts on people, society and the economy](#)).
- Forty-six percent of 1,007 groundwater monitoring sites failed to meet the New Zealand drinking water standard for *E. coli* on at least one occasion between 2019 and 2024. This indicates a risk to people if they consume water from these aquifers that has not been adequately treated (Moreau et al, 2025).⁴
- Some of our groundwater drinking water sources have been contaminated with bacteria, including deep aquifers (deeper than 30 metres) and springs. Of the 11,026 (pre-treated) samples from water supply bores that were tested for *E. coli* and reported to Taumata Arowai in 2023, 6 percent failed to meet the drinking water standard. Thirty-three percent of the 326 samples from springs also failed (Taumata Arowai, 2024).
- Twelve percent of 1,173 groundwater monitoring sites failed to meet the New Zealand drinking water standard for nitrate-nitrogen on at least one occasion between 2019 and 2024 (Moreau et al, 2025). Groundwater with concentrations above this standard must be treated for nitrate before it is safe to drink (PMCSA, 2023).
- For the 184 wells sampled in the 2022 national groundwater survey for pesticides, detected concentrations of one compound exceeded New Zealand drinking water standards in six wells. Detected concentrations of two compounds exceeded the standards in two wells, and detected concentrations of three compounds exceeded them in one well (Close & Banasiak, 2023a; Moreau et al, 2025).
- Drinking water standards for other non-natural chemicals were not exceeded in any of the wells sampled in the last national groundwater survey in 2018, or in the first national groundwater survey for per- and polyfluoroalkyl substances (PFAS) in 2022 (Close et al, 2021; Close & Banasiak, 2023b).

Some rivers and lakes are unsuitable for swimming and recreation.

- Exposure to faecal pathogens through recreational activities such as swimming, paddling and water sports can make people ill (see [section 7: Impacts on people, society and the economy](#)). Rivers and lakes can be assessed for their suitability for these activities by using measured *E. coli* concentrations to calculate the risk of infection from *Campylobacter* bacteria (see [Technical annex](#)).
- Models estimate that 45 percent of the country's total river length was not suitable for activities such as swimming between 2016 and 2020, based on having an average *Campylobacter* infection risk greater than 3 percent (corresponding to National Objectives Framework (NOF) bands D and E for *E. coli*) (see indicator: [River water quality: Escherichia coli](#); MfE, 2024f).

⁴ Moreau et al (2025) update the information in the current version of the Stats NZ Groundwater quality indicator, published in April 2020. The data from Moreau et al will be incorporated into the next indicator update, but the statistics published in the updated web page may differ due to methodological (or other) differences (see [Technical annex](#)).

- For *E. coli*, trends at 41 percent of river monitoring sites were worsening and 37 percent were improving between 2001 and 2020 (see indicator: [River water quality: Escherichia coli](#)).
- For the period 2017–22, 9 of 92 monitored lake sites had an average *Campylobacter* infection risk of more than 3 percent, making them unsuitable for activities such as swimming (Kuczynski et al, 2024; MfE, 2024f). For the 15 sites where trends could be assessed for *E. coli*, 33 percent were worsening and 20 percent were improving between 2012 and 2022 (Kuczynski et al, 2024; MfE, 2024f).

The quality of our waterways can make them less suitable for food-gathering (mahinga kai) and treasured (taonga) species, which are important cultural indicators of the health of freshwater ecosystems.

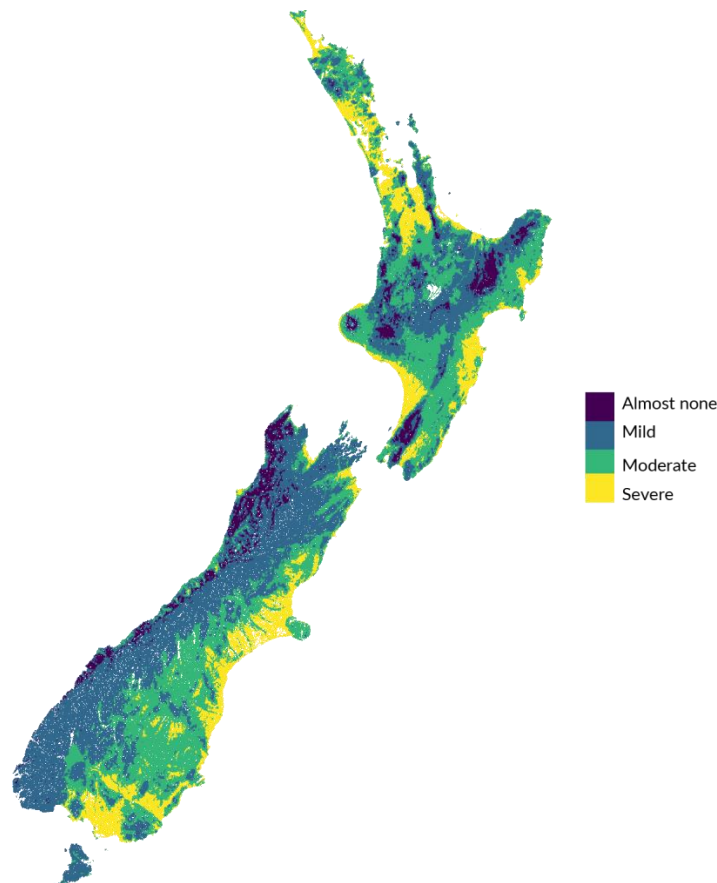
- Mahinga kai is a cultural indicator of a healthy freshwater system (Hikuroa et al, 2018; Tipa, 2009). Sustaining and accessing mahinga kai is closely linked to the state of freshwater, and is important for Māori in understanding the health of an ecosystem (Rainforth & Harmsworth, 2019; Tipa, 2009).
- A survey of five mahinga kai sites in coastal North Canterbury between 2019 and 2021 detected *E. coli* on sampled watercress, and in cockles, at concentrations that exceeded health guidelines for human consumption. Concentrations were significantly higher than in the surrounding water (van Hamelsveld et al, 2023).
- An assessment of the Wairoa and Waiau rivers using mātauranga observations from 2021 to 2023 observed a decline in the health of mahinga kai species: 9 percent of the harvest was unsafe to eat, and 7 percent of the targeted catch was not safe to harvest due to visible injury or sickness. The assessment also observed an accelerating decline in the availability of mahinga kai species that were traditionally or historically available (Galvan et al, 2024).

Some river and lake ecosystems are showing signs of degradation from excess nutrient levels.

- Nutrients, such as nitrogen and phosphorus, occur naturally in the freshwater environment. However, elevated levels can drive eutrophication – an overload of nutrients that can cause algal blooms, depleted oxygen levels and a range of harmful effects on freshwater ecosystems (Snelder et al, 2020; see [Our freshwater 2023](#)). Freshwater can carry nutrients from land into the marine environment, where they can also cause harm (see [section 4: Marine](#)).
- This subsection assesses the flow-on effects of nutrients on freshwater ecosystems using water quality indices that provide a high-level understanding of ecosystem health: macroinvertebrate community index (MCI) for rivers and trophic level index (TLI) for lakes (see [Our freshwater 2023](#) and [Technical annex](#)). For more about nutrients in water, see indicators: [River water quality: nitrogen](#), [River water quality: phosphorus](#), [Lake water quality](#) and [Coastal and estuarine water quality](#).
- Between 2016 and 2020, 55 percent of New Zealand’s river length had modelled MCI scores that indicate conditions with moderate or severe organic pollution or nutrient enrichment, and 45 percent had scores that indicate no or mild impairment (see indicator: [River water quality: macroinvertebrate community index](#); figure 3).
- For MCI, trends at 56 percent of river monitoring sites were worsening and 25 percent were improving between 2001 and 2020 (see indicator: [River water quality: macroinvertebrate community index](#)).

- Forty-six percent of lakes larger than 1 hectare had modelled TLI scores indicating poor or very poor health in terms of nutrient enrichment between 2016 and 2020 (see indicator: [Lake water quality](#)). A new TLI model that better represents less-affected lakes predicts that 34 percent of lakes larger than 1 hectare are in good or very good health, based on data from 2018 to 2021 (Wood et al, 2023; see [Technical annex](#)).
- For TLI, trends at 45 percent of lake monitoring sites were worsening and 36 percent were improving between 2011 and 2020 (see indicator: [Lake water quality](#)).
- For the period 2019–24, groundwater nitrate-nitrogen concentrations were monitored at 1,173 sites. Forty-one percent of sites indicated groundwater in these locations is likely to have accumulated excess nitrate due to human activities. For the 417 sites where trends could be assessed for nitrate-nitrogen, concentrations were increasing at 47 percent of them, and decreasing at 43 percent between 2004 and 2024 (Moreau et al, 2025; see [Technical annex](#)).
- The concentration of nitrate that is harmful to groundwater species is unknown (Fenwick et al, 2018), but nitrate-rich groundwaters can contribute to ecosystem degradation in the surface water bodies that they flow into (see [Our freshwater 2023](#)).

Figure 3: Modelled median macroinvertebrate community index scores indicating organic pollution and nutrient enrichment in rivers, 2016–20



Data source: Regional councils, NIWA

Note: Nutrient enrichment levels from 'Almost none' to 'Severe' correspond to National Objective Framework bands A to D (see indicator: [River water quality: macroinvertebrate community index](#); MfE, 2024f).

Land use and human activities are major pressures on freshwater quality

Land-based human activities contribute to excess nutrients, sediment and pathogens in fresh waterways.

- Human activities on land, such as agriculture, forest harvesting and urban expansion, can increase erosion rates and the levels of pathogens, nutrients and sediment in freshwater and marine systems (see [Our freshwater 2023](#) and [section 4: Marine](#)). In some parts of New Zealand, increased rainfall and flooding are expected to further increase the amount of eroded sediment reaching downstream environments (see [section 2: Land](#)).
- When pathogens, excess sediment and surplus nutrients wash or drain into freshwater environments, they can cause ecological and socio-economic harm. Pathogens such as *Campylobacter*, *Cryptosporidium*, *E. coli* and *Giardia* can make waters unsafe for drinking and recreation (Basher et al, 2011; Devane et al, 2018; Donovan, 2022; Larned et al, 2020; Leonard & Eaton, 2021; see [section 7: Impacts on people, society and the economy](#)).

Intensification and other land-use changes have increased pressures on water quality.

- Intensification involves increasing the use of inputs such as fertiliser and irrigation, and draining soils, to increase production. This includes converting land used for less intensive activities such as sheep farming, to more intensive uses such as dairy farming or horticulture (Burge et al, 2023). Agriculture has been intensifying in New Zealand since the 1980s, but the rate has slowed since the mid-2010s (see [section 2: Land](#)).
- Analyses of national river water quality monitoring data for 2016–20 show that water quality is more degraded when there is more high-intensity pasture and horticultural land upstream (Whitehead et al, 2022). Models indicate that measured long-term changes in water quality leading up to this period were closely associated with agricultural intensification and, to a lesser extent, better farm management (Monaghan et al, 2021; Snelder et al, 2021; see [Our freshwater 2023](#)).

Stormwater, wastewater and other waste discharges are also pressures on freshwater quality

Wastewater and stormwater are sources of freshwater contaminants, such as pathogens and heavy metals.

- Sewage and other wastewater from houses, businesses and industrial processes often contains high levels of pathogens and other contaminants. These are significantly reduced by wastewater treatment, but treated discharges can still carry contaminants into the freshwater environment (Ruffell et al, 2021; see [Our freshwater 2020](#)).
- Some wastewater bypasses treatment entirely. In the 2022 national performance review by Water New Zealand, participating wastewater service suppliers reported that between 2021 and 2022 there were 3,121 reported overflows of untreated wastewater due to wet-weather events, or due to blockages and mechanical failures during dry weather. However, it is likely that this number is under-reported (Water NZ, 2024).
- Stormwater can also carry pollutants from land into freshwater. These pollutants include hydrocarbons and heavy metals from vehicles and industrial yards, and pathogens from animal faeces, wastewater leaks and overflows (see [Our freshwater 2023](#)).

- River water quality monitoring data for Auckland, Canterbury, Otago and Wellington for 2017–22 indicates that concentrations of the heavy metals copper and zinc were highest at sites with greater proportions of urban land cover in their upstream catchments (see indicator: [River water quality – heavy metals: Data to 2022](#)).

Plastics and chemicals that have been produced and used for decades end up in freshwater.

- Plastic waste is a major problem affecting land, freshwater and the marine environments (see [section 2: Land](#) and [section 4: Marine](#)). Some plastics take centuries to break down, and large quantities are still being produced (PMCSA, 2019).
- In 2021 and 2022, most of the items (68 percent) counted in New Zealand freshwater environments in Litter Intelligence surveys were plastic (Litter Intelligence, nd).
- Microplastics are generally defined as plastic particles less than 5 millimetres in diameter (De Bhowmick et al, 2021). They have been found in urban streams and are often transported via smaller urban streams. A survey across 52 urban streams found microplastics in samples from all sites (Mora-Teddy & Matthaei, 2020).
- Pesticides can stay in the environment for long periods and can enter waterways. They have been used in New Zealand for many decades over large areas of land (Chapman, 2010; Manktelow et al, 2005; Rolando et al, 2016).
- In the 2022 national groundwater survey for pesticides and per- and polyfluoroalkyl substances (PFAS), one or more pesticides were detected in 17 of the 184 wells sampled (9 percent). Pesticides were detected in a smaller proportion of wells, and generally at lower concentrations, than in the last survey in 2018 (Close & Banasiak, 2023a).
- PFAS were included in the national groundwater survey for the first time in 2022. Of the 131 wells surveyed for PFAS, one or more were detected in 15 wells (11 percent) (Close & Banasiak, 2023b).
- Other non-natural chemical contaminants coming from the manufacture and use of products such as plastics and personal care products have been detected in groundwaters across the country, but mostly at low levels (Close et al, 2021).

Freshwater habitats and native species

New Zealand has many unique native species that depend on freshwater. When freshwater quality declines, these species and their ecosystems become threatened. This subsection looks at how pressures such as invasive species, sediment and contaminants, along with changes to water flows from irrigation and hydropower, are affecting habitats and placing some species at risk of extinction.

The effects of climate change are intensifying many of these pressures. This is discussed in [section 6: Atmosphere and climate](#).

Human activities and exotic species have led to the loss and degradation of habitats, placing significant pressure on native species

Much of our historical wetland has been converted to other uses, and the loss and degradation of these places (considered sacred or wāhi tapu by Māori) have continued. This has reduced habitat for dependent native species and diminished many environmental benefits.

- New Zealand has lost an estimated 90 percent of historical wetland (repo) area, but the small fraction that remains is vital for the survival of many threatened plant and animal species, including several treasured (taonga) bird species (Clarkson et al, 2013; Dymond et al, 2021; see [Our freshwater 2023](#)).
- Wetlands continue to be lost. Freshwater wetland area decreased by 1,498 hectares (0.6 percent), and saline repo area by 69 hectares (0.1 percent), between 2012 and 2018 (see indicator: [Wetland area](#)).
- Wetlands continue to be degraded by drainage and disturbance from adjacent land use, particularly roading and grazing (Burge et al, 2023, 2025).
- Wetlands provide many benefits, such as storing carbon, regulating water flow during storms, and purifying water by filtering out nutrients and sediments (Clarkson et al, 2013; Schallenberg et al, 2013). The extent and condition of these ecosystems affect these important processes.

Freshwater ecosystems can be widely affected by introduced species, some of which degrade freshwater habitats and threaten native species.

- Historically, over 200 species of freshwater animals and plants have been introduced to New Zealand, mostly deliberately. Illegal and accidental introductions still occur (NIWA, 2020), such as the gold clam (*Corbicula fluminea*), which was discovered in the Waikato River in 2023 and has established a breeding population there (DOC, nd-a; MPI, 2023d).
- Many introduced freshwater species, such as trout, koi carp, hornwort and didymo, place pressures on our unique native species and ecosystems. Their spread can destabilise aquatic environments and threaten indigenous biodiversity (Baker et al, 2003; DOC, nd-b; MPI, nd-b; NIWA, 2020; Otago Regional Council, 2024; see [Our freshwater 2023](#)).

Contaminants from human activities on land can affect freshwater habitats and species.

- Poor water quality, low oxygen levels and warm temperatures can allow toxic concentrations of *Clostridium botulinum* bacteria to build up in freshwater bodies. This has led to botulism outbreaks that have killed hundreds of freshwater fish and birds, including native and threatened species (BirdCare Aotearoa, 2022; Kāpiti Coast District Council, 2024; MPI, 2023e; Waikato Regional Council, 2023).
- Heavy metals in high concentrations can be toxic to aquatic life. They can accumulate in sediments and living organisms (Boehler et al, 2017).
- Kāhaki habitat decline has been attributed to river regulation, nutrient enrichment and other types of pollution (Phillips, 2007).

- Microplastics have been found to accumulate in freshwater organisms. These can cause impacts depending on their physical shape and size, age, density and chemical make-up (Ockenden et al, 2021, 2022; Zimmermann et al, 2020).

Excess sediment in waterways can degrade habitats and lead to a decline in native freshwater species

- Soil washed from the land can degrade freshwater both when it is suspended in the water and when it settles as sediment on a streambed (see indicators: [Estimated long-term soil erosion: Data to 2022](#) and [Deposited sediment in rivers](#); and [Our freshwater 2020](#)).
- Excess suspended sediment makes the water cloudy, blocking light and reducing the native freshwater plants that provide habitat for native species (NIWA, 2019b; Rowe, 2007; Schallenberg et al, 2013). It is directly harmful to freshwater fish, making it more difficult for them to breathe, feed and migrate (Collier et al, 2017).
- Excess deposited sediment smothers natural habitats on the bottom and banks of rivers and lakes – it fills in the spaces between rock and gravel that small fish and invertebrates use to hide and breed. It can also make their food harder to find (Burdon et al, 2013; Clapcott et al, 2011).

The condition of river and lake habitats is generally moderate to good, but some are degraded by contaminants from land, and invasive plants.

- Visual clarity is a measure of underwater visibility in rivers and streams. It indicates how much sediment is suspended in the water. Poorer clarity means there is more sediment, and more risk of harm to species. Clarity is an important indicator of ecosystem health, and of cultural stream health, which includes measures that incorporate Māori values (Galvan et al, 2024; MfE, 2006).
- Seventy-seven percent of the country's river length had modelled visual clarity values that indicated a minimal to moderate impact of suspended sediment on aquatic life (NOF bands A and B) between 2016 and 2020. Twenty-three percent of river length indicated a moderate to high impact (NOF bands C and D) (see indicator: [River water quality: clarity and turbidity](#) and [Technical annex](#)).
- The overall condition of river and stream habitat can be assessed based on 10 measured parameters including flow and habitat diversity, streambed sedimentation, bank erosion, bank vegetation and shade (Clapcott et al, 2019). Flow and habitat diversity, streambed sedimentation and bank vegetation are also some of the indicators used by some Māori to holistically assess the cultural health of rivers and streams (Galvan et al, 2024; MfE, 2006).
- Of the 459 river and stream monitoring sites assessed for habitat condition across seven regions between 2013/14 and 2018/19, 79 percent were good or excellent and 21 percent were fair (see indicator: [Freshwater physical habitat](#)).
- The submerged plant index is a measure of a lake's ecological health. It reflects the diversity and extent of native and invasive plant species that provide habitats and support ecosystem processes. Between 1991 and 2019, 36 percent of 295 monitored lakes were in poor ecological condition based on their plant communities or were entirely without submerged plants, and 34 percent were in excellent or high ecological condition. Eighty-eight percent of lakes with vegetation had some non-indigenous plant species present (see indicator: [Lake submerged plant index](#)).

Human changes to flows and water courses put pressure on freshwater habitats and native species

Structures for diverting or controlling water have altered and fragmented river habitats, placing pressure on fish and kōura migrations.

- Structures that divert or control water such as dams, weirs, culverts, fords, stop banks and floodgates alter river channels and flows, and the connections between waterways. These changes can reduce populations or prevent the migration and spawning of some species, affecting the range of species that rivers can support (Brierly et al, 2022; Franklin et al, 2018; Graynoth et al, 2008; Harding et al, 2009; see [Our freshwater 2023](#)).
- These changes can affect the cultural health of rivers and streams. Barriers and changes to flows place pressure on the migration of mahinga kai species such as whitebait (īnanga), eels (tuna) and freshwater crayfish (kōura) (McDowall, 2000). The re-routing of flows in the Tarawera River has greatly reduced environmental and cultural wellbeing (Hikuroa et al, 2018).
- A national assessment of river barriers estimates that a minimum of 48 percent of the river network is at least partially inaccessible to migratory fish, though a further 36 percent has not yet been assessed for barriers and could be inaccessible (Franklin et al, 2022).
- Confining waterways to well-defined channels sometimes concentrates flows, which can increase the erosion of riverbanks and the amount of sediment deposited downstream (Fuller et al, 2011; Maddock, 1999; see [Our freshwater 2020](#)).

Using water for hydropower and irrigation can change the timing and volume of freshwater flows.

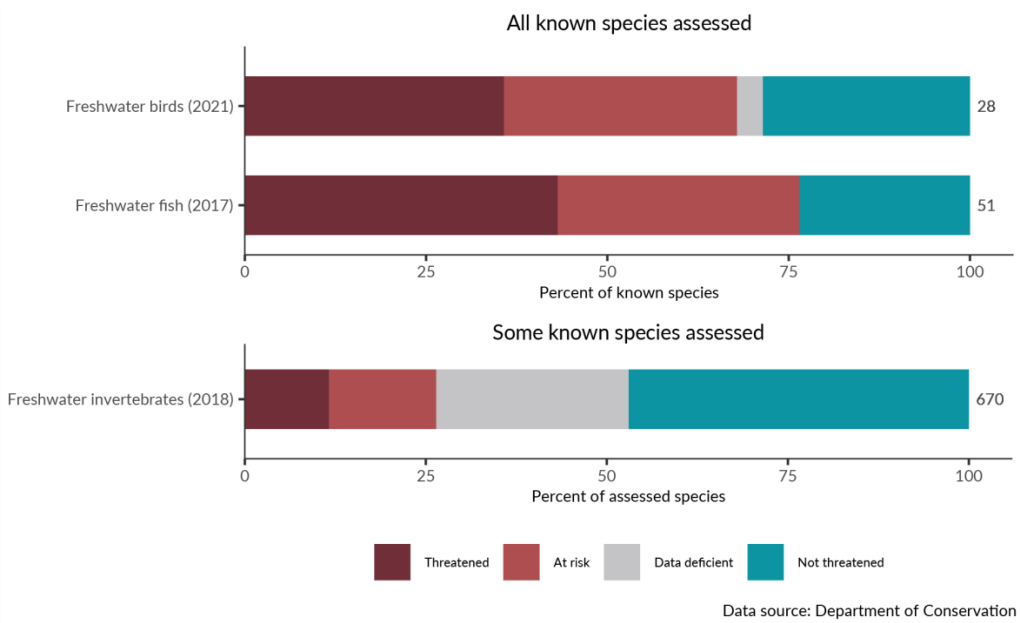
- Using and storing water for human activities can affect the natural variability of a river's flow – the volume of water, how fast it flows, how the flows vary seasonally and in response to precipitation, and the connections between waterways. Diverted or altered flows in one area can affect or alter the flows in connected water bodies, and the health of freshwater ecosystems (see [Our freshwater 2020](#)).
- About 440 billion cubic metres of freshwater flows in our rivers and streams every year (Collins et al, 2015). In the year ended June 2020, about 752 billion cubic metres were held in aquifers as groundwater (Stats NZ, 2021b).
- For the 2017/18 water reporting year, 13 billion cubic metres of surface water and groundwater was allocated for irrigation, drinking, industrial and other uses across the country. The largest share (58 percent) was allocated to irrigation (see indicator: [Consented freshwater takes](#)).
- Even when it only temporarily stores water, hydroelectric generation can affect the timing and volume of flows downstream of dams and diversions. Some hydro schemes divert flows from one river to another, or to the ocean, and are considered consumptive uses of water. The amount of water used by these consumptive schemes is significant in some regions (see [Our freshwater 2020](#)).

Indigenous freshwater species are under threat

Many indigenous freshwater species are threatened with extinction or at risk of becoming threatened.

- In 2017, 76 percent of indigenous freshwater fish species (39 of 51) were threatened with extinction or at risk of becoming threatened, including seven identified as treasured (taonga) (figure 4). Estimated population trends show 63 percent of species have decreasing populations and 2 percent have increasing populations (see indicator: [Extinction threat to indigenous species](#)).
- In 2021, 68 percent of indigenous freshwater-dependent bird species (19 of 28) were threatened with extinction or at risk of becoming threatened (figure 4). A number of these are also considered to be taonga species (Keane-Tuala, 2015; Taura et al, 2017; Te Manahuna Aoraki Project, 2022; see [Our freshwater 2023](#)). Estimated population trends show 29 percent of species have increasing populations and 25 percent decreasing (see indicator: [Extinction threat to indigenous species](#)).
- In 2017, 39 percent of indigenous freshwater plant species (71 of 180) were threatened with extinction or at risk of becoming threatened (figure 4). Estimated population trends show 20 percent of species have decreasing populations and 77 percent have stable populations (see indicator: [Extinction threat to indigenous species](#)).
- In 2018, 26 percent of assessed indigenous freshwater invertebrates (177 of 670) were threatened with extinction or at risk of becoming threatened, including three identified as taonga (figure 4). Estimated population trends show 3 percent of assessed species have decreasing populations and no species has an increasing population (see indicator: [Extinction threat to indigenous species](#) and [Technical annex](#)).
- In 2023, 43 percent of indigenous freshwater plant species (77 of 180) were threatened with extinction or at risk of becoming threatened. Estimated population trends show 21 percent of species have decreasing populations and 77 percent have stable populations (de Lange et al, 2024; see [Technical annex](#)).

Figure 4: Extinction threat status of indigenous freshwater species⁵



Note: Totals given for species on the right of this figure show the total number of species assessed. Complete assessments are those where all known species in the group have been assessed. Partial assessments are those where not all species in the group have been assessed (see indicator: [Extinction threat to indigenous species](#)).

⁵ Note that extinction threat information updated since the Extinction threat to indigenous species indicator update in 2023 has been included in the text and is based on New Zealand Threat Classification System data downloads (see [Technical annex](#); NZTCS, 2025). Figure is based only on information available in the indicator (see indicator: [Extinction threat to indigenous species](#)).

4. Marine

Introduction

Aotearoa New Zealand's marine environment plays a key role in our national identity. It supports unique habitats and species, and contributes to our quality of life and economy. For many Māori, the ability to gather seafood (kai moana) is an important indicator of the health of the ocean and enables traditional food-gathering practices (mahinga kai) (see [Environment Aotearoa 2022](#)).

The marine environment faces significant pressures from human activities, both on land and at sea, and from climate change. Land management practices that affect freshwater through sediment and nutrient run-off also affect our coasts and oceans. Fishing adds to these pressures, and climate change is altering the ocean in different ways. Although some pressures have decreased in recent years, others are increasing. Many marine species are still threatened with extinction, in part because their habitats are shrinking or being damaged.

This section looks at three interconnected issues affecting **coastal and marine ecosystem health**: the effects of land-based activities on water quality and marine ecosystems, the impacts of fishing practices, and the consequences of climate change for the oceans.

It then examines the impacts on **indigenous marine species and habitats**.

For the wider effects, see [section 7: Impacts on people, society and the economy](#).

New and updated marine indicators and evidence since *Environment Aotearoa 2022*

Updates to coastal and estuarine water quality and primary productivity indicators

More coastal and estuarine water quality monitoring sites reported improving trends than worsening ones between 2006 and 2020. This included all nutrient forms (nitrogen and phosphorus) and some sedimentation measures (suspended solids, turbidity).

Most coastal regions saw increasing primary productivity trends between 1998 and 2022, while oceanic regions showed mixed trends, with both increases and decreases in primary productivity.

(See [Land-based activities affect water quality and primary productivity](#).)

New data for fish stocks, bycatch of protected species, and bottom trawling

Most of the fish stocks in the 2023 update to the Fisheries New Zealand Quota Management System were assessed to be fished within safe limits, while 12 percent were assessed to be overfished or depleted. The latest national survey of recreational fishers reported a decrease in recreational fisheries between 2017/18 and 2022/23, particularly in the north of New Zealand.

The latest update to bycatch data shows that it continues to place pressure on marine protected species.

Two new assessments from the Ministry for Primary Industries on the extent and intensity of bottom trawling showed a decline over time for deepwater and inshore fisheries. Most seamounts and high-productivity areas are either closed to trawling or have never been trawled, while 13 percent of seamounts were trawled at least once in recent decades.

(See [Commercial activity in the marine environment affects ecosystems and biodiversity](#).)

Updates to sea-surface temperature indicator and new data for marine heatwaves

Average sea-surface temperatures have risen across New Zealand's four oceanic regions between 1982 and 2023, with their warmest years recorded in either 2022 or 2023.

New evidence shows that marine heatwaves have become more frequent, more intense and longer lasting in some parts of the ocean around the country. These trends are expected to continue.

The 2022 update to national sea-level rise projections from the NZ SeaRise Programme indicated that areas in New Zealand experiencing ongoing downward land movement, may face faster relative sea-level rise than previously reported.

(See [Climate change and our marine environment](#).)

Updated national assessment of extinction risk for indigenous marine invertebrates

An updated assessment by the Department of Conservation shows more than half of our indigenous marine invertebrate species remain threatened with extinction, or at risk of becoming threatened.

(See [Marine habitats and native species](#).)

Coastal and marine ecosystem health

This part looks at three interconnected issues affecting the health of our coasts and oceans: water quality, fishing and climate change.

Certain land-use and management practices accelerate sediment build-up and nutrient run-off, affecting water quality in marine environments. Although water quality has improved in terms of nutrients in some estuarine and coastal areas, sedimentation is worsening in many places. Plastic waste, which can end up as litter (see [section 2: Land](#)), is accumulating in the ocean and along the coasts. Although fishing pressures have decreased, overfishing, bycatch and trawling continue to deplete some fish stocks, harm protected species and damage the seabed. Climate change exacerbates these issues by driving ocean warming, acidification and sea-level rise. These changes disrupt marine species and ecosystems, and increase their vulnerability to invasive species and human disturbance.

Land-based activities affect water quality and primary productivity

Changing sediment levels in coastal and estuarine areas can cause ecological effects.

- New Zealand has naturally high rates of soil loss, with the amount of sediment entering waterways varying regionally. Land use, including agriculture and forestry, can increase the sediment in rivers, as well as downstream in estuaries and coastal waters (Marden et al, 2022, 2023; Phillips et al, 2017; PMCSA, 2021). Increased frequency and severity of extreme weather events are likely to exacerbate soil loss and downstream sediment (see [section 2: Land](#) and [section 3: Freshwater](#)).
- Between 2006 and 2020, more coastal and estuarine sites had improving trends than worsening for suspended solids (66 of 84) and turbidity, a measure of how cloudy the water is (54 of 87). Monitoring sites were not distributed evenly around the coastline, and were often clustered around urban centres (see indicator: [Coastal and estuarine water quality](#) and [Technical annex](#)).
- Sediment accumulation rates in estuaries increased by orders of magnitude after European settlement. Sedimentation has continued in some estuaries over the last 20 years, at variable rates due to factors such as the structure of each estuary, and past catchment disturbances (Jones et al, 2022).
- Excess suspended and deposited sediment in estuaries and coastal areas can reduce and alter habitats, smother sensitive species and affect the gills of some species. Fine suspended sediment can clog the gills of filter feeders such as cockles, pipi and scallops (Booth, 2020; Lowe et al, 2015; Morrison et al, 2009; O'Meara et al, 2017; PMCSA, 2021; Thrush et al, 2021).

Excess nutrients from dairy farming and horticulture can affect coastal and estuarine ecosystems.

- Nutrients such as nitrogen and phosphorus occur naturally in estuaries and coastal waters. However, land activities such as dairy farming and horticulture can lead to elevated nutrient levels (see [section 2: Land](#)). Excess nutrients that reach estuaries often have delayed effects, which can vary between different parts of an estuary (Lohrer et al, 2023).
- Excess nutrients in estuaries can cause eutrophication, which is an overload of nutrients that produces algal blooms and depletes oxygen levels. This can be harmful to plants, animals and people (Dudley et al, 2020; Plew et al, 2020; Salmond & Wing, 2022; Snelder et al, 2020).
- For nitrogen and phosphorus, more coastal and estuarine sites had improving trends than worsening between 2006 and 2020 (see indicator: [Coastal and estuarine water quality](#)).
- Land activities also cause pathogens such as faecal bacteria to enter rivers, lakes, estuaries and coastal waters. These bacteria come from animal excrement, wastewater discharges and contaminated soil run-off, and can harm ecosystems and people (LAWA, 2021; see section 3: Freshwater and section 7: Impacts on people, society and the economy).
- Faecal coliforms are monitored as an indicator of the presence of disease-causing bacteria in waters. Between 2006 and 2020, faecal coliform levels were improving at 50 percent of coastal and estuarine monitoring sites (25 of 50) and worsening at 24 percent (12 of 50) (see indicator: [Coastal and estuarine water quality](#)).

Primary productivity is increasing in coastal regions.

- Marine primary productivity describes the growth of phytoplankton in coastal and ocean waters, which provides the energy that supports most marine food webs. It is affected by nutrients, water temperature and the availability of light (see indicator: [Marine primary productivity: Data to 2023](#)).
- Areas of high primary productivity support productive marine ecosystems, including various commercial shellfish and finfish fisheries (MPI, 2021a). However, high primary productivity in estuarine and coastal waters can indicate the presence of harmful algal blooms due to excess nutrients from land (Gall & Pinkerton, 2024; Pinkerton et al, 2023; Roberts & Hendriks, 2022).
- Primary productivity is monitored by measuring chlorophyll-a, an indicator of phytoplankton abundance. Phytoplankton monitoring between 1998 and 2022 indicates that primary productivity very likely increased in most coastal regions, at average rates ranging from 5 to 13 percent per decade.
- The oceanic regions showed increasing and decreasing trends in chlorophyll-a concentrations (see indicator: [Marine primary productivity: Data to 2023](#) and [Technical annex](#)).

Plastics continue to accumulate throughout the marine environment and affect marine species, including seabirds.

- Plastic waste can stay in the environment for centuries, and is a major problem affecting the land, freshwater and marine environments (PMCSA, 2019; see [section 2: Land](#) and [section 3: Freshwater](#)).
- In 2023, most of the items (67 percent) counted on beaches in Litter Intelligence surveys were plastic (Litter Intelligence, nd). Some hazardous additives in plastic have also been detected in plastic debris on our beaches (Bridson et al, 2024).
- Marine species and seabirds are at risk from eating or getting tangled in plastics, which can cause injury or death (Buxton et al, 2013; Clark et al, 2023; PMCSA, 2019).
- Microplastics (less than 5 millimetres long), which result from the breakdown of larger plastics, are widespread throughout the marine environment (Asher, 2023; De Bhowmick et al, 2021; Li et al, 2024; PMCSA, 2019). They typically occur in greater quantities near urban centres (Munsterman et al, 2024).
- Microplastics and the chemicals they release accumulate in animals as they move up food chains, harming marine species, and could pose risks to human health (PMCSA, 2019). They have been found in many of New Zealand's fish species that are eaten by humans, and in green-lipped mussels (Clere et al, 2022; Mazlan et al, 2022). Understanding the effects of microplastics on ecosystems and human health is a growing area of research (Asher, 2023; De Bhowmick et al, 2021; Li et al, 2024; PMCSA, 2019).

Commercial activity in the marine environment affects ecosystems and biodiversity

- While pressures from commercial and recreational fishing have reduced and most is within safe limits, some fish stocks continue to be overfished. Commercial fishing methods in New Zealand include bottom trawling, dredging, longlining and set netting. Bottom trawling is the most common (MPI, 2023f; see [Our marine environment 2022](#)).

- In 2023, 88 percent of fish stocks in the New Zealand Fish Quota Management System (133 of 152 stocks) were assessed to be fished within safe limits, with 82 percent at or above their management goals (MPI, 2024b).
- However, 12 percent of stocks (19 of 152) were overfished or depleted in 2023, including some stock of black cardinalfish, orange roughy and scallops. Five stocks had collapsed, indicating fishery closures should be considered to rebuild the stock quickly (MPI, 2024b).
- The total estimated catch from recreational fishing in 2022/23 was 3.7 million fish and 1.6 million shellfish. Snapper, kahawai, blue cod and red gurnard together made up 80 percent of all fish harvested by recreational fishers (MPI, 2024c).
- Recreational fisheries declined between 2017/18 and 2022/23, particularly in the north of New Zealand. Contributing factors include extreme weather events in 2023, prolonged La Niña conditions and changes in fishing habits (MPI, 2024c).

Bycatch continues to contribute to population decline and extinction risk of some protected species.

- Bycatch is the unintended capture during fishing of non-target species, including protected ones. Removing or killing important species through bycatch threatens biodiversity and puts pressure on marine ecosystems (MPI, 2021b, 2024c).
- Since 2019/20, Hector's dolphin deaths due to commercial bycatch have ranged from 0 to 5 per year, except in 2023/24, when 15 deaths were reported. All 15 deaths in 2023/24 were reported on the east coast of the South Island, where an estimated 9,728 (61 percent) of the total estimated 15,847 Hector's dolphins reside (DOC, 2024a; MPI, 2019a).
- Other marine mammals, large numbers of seabirds and some protected corals are also caught as commercial bycatch. For example, models estimated 3,613 seabirds and 476 fur seals were bycaught in trawling and longline fisheries in 2020/21 (Protected species bycatch, nd). In the 2021/22 fishing year, 2,073 kilograms of protected coral were reported as bycaught (McGovern, 2024).
- Between 2 and 34 captures of protected sea turtles were reported each year between 2007/08 and 2019/20, and 58 were reported in 2020/21 (including 50 leatherback turtles). This reporting includes reports by fishery observers and self-reporting by commercial fishers (Dunn et al, 2022).

The area trawled each year has been declining, but trawling still affects the seafloor and the animals that live there.

- Commercial fish trawling and dredging have lasting impacts on the seabed and its habitats. These include altering seabed structure, damaging habitats, re-suspending sediment, removing species from food webs and disrupting marine populations (Clark et al, 2019, 2022a; MPI, 2023f).
- Between 1990 and 2021, about 11 percent of the exclusive economic zone and territorial seas were trawled. The area trawled each year has been declining over time and was 74,500 square kilometres in 2021 (MPI, 2023f). Methods have also improved in recent years to reduce contact with the seabed, in both deepwater and inshore fisheries (MacGibbon et al, 2024).

- Seamounts, knolls and hills are underwater areas of high productivity and biodiversity that are targeted by some deepwater fisheries (Clark et al, 2019, 2022b). Seamount recovery from trawling is slow: it took about two decades for the first signs of potential benthic (seafloor) community recovery to appear after trawling ceased on the Graveyard Knolls of the Chatham Rise (Clark et al, 2022a).
- Thirteen percent of seamounts, knolls and hills in New Zealand’s exclusive economic zone and territorial seas were trawled at least once between 1989 and 2019 (Clark et al, 2022b).

Aquaculture is a growing sector with positive and negative effects on marine ecosystems.

- The growing aquaculture industry, which includes species like green-lipped mussels, Chinook salmon and Pacific oysters, can have both positive and negative impacts on marine ecosystems (Howarth & Major, 2023; MPI, 2013).
- Mussel farming, for example, can support seafloor communities and some wild fish. However, it can lead to local enrichment of the seabed, and alters the composition of sediments (Howarth & Major, 2023; Underwood et al, 2023). Farm infrastructure can disrupt currents, damage the seabed, shade the seafloor and pose entanglement risks to wildlife (Howarth & Major, 2023; MPI, 2013).

Climate change and our marine environment

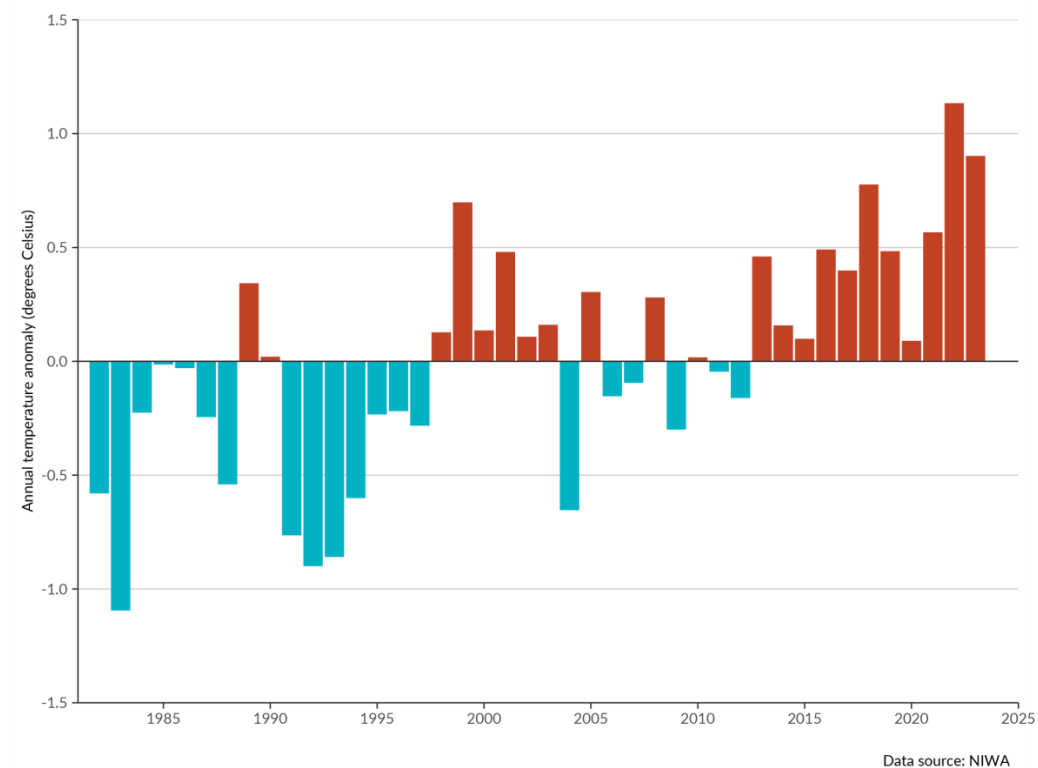
The ocean is becoming warmer and more acidic due to climate change, with impacts on marine ecosystems.

- Global oceans have captured nearly 25 percent of total human carbon emissions since industrialisation (Friedlingstein et al, 2020). This is making the ocean more acidic. Surface ocean acidity is estimated to have increased by almost 30 percent from 1750 to 2000 (Jiang et al, 2023). Acidity increased 8.6 percent in subantarctic surface water off the coast of Otago between 1998 and 2020 (see indicator: [Ocean acidification](#)).
- Oceans have also captured 90 percent of the excess heat from greenhouse gas emissions, increasing the ocean temperatures (Venegas et al, 2023).
- Between 1982 and 2023, sea-surface temperature in the country’s oceanic regions increased an average of 0.16 to 0.26 degrees Celsius per decade, and in coastal regions an average of 0.19 to 0.34 degrees per decade (figure 5) (see indicator: [Sea-surface temperature: Data to 2023](#)).
- Marine heatwaves have become more frequent, intense and longer-lasting, including in New Zealand (Montie et al, 2024; Sun et al, 2023). In 2022, New Zealand experienced a record number of marine heatwave days, and the two longest and most intense marine heatwaves on record in some locations (Salinger et al, 2023; Shears et al, 2024). These trends are expected to continue (Behrens et al, 2022; Bodeker et al, 2022; Sun et al, 2023).
- Marine heatwaves have caused declines and local extinctions of some populations of ocean species. Warmer sea-surface temperatures and ocean acidification alter habitats, and affect the food supply and the growth and life cycles of native marine species, including treasured (taonga) species. This intensifies other pressures such as invasive species and human disturbances (see [section 6: Atmosphere and climate](#)).

Warmer seas are accelerating sea-level rise.

- Increasing ocean temperatures cause the water to expand (Venegas et al, 2023). Combined with melting glaciers and ice sheets, this contributes to sea-level rise (Lindsey & Dahlman, 2023; Venegas et al, 2023). Global mean sea level has risen 21–24 centimetres since 1880, and is projected to rise to 0.3–1.0 metres above 2000 levels by 2100 under a low emissions scenario (Grandey et al, 2024; Lindsey, 2023).
- Annual mean coastal sea levels rose faster (relative to land) at four longer-term monitoring sites around New Zealand between 1961 and 2020 when compared with 1901–60. This rate is accelerating – the mean rate of rise between 1961 and 2020 was double that between 1901 and 1960 at three of the four sites (see indicator: [Coastal sea-level rise](#)).
- In New Zealand, sea levels relative to land are rising faster in some areas due to downwards land movement. Sea level in those areas is expected to rise 20 to 30 centimetres by 2050 compared with 2005 levels. For many parts of the country, a 30-centimetre rise is a threshold for extreme flooding, above which a 100-year coastal storm becomes an annual event (MfE, 2024g; NZ SeaRise, nd) (see [section 7: Impacts on people, society and the economy](#)).

Figure 5: Coastal sea-surface temperature annual average anomaly, 1982–2023



Note: The baseline for anomalies is the average sea-surface temperature from 1991 to 2020, following World Meteorological Organization guidelines (WMO, 2017). This national average is aggregated from nine regional measurements (see indicator: [Sea-surface temperature: Data to 2023](#)).

Marine habitats and native species

Our marine environment is made up of diverse habitats. These include estuaries, rocky reefs and shores, fiords and seamounts, and open and deep-water habitats. Knowledge of marine habitats and their distribution is limited in New Zealand (Anderson et al, 2019; Lundquist et al, 2024).

These habitats support a large number of native animals and plants, many of them threatened or at risk of becoming threatened with extinction. The spread of non-native species can also contribute to the decline of native species and changes to habitats.

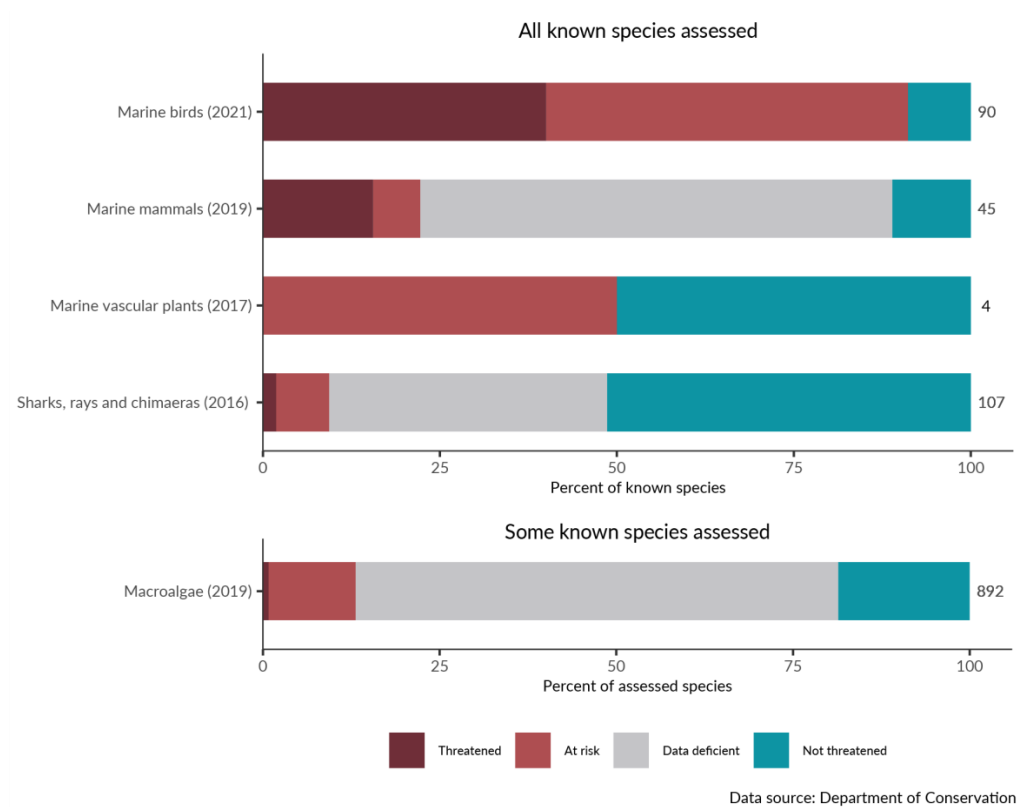
The effects of climate change are intensifying many of the pressures on marine ecosystems; these are discussed in [section 6: Atmosphere and climate](#).

Our indigenous marine species and habitats are under threat

Most indigenous marine bird species are threatened with extinction or at risk of becoming threatened; however, most are estimated to have stable or increasing populations

- In 2021, 91 percent of indigenous marine bird species (82 of 90) were threatened with extinction or at risk of becoming threatened, including 16 species identified as treasured (taonga) (figure 6). Estimated population trends show 27 percent of species have decreasing populations, 18 percent increasing, 12 percent stable or increasing, and 43 percent stable (see indicator: [Extinction threat to indigenous species](#)).
- In 2019, 22 percent of indigenous marine mammal species (10 of 49) were threatened with extinction or at risk of becoming threatened, including seven species identified as taonga (figure 6). Estimated population trends show 13 percent of species have decreasing populations and 2 percent have increasing populations (see indicator: [Extinction threat to indigenous species](#)).
- In 2016, 9 percent of shark, ray and chimaera species (10 of 107) were threatened with extinction or at risk of becoming threatened, including one species identified as taonga (figure 6). Estimated population trends show 2 percent of species have increasing populations and 1 percent have decreasing populations (see indicator: [Extinction threat to indigenous species](#) and [Technical annex](#)).
- In 2021, 56 percent of assessed indigenous marine invertebrate species (443 of 786) were threatened with extinction or at risk of becoming threatened. Estimated population trends show 5 percent of assessed species have decreasing populations, 66 percent stable, and one species increasing⁶ (Funnel et al, 2024; see [Technical annex](#)).

⁶ Note that only some known species of marine invertebrates have been assessed for extinction threat status and estimated population trends.

Figure 6: Extinction threat to indigenous marine species⁷

Note: Totals given on the right of this figure show the total number of species assessed. Complete assessments are those where all known species in the group have been assessed. Partial assessments are those where not all species in the group have been assessed.

More non-native species are in our marine waters and are spreading to new locations.

- Non-native marine species are being introduced continually, usually carried by ballast water or on the hulls of shipping and recreational vessels (see indicator: [Marine non-indigenous species: Data to 2022](#); Davis & Hepburn, 2020). Several biosecurity measures are in place to prevent non-native species from entering New Zealand and to detect, remove or control these species early (Marine Biosecurity Porthole, nd; MPI, nd-c).
- Non-native marine species can spread quickly and compete with native species. This can result in the decline of native species and changes to habitat. There is also a risk that pathogens could be introduced that may threaten native species, aquaculture or human health (Lane et al, 2022; see [Our marine environment 2022](#)).
- As of 2022, a total of 428 non-native marine species had been found in marine waters around New Zealand; 266 (62 percent) have established populations here. Seventy-three new non-native species were found between 2010 and 2022, 44 of which have become established (see indicator: [Marine non-indigenous species: Data to 2022](#)).

⁷ Note that extinction threat information updated since the Extinction threat to indigenous species indicator update in 2023 has been included in the text and is based on New Zealand Threat Classification System data downloads (see [Technical annex](#); NZTCS, 2025). Figure is based only on information available in the indicator (see indicator: [Extinction threat to indigenous species](#)).

- In 2021, two exotic sea mustard species, *Caulerpa brachypus* and *Caulerpa parvifolia*, were discovered on Aotea Great Barrier Island (see indicator: [Marine non-indigenous species: Data to 2022](#)). By August 2024 they had spread to over 1,500 hectares of the upper North Island seabed, competing with other species, disrupting local ecosystems and posing risks to recreational, cultural and commercial marine activities (MPI, 2024d).

Few biogenic and coastal ecosystems are monitored, but data suggest they are experiencing loss or damage.

- Biogenic habitats are those formed by plants and animals. They support biodiversity, stabilise sediments, recycle nutrients, and have cultural, recreational and economic value. Examples include kelp forests, seagrass meadows and sponge gardens (Anderson et al, 2019).
- Few biogenic habitats are monitored in New Zealand, but most that are have experienced loss or damage (Anderson et al, 2019; Bennion et al, 2024; Morrison et al, 2014).
- Mangrove forests are one of the few biogenic habitats that have increased in extent (Anderson et al, 2019; Jones et al, 2022; Morrison et al, 2014). Seagrass meadows are also showing sign of recovery in some locations in recent decades (Lundquist et al, 2018).
- Native vegetation, wetlands and dunes on and near the coast help protect coastal ecosystems from excess sedimentation, nutrient pollution and sea-level rise, among other benefits (Allan et al, 2023; Thompson, 2022).
- Between 1950 and 2008, active sand dune extent decreased 80 percent (see indicator: [Active sand dune extent](#)). Remaining active dunes are increasingly threatened by introduced marram grass (*Ammophila arenaria*). This, coupled with grazing, land development and erosion, degrades the integrity and function of dune ecosystems (Thompson, 2022; see [Our land 2024](#)).

5. Air

Introduction

The air we breathe plays an important role in our health and our quality of life. Although we cannot see the air, we can see its impacts on people and the environment.

Air and light link all components of Earth, and reflect cultural connections to the environment (te taiao). In the Māori language (te reo Māori), the word hau can mean air or wind, and can also refer to the vital essence or vitality of a person, place or object. The origins of these words recognise that our health (hauora) and the health of the air (hau takiwā) are interlinked. The clarity of the air and visibility of the night sky are important for many Māori cultural practices.

This section looks at two key issues. The first relates to **air quality** and the sources of air pollution. In Aotearoa New Zealand, air quality is generally good compared with many other countries, largely due to prevailing winds. However, increasing urbanisation can mean that more people are at risk of exposure to polluted air.

The second key issue in this section is **artificial light** and its effects on the environment. Artificial light at night is increasing in both extent and brightness, with potential impacts on native species.

Air pollution and artificial light also have wider consequences – see [section 7: Impacts on people, society and the economy](#).

New and updated air indicators and evidence since *Environment Aotearoa 2022*

Updates to air quality indicators

Concentrations of the air pollutants particulate matter (PM₁₀ and PM_{2.5}), nitrogen dioxide, and sulphur dioxide continue to decrease at most monitoring sites. However, many sites still exceed World Health Organization (WHO) guidelines at times.

No monitoring sites exceeded WHO guidelines for the air pollutants ground-level ozone and carbon monoxide.

(See [Air quality is improving, but pollutant levels in some areas could pose risks to human health](#).)

Updated data for road vehicles and reductions in transport emissions

Although the air pollutant emission factor has not been updated, new evidence shows that motor vehicle engine and fuel improvements continue to reduce air pollutant emissions from transport. This is despite increases in the total number of kilometres travelled in a year, the size of our vehicle fleet, and the proportion of our vehicles with diesel engines (which has been growing steadily). However, the number of electric vehicles (battery electric and plug-in hybrid) has grown, nearly doubling from 2022 to 2024.

(See [Transport is a major source of air pollutants, including sulphur dioxide, carbon monoxide and nitrogen oxides.](#))

Updates to home heating data

New data show that burning wood and coal for home heating (which is a major source of particulate matter emissions) continues to decline in favour of heat pumps and electric heaters. However, although coal burning is now very rare, about one-third of homes still rely on burning wood or pellets.

(See [Burning wood for home heating is a major source of PM_{2.5}.](#))

Air quality

Air quality standards in New Zealand require monitoring of four gas pollutants: nitrogen dioxide (NO₂), sulphur dioxide (SO₂), carbon monoxide (CO) and ground-level ozone (O₃) (LAWA, 2023b).

Particulate matter (PM) is another form of monitored air pollution. PM is tiny solid particles and liquid droplets suspended in the air. It can include substances such as heavy metals and microplastics (Fan et al, 2022; Semadeni-Davies et al, 2021).

This subsection compares air quality measures to national standards (NESAQ) and international guidelines (WHO), to understand the risks to human health (for details on standards, see [Technical annex](#)).

Most of the monitoring network is in urban areas where we expect pollution to be highest and where people are more exposed. As a result, we know little about air pollution in less populated areas, or its effects on native species and ecosystems.

This subsection also reports on air pollutants that have direct impacts on human health. It does not cover greenhouse gas emissions (for this information, see [section 6: Atmosphere and climate](#)).

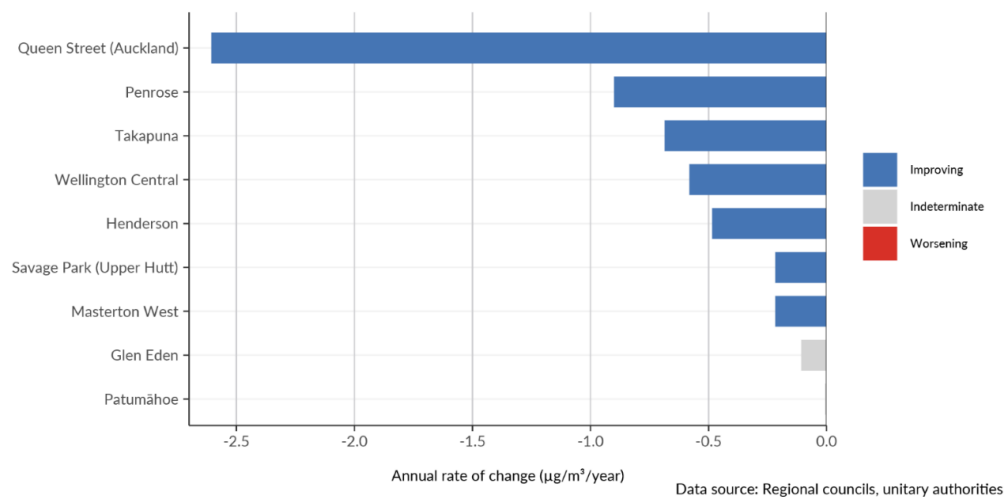
Air quality is improving, but pollutant levels in some areas could pose risks to human health

Gas pollutants are decreasing in most places where they are monitored, but NO₂ and SO₂ concentrations exceed guidelines in some areas.

- Trends in annual average NO₂ concentrations were improving at 99 of 114 sites (87 percent) in the New Zealand Transport Agency | Waka Kotahi monitoring network between 2014 and 2023. No sites showed worsening. Trends in NO₂ concentrations were improving at seven of the nine regional council and unitary authority sites between 2016 and 2023, and no trend was detected at the other two (figure 7).
- Concentrations of NO₂ were above the 24-hour WHO guideline at 6 of 10 sites (60 percent) between 2020 and 2023. Five of 10 sites were above the annual WHO guideline at least once during the same period and one site was above the one-hour NESAQ standard (see indicator: [Nitrogen dioxide concentrations: Data to 2023](#) and [Technical annex](#)).
- Between 2016 and 2023, trends in annual average SO₂ concentrations were improving at three of four sites, and no trend was detected for the other site.

- Concentrations of SO₂ were above the 24-hour WHO guideline at two sites between 2020 and 2023. No sites exceeded the one-hour NESAQ standard (see indicator: [Sulphur dioxide concentrations: Data to 2023](#)).
- Between 2016 and 2023, trends in annual average ground-level ozone concentrations were improving at Patumāhoe (Auckland) and worsening at Wellington Central. Both sites were within WHO guidelines between 2020 and 2023 (see indicator: [Ground-level ozone concentrations: Data to 2023](#)).
- Between 2016 and 2023, trends in annual average CO concentrations were improving at one of the three sites in the Greater Wellington region where trends could be assessed, and no trends were detected for the other two. All four sites across the Auckland and Greater Wellington regions were within the WHO guidelines between 2020 and 2023 (see indicator: [Carbon monoxide concentrations: Data to 2023](#)).

Figure 7: Nitrogen dioxide trends by monitoring site, 2016–23

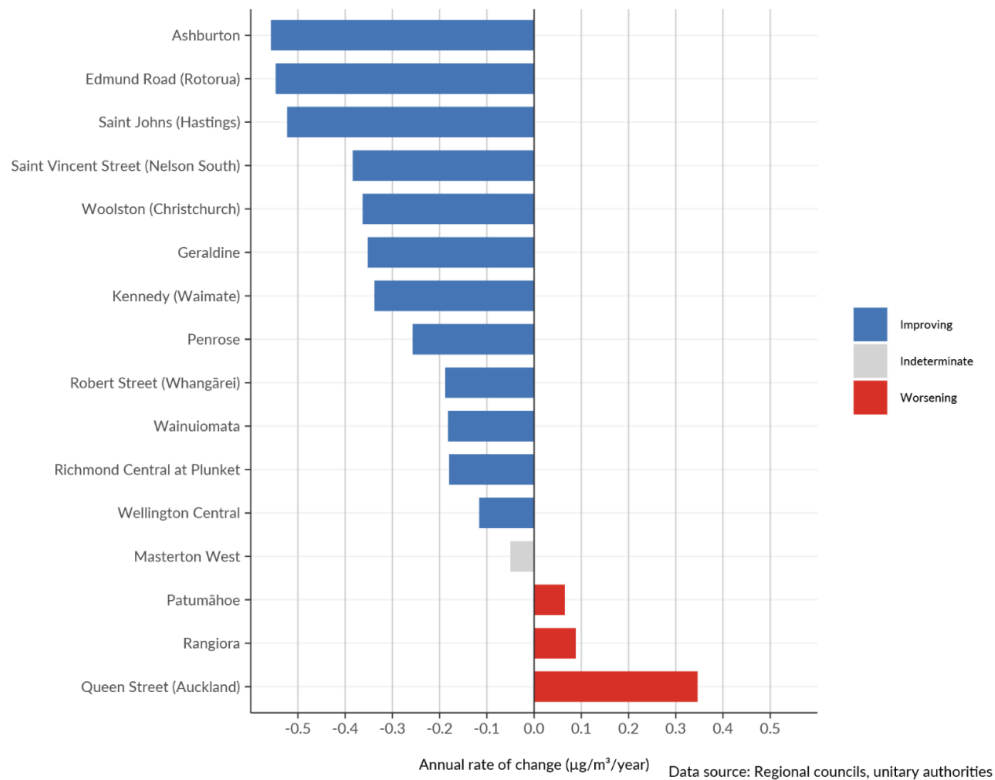


Particulate matter is decreasing in most places where it is monitored, but concentrations exceed health guidelines in some areas.

- Air quality monitoring in New Zealand focuses on two categories of PM. PM₁₀ refers to airborne particles that are less than 10 micrometres in diameter. PM_{2.5} is fine particulate matter, a subset of PM₁₀, referring to airborne particles less than 2.5 micrometres in diameter (LAWA, 2023b).
- Between 2016 and 2023, trends in annual average PM₁₀ concentrations were improving at 30 of 41 sites where trends could be assessed (73 percent) and worsening at 4 (10 percent).
- Concentrations of PM₁₀ exceeded the 24-hour NESAQ standard at 19 of 58 assessed sites (33 percent) on two or more days between 2020 and 2023. Thirty-eight sites (66 percent) were above the 24-hour WHO guideline on at least one day per year during the same period. Twenty-seven sites (47 percent) were above the annual WHO guideline in at least one of those years (see indicator: [PM₁₀ concentrations \(air quality\): Data to 2023](#)).
- Between 2016 and 2023, trends in annual average PM_{2.5} concentrations were improving at 12 of 16 sites where trends could be assessed (75 percent) and worsening at 3 (19 percent) (figure 8).

- Concentrations of PM_{2.5} were above the 24-hour WHO guideline at all 31 assessed sites at least once per year between 2020 and 2023. Twenty-eight sites (90 percent) were above the annual WHO guideline for at least one year during the same period, and 18 were above it every year from 2020 to 2023 (see indicator: [PM_{2.5} concentrations \(air quality\): Data to 2023](#)).

Figure 8: PM_{2.5} trends by monitoring site, 2016–23



Air pollution emissions are reducing, but transport and home heating are still the main contributors

Transport is a major source of air pollutants, including sulphur dioxide, carbon monoxide and nitrogen oxides.

- Air pollutant emissions from transport (including road, aviation, shipping and rail) were lower in 2019 than in 2012 for all monitored pollutants except SO₂. Emissions of CO were down 47 percent (over 85,000 tonnes). Nitrogen oxides (NO₂ and nitric oxide [NO]) were down 12 percent (over 8,000 tonnes) (see indicator: [Air pollutant emissions](#)).
- Road vehicles were the largest source of nitrogen oxides (39 percent) in 2019, with the greatest contribution coming from diesel vehicles (see indicator: [Air pollutant emissions](#)). Vehicle fuel combustion, particularly diesel, is also a significant source of PM_{2.5}. Wear of brake pads and tyres, and road surface dust, are major sources of PM₁₀ (LAWA, 2023b; Semadeni-Davies et al, 2021).
- Vehicle ownership per person in New Zealand is among the highest in the world. In 2022, we reached the largest fleet size to date, and the largest percentage of diesel vehicles (21 percent) (EHINZ, 2023; MOT, nd-a). The total number of vehicle kilometres travelled in a year has also increased over recent decades (MOT, nd-a, 2022).

- However, emissions of air pollutants from motor vehicle exhaust are reducing due to stronger vehicle emissions standards, increased uptake of lower-emissions vehicles and improvements in engine technology and fuel quality. This trend is expected to continue (Boamponsem et al, 2024; Metcalfe & Kuschel, 2022; NZTA, 2023).
- Domestic shipping is a significant source of SO₂ (contributing 16 percent of all SO₂ emissions in 2019), although an international treaty now limits the level of sulphur in ship fuel (MOT, nd-b; see indicator: [Air pollutant emissions](#)).

Burning wood for home heating is a major source of PM_{2.5}

- The residential energy sector accounted for 30 percent of PM_{2.5} and 41 percent of CO emissions in 2019, mainly from wood burning for home heating (see indicator: [Air pollutant emissions](#)).
- Heat pumps and electric heaters were the most common types of heating used in houses in 2023. Over time, a smaller proportion of homes have been burning wood and coal, but almost one-third relied on wood or pellet burners in 2023. Less than 1 percent of houses used coal burners (EHINZ, 2020; Stats NZ, nd).

Air pollution comes from various human activities, as well as natural sources and climatic conditions

Other contributors to air pollution emissions include agriculture, construction, industry and other human activities.

- Agricultural activities emit PM, including through tillage, burning vegetation, crop harvesting, applying fertiliser and livestock waste (Metcalfe et al, 2022; Parfitt et al, 2012; see [Our air 2018](#)).
- Construction also emits air pollutants, including PM and nitrogen oxides (Cheriyen & Choi, 2020; Kunak, 2023; Yan et al, 2023).
- Dust from unsealed roads was the largest source of PM₁₀ (28 percent) in 2019. Less than 10 percent of this was PM_{2.5} (see indicator: [Air pollutant emissions](#)).
- Burning coal was a major source of SO₂ emissions in 2019 (41 percent), mainly from manufacturing, construction, and public electricity generation and heat production. Aluminium production was another significant source (13 percent) (see indicator: [Air pollutant emissions](#)).
- Air pollutant emissions from public electricity generation and heat production were lower in 2019 than in 2012 for all pollutants. Sulphur dioxide emissions were down 40 percent, due to lower emissions from coal burning (see indicator: [Air pollutant emissions](#)).

Particulate matter can come from natural sources and is influenced by climate, including wind patterns.

- Particulate matter can come from natural sources, including the oceans and volcanoes. Sea salt is the largest natural source of particulate matter in urban areas of New Zealand (Boamponsem et al, 2024; Davy et al, 2024; Revell et al, 2024).
- Climate conditions influence the amount and types of PM and gases in the air. Stable weather allows pollutants to accumulate, while wind and rain can disperse them (Talbot, 2019; UCAR Center for Science Education, nd; Waikato Regional Council, nd). The weather and climate can also be directly influenced by PM (see [section 6: Atmosphere and climate](#)).

- As wind and rain patterns alter with climate change, they will affect the extent to which particulate matter disperses and is removed from the air. Areas with drier conditions and more frequent drought could experience worsening air quality due to lower rainfall, higher fire risks and more windblown dust (Bodeker et al, 2022).

Artificial light

Artificial light at night influences the broader quality of the air we experience. Light pollution affects health and cultural practices, and has economic consequences (see [section 7: Impacts on people, society and the economy](#)).

Artificial light at night is becoming brighter and more widespread

Light pollution affects much of the population and may affect native species.

- In 2014, 97 percent of New Zealand's population lived under light-polluted skies (Cieraad & Farnworth, 2023).
- Between 2012 and 2021, the lit surface area of the country increased by 37.4 percent (from 3.0 percent to 4.2 percent), primarily in rural areas (Cieraad & Farnworth, 2023).
- Brightness intensity increased across 4,694 square kilometres during the same period, and decreased across 886 square kilometres. Most of the decreases were observed in urban centres, but their brightness levels remained high relative to rural areas (Cieraad & Farnworth, 2023).
- Evidence of the negative impact of light pollution on species in New Zealand is limited. However, growing evidence indicates that it affects and disrupts the habits, interactions and navigation of some native species, such as bats, wētā and seabirds (Cieraad & Farnworth, 2023; Falcón et al, 2020; McNaughton et al, 2022; Meeuwen-Dijkgraaf, 2021; Schofield, 2021; Sterup, 2024).

6. Atmosphere and climate

Introduction

Human activities have driven rapid increases in atmospheric greenhouse gas concentrations, causing Earth to warm. The global mean surface temperature was estimated to be 1.1 degrees Celsius above pre-industrial levels in 2011–20. Projections suggest it will exceed 1.5 degrees by 2030 (IPCC, 2023; WMO, 2024). While this may seem like a small increase, even slight rises can drive increasingly significant changes to the natural environment (see [Our atmosphere and climate 2023](#)). The 10 warmest years on record have all been in the past decade (2015–24), with 2024 the warmest (WMO, 2025).

In Aotearoa New Zealand, we see rising air and sea temperatures, changing rainfall, more frequent droughts, accelerating sea-level rise, glacial retreat and more frequent or severe extreme weather events. These trends are expected to continue with further warming.

Climate change intensifies pressures and accelerates changes in land, freshwater, marine and air ecosystems. It exacerbates threats such as land degradation, invasive species, resource extraction and pollution. Biodiversity is under pressure from climate change. We see this through changes in where species live, their habitats, their interactions, and in life cycles and seasonal timing. Extreme weather events have direct and damaging impacts on species and ecosystems.

Biodiverse and resilient ecosystems can shield us from the worst impacts, as they absorb some emissions and can provide buffers against extreme weather events and rising seas. Conversely, the continuing loss of biodiversity and degradation of ecosystems weaken their ability to provide these benefits (see [Our land 2024](#)).

This section looks at **our emissions** and how our activities are contributing to an increase in concentrations of greenhouse gases in the atmosphere. It then focuses on **our changing climate** and how this is affecting the environment.

For the wider consequences, see [section 7: Impacts on people, society and the economy](#).

New and updated atmosphere and climate indicators and evidence since *Environment Aotearoa 2022*

Update to greenhouse gas concentrations indicator

The 2023 indicator update confirms that atmospheric concentrations of carbon dioxide, methane and nitrous oxide, measured in the Wellington area, increased in the decade up to 2022.

(See [Atmospheric concentrations of greenhouse gases in New Zealand have increased substantially since pre-industrial times, and have continued to increase in recent years.](#))

New data on greenhouse gas emissions from human activities

The 2024 update of New Zealand's greenhouse gas inventory shows that in 2022 our total gross emissions were at their lowest since 1999, but still higher than in 1990. All sectors (except Tokelau) saw reductions in emissions between 2021 and 2022.

Carbon sequestered by land use, land-use change and forestry offset a quarter of our emissions in 2022, compared with 1990 when sequestration by this sector offset about a third of our emissions.

(See [Our greenhouse gas concentrations and emissions profile](#).)

Updated climate indicators and new evidence

Indicator updates show New Zealand's average air temperature continues to rise, and most monitored areas are experiencing more warm days and higher growing degree days (indicating longer growing seasons). The frequency of medium-term (agricultural) drought is increasing in many places.

The updates also show that the south of New Zealand is becoming wetter, and the north and east are becoming drier. Maximum daily rainfall is likely increasing across more areas of the South Island, and likely decreasing across more areas of the North Island, and extreme wind is likely decreasing across most of New Zealand. These findings are supported by additional new evidence indicating that extreme weather events are becoming more frequent and severe due to climate change from human activities.

The 2024 update to the national climate projections for New Zealand provides insight into the future state of several climate variables, including temperatures, rainfall, drought and extreme winds.

(See [New Zealand's climate is changing](#).)

More evidence for climate impacts on species and ecosystems

Evidence continues to grow that climate change intensifies pressures on land, freshwater and marine ecosystems, exacerbating threats such as land degradation, invasive species, resource extraction and pollution.

Evidence continues to grow that climate change affects where species live, their habitats, interactions, life cycles and seasonal timing across terrestrial, freshwater and marine ecosystems.

(See [Many impacts of climate change affect biodiversity and ecosystems](#).)

Our emissions

Greenhouse gas emissions from human activities are accumulating in the atmosphere. They are the most significant driver of climate change since pre-industrial times.

Natural influences, such as climate oscillations, can also lead to shorter-term changes over years and decades. However, by increasing the amount of greenhouse gases in the atmosphere, humans are having a significant impact on our climate.

Our greenhouse gas concentrations and emissions profile

Atmospheric concentrations of greenhouse gases in New Zealand have increased substantially since pre-industrial times, and have continued to increase in recent years.

- In 2023, global atmospheric carbon dioxide (CO₂) concentrations were 419.3 parts per million (ppm), higher than at any time in at least 2 million years (IPCC, 2023).
- The highest atmospheric CO₂ concentration observed in New Zealand between 1972 and 2022 (415.5 ppm) was in August 2022. This was up 6 percent since 2012, and around 48 percent higher than pre-industrial levels of 280 ppm (Ciais et al, 2013; see indicator: [Greenhouse gas concentrations](#)).
- The highest observed atmospheric methane (CH₄) concentration in New Zealand between 1989 and 2022 (1881.4 parts per billion [ppb]) was in October 2022, around 169 percent higher than pre-industrial levels of 720 ppb (Ciais et al, 2013; see indicator: [Greenhouse gas concentrations](#)).
- The highest atmospheric nitrous oxide (NO₂) concentration observed in New Zealand between 1996 and 2022 (335.5 ppb) was in December 2022, around 24 percent higher than pre-industrial levels of 270 ppb (Ciais et al, 2013; see indicator: [Greenhouse gas concentrations](#)).

New Zealand has a unique greenhouse gas emissions profile.

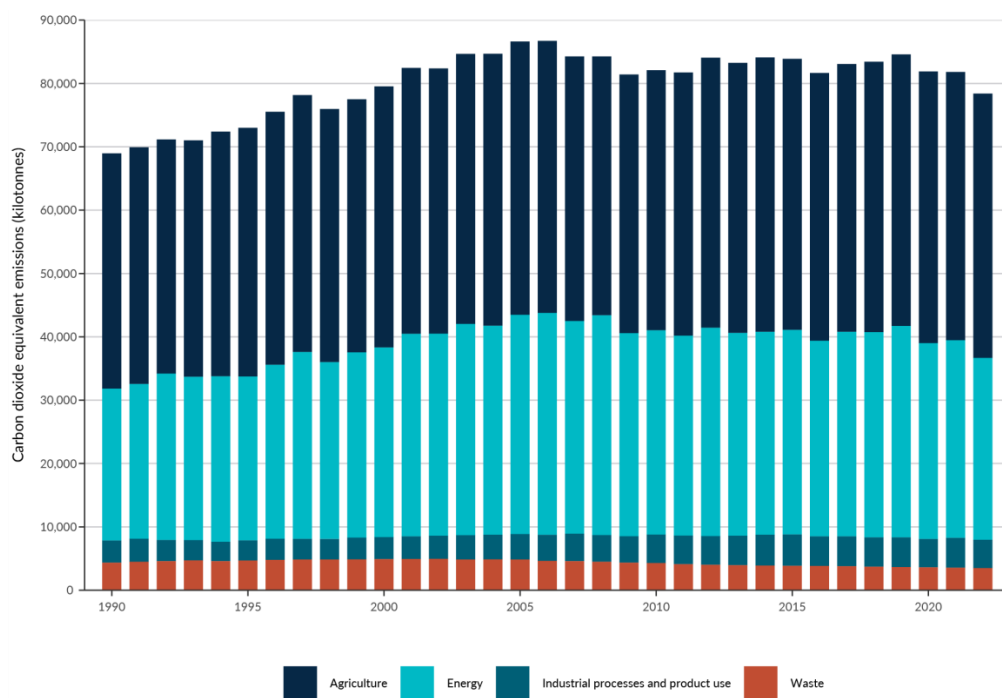
- Our share of global greenhouse gases emissions is small, but gross emissions per person are high compared with other developed countries (MfE, 2024d).
- Most developed countries emit more CO₂ than CH₄ and NO₂, but for New Zealand it is the opposite. This is mainly due to the scale of the agriculture sector proportional to population, a relatively small energy sector and a high proportion of renewable electricity (MfE, 2024d); (figure 9).
- Methane and NO₂ emissions from agriculture made up 52 percent of gross emissions in 2022. Livestock emitted 90 percent of CH₄, and agricultural soils emitted 92 percent of NO₂, mainly due to effects of livestock waste and fertiliser use (MfE, 2024c).
- Carbon dioxide emissions made up 40 percent of the country's gross emissions in 2022. Emissions from road transport (part of the energy sector) accounted for 39 percent of gross CO₂ emissions in 2022 (MfE, 2024c). This is driven by a high rate of road vehicle use – per capita rates of CO₂ emissions from road transport are some of the highest in the world (MfE, 2024d; see [section 5: Air](#)).

Gross emissions peaked in 2006 and have been declining since 2019.

- In 2022, our gross greenhouse gas emissions were 14 percent higher than in 1990, and 7 percent lower than in 2019. After peaking in 2006, they stayed relatively stable through to 2019, after which they declined year on year (MfE, 2024c).
- The effects of the COVID-19 pandemic were a factor in lower emissions between 2020 and 2021, but did not influence their continued decrease between 2021 and 2022. This most recent reduction has seen emissions at their lowest since 1999, with reductions across all sectors, except Tokelau (MfE, 2024c).

- Methane emissions increased by 2 percent between 1990 and 2022. Since peaking in 2006, they have declined slightly (MfE, 2024c). Carbon dioxide emissions increased 24 percent between 1990 and 2022. They increased between 1990 and 2008, before plateauing and beginning to decline in 2019 (MfE, 2024c).
- Nitrous oxide emissions increased 35 percent between 1990 and 2022, and combined fluorinated gases increased 87 percent (MfE, 2024c).
- Our net emissions are projected to decrease in the future. Based on the economic conditions and policies in late 2024, net target accounting emissions (which include all gross emissions and a subset of emissions and removals from the land use, land-use change and forestry sector) are projected to decrease 20 percent between 2020 and 2030, and 35 percent between 2020 and 2050 (MfE, 2024j).

Figure 9: Annual gross greenhouse gas emissions by sector, 1990–2022



Data source: Ministry for the Environment

Note: Emissions presented here exclude those from Tokelau. Gross emissions do not include reductions from the land use, land-use change and forestry sector (MfE, 2024c). The energy sector includes transport.

Greenhouse gas emissions from most sectors decreased in 2022.

- **Agriculture:** Emissions have been declining slowly since peaking in 2014, and decreased 1.4 percent between 2021 and 2022. This reduction is mainly due to long-term decreases in beef cattle and sheep populations, and lower synthetic fertiliser use (MfE, 2024c; see [section 2: Land](#)).
- **Energy:** Emissions decreased 8 percent between 2021 and 2022. This included a 39 percent reduction in public electricity generation and heat production emissions due to high rainfall increasing the proportion of power generated by hydropower. Petroleum-refining emissions also dropped 76 percent following the closure of the country's only oil refinery (Marsden Point) in March 2022 (MfE, 2024c).

- Road transport: Emissions decreased 1.6 percent between 2021 and 2022, to levels 5 percent lower than before the COVID-19 pandemic (MfE, 2024c). This reduction may be due to a combination of factors, such as changes in driving patterns or the increased use of more fuel-efficient cars (MfE, 2024d).
- Industrial processes and product use: Emissions decreased 5 percent between 2021 and 2022, mainly due to the closure of the Marsden Point Oil Refinery, and the effects of the COVID-19 pandemic (MfE, 2024c).
- Waste: Emissions decreased 1.5 percent between 2021 and 2022, to levels 4 percent lower than 2019. Waste emissions have been declining since 2002 due to ongoing improvements in landfill management and wastewater treatment (MfE, 2024c).

Carbon dioxide is removed from the atmosphere when plants grow and store carbon, which offsets some, but a decreasing percentage, of our emissions.

- The land use, land-use change and forestry sector offset 25 percent of New Zealand's gross greenhouse gas emissions in 2022, a decrease from 1990, when it offset 35 percent. Net removals from this sector are variable because of the influence of forest planting and harvesting cycles (MfE, 2024c).
- New Zealand is experiencing historically high rates of afforestation, and low deforestation rates, mostly affecting exotic forests, which help absorb carbon (MfE, 2024c). Up to the latest measurement in 2018, native vegetation cover was decreasing, reducing the ability of native forests and other native vegetation to absorb carbon (see [section 2: Land](#)).
- Healthy peatlands and wetlands offer vast, long-term carbon storage potential (Ausseil et al, 2015). However, their ongoing degradation and drainage for agriculture (see [section 3: Freshwater](#)) results in releases of stored organic carbon into the atmosphere (Clarkson et al, 2013). More than 600,000 tonnes of carbon were lost to the atmosphere from peatland fires at Kaimaumau-Motutangi and Awarua wetlands in 2022 (Pronger et al, 2024).

Other emissions also affect the climate and atmosphere

Global efforts to reduce the use of ozone-depleting substances have reduced the hole in the ozone layer, but some substitutes are potent greenhouse gases.

- New Zealand has phased out the use and manufacture of the ozone-depleting substances, controlled under the Montreal Protocol to protect the stratospheric ozone layer, which took effect in 1992 (MfE, 2021b).
- The size of the ozone hole naturally varies from year to year, but is on track to recover. Global ozone levels are projected to return to pre-1980 levels by the mid-2060s (NASA, 2024; WMO, 2022).
- The annual average thickness of the ozone column at Lauder, Otago decreased between 1979 and 2022 but was slightly thicker than the global average over the same period (see indicator: [Atmospheric ozone](#)).
- Hydrofluorocarbons are potent greenhouse gases often used as substitutes for ozone-depleting substances. From 2019, hydrofluorocarbons and related compounds have been phased down under the Kigali Amendment to the Montreal Protocol (MfE, 2019).
- New Zealand's hydrofluorocarbon emissions were 14 percent higher in 2022 than in 2019, and accounted for 34 percent of emissions from the industrial processes and product use sector (MfE, 2024c).

Particles in the atmosphere can have heating and cooling effects on the climate.

- Aerosols are small solid or liquid particles in the atmosphere that are formed by human and natural sources. They affect the weather and climate in many ways, including by influencing cloud formation and solar radiation (Hamilton, 2015; Ruiz-Arias, 2021; Sakai et al, 2016; Shi et al, 2022; Spada et al, 2015; Su et al, 2024).
- Understanding of how these particles interact with clouds remains limited, and is a large source of uncertainty in understanding Earth's climate and future changes (Boucher et al, 2013; Su et al, 2024).
- Black carbon absorbs sunlight due to its dark colour, and has localised warming effects in New Zealand (see [Our atmosphere and climate 2023](#)). It mostly comes from vehicles, domestic fires and wildfires (Bond et al, 2013; Lee et al, 2022). No inventory exists for black carbon emissions in New Zealand, though nitrogen dioxide emissions can be used as a proxy for these (see [section 5: Air](#) and [Our atmosphere and climate 2023](#)).
- Wildfires and dust storms in Australia produce dust that can be carried to New Zealand. They have the potential to influence our climate (Brahney et al, 2019; Nguyen et al, 2019).

Our changing climate

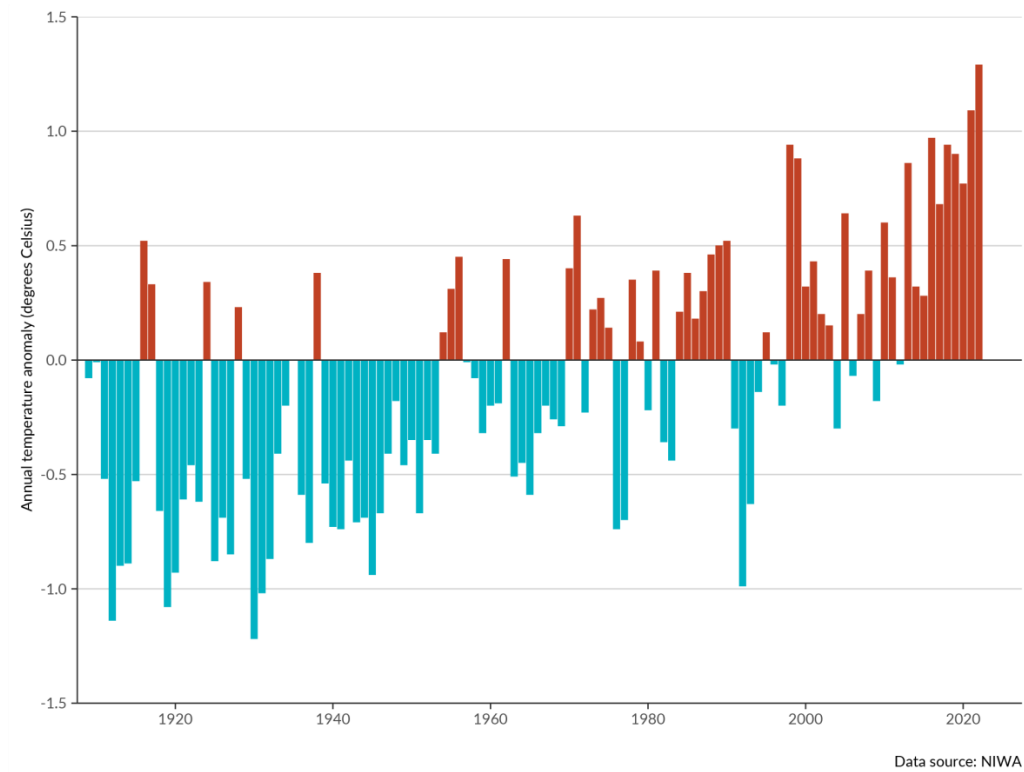
Climate change is causing warmer temperatures, shifting rainfall patterns, more frequent droughts and stronger winds. These changes affect how and when we can grow food, store water or build infrastructure.

The changing climate is also altering natural climate phenomena such as El Niño and La Niña, making extreme weather events more intense. This puts additional pressure on habitats and species, leading to biodiversity loss and ecosystem disruption.

New Zealand's climate is changing

Long-term annual average temperatures are rising, with fewer frost days and increasing growing degree days (indicating longer growing seasons).

- The annual average temperature in New Zealand has increased 1.26 (± 0.27) degrees Celsius between 1909 and 2022, and 8 of the 10 warmest years on record occurred between 2013 and 2022 (see indicator: [Temperature](#) and figure 10). The annual average temperature is projected to increase 1.9 degrees Celsius by 2090, compared with the 1995–2014 period under the Shared Socio-economic Pathway 2-4.5 scenario (MfE, 2024b; see [Technical annex](#)).
- The number of warm days (when the maximum temperature is above 25 degrees Celsius) increased at 25 of 30 monitoring sites across New Zealand between 1972 and 2022, and decreased at three (see indicator: [Temperature](#)). More warm days are projected for most of the country, especially the north and east of the North Island (MfE, 2024b).
- The number of frost days (when the minimum air temperature is below zero degrees Celsius at 1.2 metres above the ground) decreased at 20 of 27 sites between 1972 and 2022, and increased at five (see indicator: [Frost and growing degree days](#)). Fewer frost days are projected for the west and south of the South Island (MfE, 2024b).
- Growing degree days (the amount of warmth available for plant and insect growth during a growing season) increased at 29 of 30 sites between 1972 and 2022 (see indicator: [Frost and growing degree days](#)).

Figure 10: New Zealand annual average temperature anomaly, 1909–2022

Note: The baseline for temperature anomalies is the average annual temperature for the 30 years from 1961 to 1990 (see indicator: [Temperature](#)).

Rainfall patterns are changing, with the south becoming wetter and the north and east becoming drier.

- Annual rainfall increased at 15 of 30 monitoring sites between 1960 and 2022, and decreased at eight. There were increases at many sites in the southern South Island, and decreases at many sites in the northern half of the North Island (see indicator: [Rainfall](#)). By 2090, the west and south of the South Island are projected to have higher annual rainfall. The North Island is projected to have lower annual rainfall, particularly in the north and the east (MfE, 2024b).
- Most sites with increasing rainfall trends also had increases in their annual maximum one-day rainfall amounts. Annual maximum one-day rainfall increased at 12 of 30 sites, and decreased at 10 (see indicator: [Extreme rainfall](#)).

Frequency of medium-term agricultural drought is increasing in many places.

- The frequency of medium-term agricultural drought events (a marked shortage of moisture compared with what is expected across a six-month period) increased at 15 of 30 monitoring sites between 1972 and 2022, and decreased at six (see indicator: [Drought](#)). By 2090, drought is projected to increase in the east of New Zealand and decrease in the west (MfE, 2024b).

Extreme winds are decreasing at most sites.

- Annual averages of the daily maximum wind gust decreased at 14 of 17 sites between 1980 and 2022, and increased at three (see indicator: [Extreme wind](#)).
- Fewer windy days (with maximum wind speed more than 10 metres per second) per year are projected for much of the North Island, and more are projected for most of the South Island by 2090 (MfE, 2024b).

Extreme weather events are becoming more frequent and/or more intense.

- New Zealand has recently seen multiple severe weather events happening at the same time or in the same place, or both. One example is the atmospheric river that delivered an unprecedented amount of rainfall to Auckland in January 2023, closely followed by the effect of Cyclone Gabrielle across much of the North Island in February 2023 (Harrington et al, 2023; Stone et al, 2024).
- In 2021, extreme rainfall events that caused flooding in Canterbury were 10 to 15 percent more intense because of climate change. Similarly, extreme weather and associated flooding on the West Coast in 2021 were nearly 10 percent more intense due to climate change (MfE, 2023a; Stone et al, 2022).
- Floods are among the most frequent and damaging natural hazards in New Zealand (Frame et al, 2020; Royal Society Te Apārangi, 2016). They are mostly caused by heavy and/or prolonged rainfall but can be mitigated or exacerbated by other factors such as land use and infrastructure (Auliagisni et al, 2022). As the climate changes, flooding caused by higher rainfall and rising sea levels is expected to increase (Bodeker et al, 2022; Pourzand et al, 2023; Thomas et al, 2024).
- The frequency of tropical cyclones is slightly decreasing over the South Pacific basin (Roberts et al, 2020), but the cyclones that do form are more severe (Bodeker et al, 2022; Chand et al, 2022).
- The frequency of extreme temperature events in New Zealand has increased two to threefold due to human influence since pre-industrial times (Thomas et al, 2023; see [Technical annex](#)).
- The wildfire risk is changing. The number of days with very high and extreme fire danger increased at 12 of 28 sites between 1997 and 2019, and decreased at eight (see indicator: [Wildfire risk](#)). Comparison of fire risk is complicated due to the difference in fuel type used for analysis between sites (see [Technical annex](#) and [Our atmosphere and climate 2023](#)).
- In the 2021/22 wildfire season, 4,417 fires burnt an area of 4,864 hectares. This area was smaller than in the wildfire seasons in 2020/21 (4,586 fires burnt an area of 13,348 hectares) and 2019/20 (5,735 fires burnt an area of 10,415 hectares) (FENZ, 2021, 2022, 2023).
- The wildfire risk is expected to increase across many regions of New Zealand through the rest of the century, compared with its first two decades (Langer et al, 2021; Melia et al, 2022).

Climate varies naturally but natural variation might be changing too

El Niño Southern Oscillation and Southern Annular Mode influence natural climate variability.

- Natural patterns of change (oscillations) influence the weather and climate in New Zealand, including the El Niño Southern Oscillation (ENSO), Interdecadal Pacific Oscillation (IPO) and

Southern Annular Mode (SAM) (see indicators: [El Niño Southern Oscillation](#), [Interdecadal Pacific Oscillation](#) and [Southern Annular Mode](#)).

- ENSO has three phases: neutral, El Niño and La Niña (NIWA, nd-a). New Zealand may experience more northeasterly winds and wetter conditions in the north and east, and warmer-than-average air and sea temperatures during La Niña. During an El Niño phase in summer, increased westerly winds, more rain in the west and dryness in the east occur. In winter, El Niño can lead to more frequent, cooler southerly winds (see indicator: [El Niño Southern Oscillation](#); Ummenhofer et al, 2009). However, understanding of how ENSO modulates the climate remains limited.
- The most recent El Niño phase was from July 2015 to April 2016. This was one of the two strongest El Niño phases between 1990 and 2022, the other occurring during 1997 to 1998. The most recent La Niña phase was from April 2022 to December 2022 (see indicator: [El Niño Southern Oscillation](#)).
- Climate models indicate that ENSO variations have increased in size by up to 10 percent since 1960, partly due to rising greenhouse gas concentrations in the atmosphere (Cai et al, 2023). One result is that El Niño and La Niña events are becoming stronger and more frequent (Cai et al, 2023).
- SAM is associated with the strength and position of westerly winds and storm tracks. The recent declines in extreme wind magnitude and frequency in New Zealand are likely related to SAM more often being in a 'positive' phase, which moves storm tracks further south (NIWA, nd-b; Thompson et al, 2011).
- Evidence indicates the positive trend of SAM over recent decades is an indirect response to stratospheric ozone depletion and climate change (Goyal et al, 2021; King et al, 2023; Morgenstern, 2021).

Complex atmospheric phenomena influence rainfall and flooding.

- Varying atmospheric circulation affects the transport of moisture and has a complex connection to precipitation in New Zealand (Bennet & Kingston, 2022; Thomas et al, 2024).
- New Zealand is exposed to extreme precipitation events caused by fronts, atmospheric rivers, cyclones and other atmospheric phenomena. In particular, we are in a region of high atmospheric river activity (Reid et al, 2021). Longer extreme precipitation events generally lead to higher rainfall accumulation and more widespread flooding (Vishwanathan et al, 2024).
- Extreme precipitation events often occur when multiple atmospheric phenomena interact. For example, prolonged heavy rain can occur when atmospheric blocking (high-pressure systems that halt normal weather movement) interacts with atmospheric rivers (Prein et al, 2023; Vishwanathan et al, 2024).
- Notable examples include the July 2021 Westport flood, caused by an atmospheric river stalling over the Buller River catchment (Stone et al, 2022), and the February 2023 northeastern flood, linked to Cyclone Gabrielle stalling off the north coast (Harrington et al, 2023).

Many impacts of climate change affect biodiversity and ecosystems

Climate change intensifies pressures from human activities on ecosystems, amplifying threats such as land degradation, invasive species, resource extraction and pollution.

- Increased frequency and intensity of heavy rainfall events exacerbate land degradation through landslides and soil erosion, especially in areas with exposed soils or non-native vegetation. This can reduce the productivity of the land, and increase the amount of sediment that washes into downstream environments (see [section 2: Land](#), [section 3: Freshwater](#), [section 4: Marine](#) and [section 7: Impacts on people, society and the economy](#)).
- Climate change creates more favourable conditions for exotic pests and diseases to invade, establish and spread (Keegan et al, 2022; Meurisse et al, 2023; Mouton et al, 2022). This poses a growing threat to the natural environment and primary sectors (Meurisse et al, 2023; see [section 3: Land](#), [section 4: Marine](#) and [section 7: Impacts on people, society and the economy](#)).
- Total glacier ice volumes in New Zealand decreased 35 percent, and the rate of annual loss increased between 1978 and 2020 (see indicator: [Annual glacier ice volumes](#)). Receding glaciers and changes to snow cover are expected to affect flows in glacier- and snow-fed rivers, altering downstream water supply for ecosystems, irrigation and hydropower (Keegan et al, 2022; Purdie, 2022; Queen et al, 2023). This also increases risks of natural hazards arising from higher run-offs and lake outburst (IPBES, 2018).
- Streamflow patterns have changed across the country as the climate has changed. Between 1969 and 2019, winter streamflow increased in the western South Island and decreased in the northern North Island. Summer streamflow decreased across the northern regions of the North Island (Queen et al, 2023). This has compounded the effects of water take and land use on river flows in some areas (Booker & Snelder 2023; see [section 3: Freshwater](#)).
- More frequent floods and droughts can exacerbate many forms of water pollution, from sediments to pathogens and pesticides (IPCC, 2022). Increasing freshwater temperatures are expected to increase the risk of cyanobacteria blooms, degrading water quality and potentially rendering some freshwater unsafe for consumption (Puddick et al, 2022).
- Rising sea-surface temperatures, marine heatwaves and ocean acidification can exacerbate fishing pressure by affecting the lifecycle and reproduction of marine species such as kōura (crayfish) and tāmure (snapper), which are already declining due to overfishing and other human activities (Cummings et al, 2021; Gee, 2021; Heeringa, 2021; Shears et al, 2024).

Climate change is directly affecting land, freshwater and marine habitats and species already under pressure from other human activities.

- Wildfires pose a growing risk to forests, as well as to wetlands and tussock grassland, which are already in decline (Case et al, 2023; Melia et al, 2022; Pronger et al, 2024; see [section 2: Land](#) and [section 3: Freshwater](#)). Recovery from fire events is slow, and fires can disrupt the natural succession of ecosystems and favour non-native species over native ones (Case et al, 2023; Perry et al, 2014; Richardson et al, 2018).
- Changes in precipitation and rising temperatures alter the timing of seasonal events such as flowering, growth and migration, and species interactions. The impacts are felt across entire terrestrial ecosystems. For example, rising temperatures contribute to the increased frequency of beech mast (a period during which beech trees produce a large

amount of seeds). This can lead to outbreaks of pests (rats, mice and stoats) that threaten native forest birds and long-tailed bats (King, 1983; O'Donnell et al, 2017).

- Some alpine species of lizards, insects and birds may face habitat loss as warming is expected to shift snowlines (Jarvie et al, 2022; Koot et al, 2022; Lorrey et al, 2022; Weinhäupl & Devenish-Nelson, 2024).
- Droughts can alter soil properties and carbon cycling (Macinnis-Ng & Schwendenmann, 2015) and cause changes to forest diversity as more drought-resistant species survive (Wyse et al, 2013). Droughts can harden soils, making it difficult for species such as kiwi to extract food (Boffa Miskell, 2020).
- Changes in freshwater temperatures, and in drought and flood frequency, are predicted to influence the life cycles and successful migrations of some native freshwater fish species (Awatere et al, 2021; Egan et al, 2020; Keegan et al, 2022). Increased rainfall and flooding can degrade habitats for freshwater fish, freshwater-dependent birds and other freshwater species (Awatere et al, 2021; Goodman, 2018; Keegan et al, 2022).
- Rising sea-surface temperatures can reduce food availability for seabirds in some areas (Mills et al, 2008; Salinger et al, 2023). Ocean acidification and warmer temperatures are expected to make it harder for species such as molluscs and corals to grow and maintain their shells and skeletons (Anderson et al, 2022; Law et al, 2018).
- Primary productivity (see [section 4: Marine](#)) is expected to decrease around the North Island and west coast of the South Island in response to increasing sea temperatures, but may increase in water off southern New Zealand (Roberts & Hendriks, 2022).
- Marine heatwaves have caused unusual fish migrations, severe bleaching and necrosis of sponges, large losses of farmed salmon and southern bull kelp (rimurapa), and likely contributed to the mass mortality of blue penguins (kororā) in the Bay of Plenty (Salinger et al, 2019, 2020, 2023). In some areas where the bull kelp was completely lost during the 2017/18 heatwave, an invasive, non-native kelp established. This coincided with a sharp decrease in green-lipped mussels (kākahī), an important traditional food-gathering (mahinga kai) species (Awatere et al, 2021; Thomsen et al, 2019).
- Sea-level rise and storm surges threaten coastal ecosystems and freshwater species by moving saltwater farther into coastal freshwater environments, altering their salinity (Cañedo-Argüelles et al, 2013; IPCC, 2022; Neubauer et al, 2013; Schallenberg et al, 2003). Rising sea levels have also led to a loss of nesting sites for various shorebirds (Keegan et al, 2022).
- Seawalls and coastal hardening protect our homes and communities from rising sea levels. However, they also limit the ability of coastal habitats, such as sandy beaches, dunes and wetlands, to retreat inland. This may cause further loss of these important habitats (Allan et al 2023; Douglas et al, 2022; MfE, 2024g; Stewart et al, 2020).

7. Impacts on people, society and the economy

This section examines how changes in the environment are impacting our lives, in three areas.

The first part of this section looks at how our **health and quality of life** are deeply rooted in the environment. A healthy environment provides clean air, water, food and spaces for recreation, all of which support physical and mental well-being. Conversely, environmental degradation – such as pollution, biodiversity loss and climate change – can harm health. It contributes to respiratory illnesses, heat-related conditions, waterborne diseases, and mental health challenges stemming from the loss of natural spaces or increased environmental stresses.

The second part looks at **people's connection to place**, which is also intertwined with nature. The environment shapes cultural values, traditions and a sense of identity. It fosters strong bonds between communities and the landscapes they inhabit. Healthy ecosystems sustain these connections, supporting cultural practices and community resilience.

The third part looks at how our **homes and livelihoods** depend on the services provided by nature. Ecosystems play a critical role in food production, water availability and energy generation, creating the foundation for social and economic stability. However, challenges such as biodiversity loss and climate change (including severe weather events) pose risks to our homes and jobs and to the broader natural and built environment that supports them.

Addressing these interconnected challenges is vital for our lives and the resilience of the environment.

Health and quality of life

Access to nutritious food, fresh air and safe drinking water is fundamental to our health and quality of life. These essential needs depend on a healthy environment, including fertile soil, clean air and unpolluted water. Degradation of the environment, climate change and extreme weather events pose significant threats to human health, increasing risks such as food insecurity, poor air quality and contaminated water.

In contrast, a healthy environment enhances the resilience of food systems, supports natural air filtration and ensures water infrastructure can withstand the challenges of climate change and extreme weather.

Our health and vulnerability are also shaped by who we are and where we live. Urban areas, where many of us live, benefit from well-functioning ecosystems that can provide critical services. However, environmental drivers and pressures increasingly threaten these ecosystems. Emerging contaminants, such as microplastics, add another layer of risk to human health, infiltrating food, air and water, though their full impact remains poorly understood.

This subsection focuses on two aspects of human health: access to healthy food and clean air; and how climate change amplifies health risks. Both aspects highlight the profound connection between environmental health and overall quality of life.

Our food, water and air are impacted by the state of the environment, with consequences for our health

Access to affordable and nutritious food is vulnerable to global disruptions and extreme events.

- Access to affordable and nutritionally dense food relies on a resilient and stable food system. This includes, among other things, access to reliable sources of water, and stable supply chains and distribution infrastructure. These are at risk from disruptors such as pandemics, international wars, climate change, sea-level rise, drought and other extreme weather events that can cause instability and price fluctuations. Changes in food prices can influence people's choices towards buying less healthy but more affordable products. This affects our health, particularly in lower socio-economic communities, rural communities and children (Resilience to Nature's Challenges, 2024; Strom et al, 2024; Vatsa & Renwick, 2024).
- Outdoor horticulture, including fruit and vegetable growing, relies on a finite supply of highly productive land that is becoming less available due to urban development (see [section 2: Land](#)). This constrains this sector's ability to adapt to other pressures, threatening diverse supply of vegetables for domestic use and access to healthy diets (Curran-Cournane & Rush, 2021; Curran-Cournane et al, 2021a; Davis et al, 2023; Greenhalgh et al, 2017; MPI, 2019b).

The water we drink can carry diseases.

- Since 1980, at least 49 drinking water illness outbreaks have been reported in New Zealand (DPMC, 2024). This includes the 2016 campylobacteriosis outbreak in Havelock North, which made an estimated 6,000 to 8,000 people ill, led to 42 hospitalisations and contributed to at least four deaths (Gilpin et al, 2020).
- A cryptosporidiosis outbreak occurred in Queenstown in September 2023, causing illness in at least 72 people and requiring three hospitalisations. Human faecal contamination was considered the most likely cause of the outbreak (Baker et al, 2023; Grout et al, 2024).
- Rural communities face a higher risk of waterborne disease. Compared with the urban population, the proportion of the rural population reporting cryptosporidiosis is four to six times larger, and for reporting campylobacteriosis, two to four times larger. Young children and people living in deprived areas are also at greater risk of waterborne disease (EHINZ, 2024a).

Contaminated water in lakes, waterways and coastal waters used for recreation and food gathering can lead to disease and illness.

- Regional councils monitor popular swimming sites to assess their health risk for swimming and food gathering. Faecal contamination from humans and animals is a common reason why exposure to water can become unhealthy, as it can cause infections and gastroenteritis (LAWA, 2022). Some sites are under harvest bans because food harvested is not safe to eat (Clough, 2013; Morrison et al, 2023; van Hamelsveld et al, 2023).
- In 2023 there were 388 notifiable illness cases of campylobacteriosis, 135 of giardiasis, 106 of cryptosporidiosis, 102 of salmonellosis and 138 of *Escherichia coli* infection, for cases where people reported contact with recreational water (river, lake or sea) (ESR, 2025).

- Exposure to freshwater with high levels of toxic algae can cause illnesses in humans, including nausea, diarrhoea and, in extreme cases, liver damage, and can also kill dogs (LAWA, 2023a). Toxic algae are generally only present at low levels in New Zealand's freshwater environments, but blooms occur more frequently in nutrient-rich waters and during summer when there are higher temperatures, more sunlight and lower rainfall (BPAC, 2020; LAWA, 2023a; Puddick et al, 2022).

Breathing polluted air can cause serious health issues for thousands of people each year and lead to high social costs.

- The health impacts and social costs from human-made air pollution are higher than previously thought, based on our growing understanding of the extensive health and social damage caused by motor vehicle pollution (Kuschel et al, 2022).
- In 2019, it is estimated that human-made air pollution in the form of fine particulate matter PM_{2.5} (airborne particles less than 2.5 micrometres in diameter) and nitrous oxide (NO₂) was a factor in 3,239 premature deaths, 13,237 hospitalisations, 12,653 cases of childhood asthma and over 1.771 million restricted activity days. It is estimated that air pollution from motor vehicles was associated with 71 percent of these hospitalisations and 69 percent of premature deaths. Social costs resulting from the health impacts associated with air pollution were estimated at \$15.3 billion for the year 2019, with 69 percent of these costs associated with air pollution from motor vehicles (Metcalf & Kuschel, 2023; see [Our air 2024](#)).
- The estimated health impacts associated with human-made air pollution (PM_{2.5} and NO₂) increased between 2006 and 2016 due to population growth and rising NO₂ exposure. Premature deaths associated with NO₂ exposure from motor vehicle emissions increased 28 percent, and hospitalisations increased 39 percent. However, health impacts from PM_{2.5} exposure decreased during this period, likely due to reduced emissions from domestic fires (see indicator: [Human health impacts of PM_{2.5} and NO₂](#) and [Technical annex](#)).
- The health risks from air pollution are higher for some people and communities than for others. Children, the elderly, pregnant people, and those with pre-existing cardiovascular or respiratory disease are more vulnerable (Peled, 2011). People in the most socio-economically deprived areas are exposed to more air pollution, and suffer greater health impacts as a result, than those in the least deprived areas (Telfar-Barnard & Zhang, 2021; Wickham et al, 2023).
- Plants in urban green spaces can filter pollution from the air, but these spaces are under pressure from development. It is estimated that each year, trees in Auckland alone remove 1,230 tonnes of NO₂, 1,990 tonnes of ground-level ozone and 1,320 tonnes of particulate matter (PCE, 2023).

A changing climate can pose risks to our physical and mental health

Climate change could further jeopardise access to healthy food and water.

- Food production in New Zealand often concentrates specific industries in certain regions, making the food system more vulnerable to climate change and extreme weather events in those areas (Renwick, 2023; Resilience to Nature's Challenges, 2024). For example, Cyclone Gabrielle and the Auckland floods in 2023 disrupted road access, and damaged infrastructure and crops (eg, vegetables and orchards), in key production areas in the North Island (The Treasury, 2023; Vatsa & Renwick, 2024). This led to shortages of specific foods and a temporary increase in prices for some goods and services, adding to the rising cost of living (MFAT, 2023b; The Treasury, 2023).

- Climate change will have a negative impact on crop productivity around the world, making it more difficult to access a variety of food – a fundamental need, especially for children (Binns et al, 2021).
- Drinking water supply is at risk from climate change. Effects will be localised, with drought posing a risk to reservoir and catchment yield for drinking water supply, and increasing water demand from other uses (Kamish et al, 2020; MfE, 2020).
- There are existing health risks for rural communities and marae who rely on water from untreated systems, such as tank water and groundwater wells in intensively farmed areas. This risk can increase with extreme rainfall events and higher temperatures through contaminated drinking water (Awatere et al, 2021; Teen, 2024).

Higher temperatures and heatwaves could lead to growing health impacts.

- Higher temperatures and heat waves can cause illness and worsen chronic health conditions. Some people, including babies, infants, older people and people working outside, are more at risk than others. Higher temperatures have also been associated with an increased incidence of assaults (EHINZ, 2022; Lai et al, 2024; Royal Society Te Apārangi, 2017; Stevens et al, 2019).
- International evidence shows that extreme heat poses an increasing risk of mortality and morbidity with climate change, particularly for the elderly and those with cardiovascular disease. There is currently a lack of data for this connection in New Zealand (Chaseling et al, 2023).
- Our growing urban areas produce, absorb and retain more heat than rural and natural areas. This will make them even hotter as temperatures rise (IPCC, 2021). Urban heat can stress infrastructure and ecosystems and may exacerbate the health impacts of heat in cities. Urban forests and green space help to lower temperatures through transpiration and providing shade, reducing this urban heat island effect (PCE, 2023; Toi Te Ora Public Health, 2024).

Climate change could amplify the risk of disease.

- Allergic rhinitis, or hay fever, is commonly caused by windborne pollen. While data are limited, one study estimated that it affects 35 to 40 percent of those aged 20–44 years in New Zealand, and this number is increasing (Newnham, 2017, 2021). Warmer temperatures and higher carbon dioxide concentrations could increase the suitable growing areas of major pollen-producing species, so that they produce more pollen for longer (Damialis et al, 2021; Newnham, 2021). Recent monitoring and research indicate that our high pollen count days have increased by 75 percent over the last three decades (RNZ, 2024).
- Thunderstorm asthma occurs when a thunderstorm coincides with a significant amount of pollen in the air, causing immediate asthma flare-ups. Emerging evidence indicates that these events are likely to increase because of climate change (D’Amato et al, 2021) and could possibly occur in New Zealand (Asthma Foundation NZ, 2021; Sabih et al, 2020; Stewart et al, 2022).
- Smoke from wildfires has adverse physical and mental health effects, which children and people with asthma are particularly vulnerable to (Aguilera et al, 2021; McDonald et al, 2023).

- As our climate becomes increasingly suitable for insects such as mosquitos, there is an increasing risk that insect-spread viruses like the Zika virus and dengue fever will be introduced from overseas and locally transmitted (Ammar et al, 2021).
- Extreme weather events such as heavy rainfall and flooding are linked to a higher chance of waterborne disease outbreaks, which could become more frequent with climate change (Grout et al, 2022, 2024; Pourzand et al, 2023). Regions experiencing increased extreme rainfall may face greater risks of waterborne diseases, particularly through contaminated water supplies (Hales, 2019; Lai et al, 2020).

Climate change and extreme weather could harm mental health, affecting some groups more than others.

- Some population groups will be more affected by climate change health impacts than others, and existing health and social system inequities will be exacerbated by climate change. The already disadvantaged, including young, elderly, disabled and lower-income communities, people living in poverty, and Māori and Pasifika communities, will be disproportionately affected (Bennett et al, 2014; EHINZ, nd-b; EHINZ, 2024; Jones et al, 2014; Masters-Awatere et al, 2023).
- With an increasing number of extreme events, a rise in related health and wellbeing effects is expected, including injuries and deaths, displacement, and significant damage to community infrastructure. Vulnerable groups including children, elderly and disabled will be particularly at risk (Grout et al, 2022; Mason et al, 2021).
- Climate anxiety, including feelings of hopelessness and frustration, particularly affects some groups. Young people face an uncertain future, and Pacific communities have connections to small island countries susceptible to climate-induced displacement (Burkett, 2011; Campbell, 2010; Fritze et al, 2008; Health Navigator New Zealand, 2022; McBride, 2022; Tiatia-Seath et al, 2020).
- Emerging evidence indicates that children and young people are showing increasing levels of mental distress due to climate change, and research suggests they will be disproportionately burdened by the impacts of climate change (Gislason et al, 2021; Ma et al, 2022).
- Severe weather events such as extreme rainfall, drought, wildfires and floods have been linked to elevated levels of anxiety, depression and post-traumatic stress disorder (Ministerial Inquiry into Land Use in Tairāwhiti and Wairoa, 2023). People with pre-existing mental health conditions are at higher risk, as exposure to these events can worsen mental health and lead to higher mortality, with increased psychiatric hospitalisations and suicide rates (Charlson et al, 2021).
- Extreme weather events have long-term health and wellbeing implications for individuals and entire communities. Increased frequency of severe events can lead to exhaustion and emotional tolls on individuals and communities (Grout et al, 2022; Jones et al, 2023; Ministerial Inquiry into Land Use in Tairāwhiti and Wairoa, 2023).

People and their connection to place

The natural beauty of our environment, including mountains, rivers and coasts, is central to our culture and national identity.

As individuals, we each connect to the environment in our own way and for different reasons – including walking, swimming and gathering food. As communities, we also have different ways of enjoying our local environment – spending time in city parks, along rivers or at beaches. As the environment changes, these connections change, whether those changes are sudden and we notice them, or are more gradual and not immediately obvious.

These changes require knowledge adaptation, and affect mātauranga Māori and associated practices such as traditional food-gathering (mahinga kai) and using plant medicines (rongoā rākau). We also have intergenerational connections to the environment. Just as the way that those before us lived with the landscape influences the current state of the environment and how it affects society today, so will future generations be affected by the way that we live with the environment today.

Access to a healthy environment is important for maintaining our ties with nature

Access to urban greenspaces is important to stay connected to nature.

- Spending time in urban green spaces, and in or near rivers and lakes can support good mental health – reducing fatigue and stress, improving immune system function, lowering blood pressure and providing space for physical activities (Gascon et al, 2017; MfE, 2022; Nutsford et al, 2013; Pasanen et al, 2019; Tzoulas et al, 2007; White et al, 2020).
- Lower-income communities have less access to urban green spaces and their benefits, which can reduce the positive impact of green spaces on human health (Blaschke et al, 2024; Regional Public Health, 2010; Zhang et al, 2024).
- The accessibility of urban green spaces for adolescents is associated with reductions in stress, substance problems and depressive symptoms, as well as with improvements in mental health, behaviour and cognitive development (Hobbs et al, 2023; Mavoa et al, 2019; McCormick, 2017; Tzoulas et al, 2007). This association is important as one-third of New Zealand's adolescents aged 15 to 17 years have reported difficulties in everyday activities such as communicating and social interaction, due to mental illness (HPA, 2020).

Environmental degradation is affecting people's ability to connect with nature.

- Many New Zealanders engage in outdoor recreation, and we get important cultural and health benefits from activities such as walking, swimming, waka ama, surfing, kayaking, fishing and gathering shellfish. It can impair our communities' engagement and connection with the environment if these activities cannot be enjoyed safely (see [Environment Aotearoa 2022](#)).
- Our native ecosystems and unique wildlife provide opportunities for recreation. For many New Zealanders, having access to nature is a major advantage of living here, with around one in two visiting protected areas such as parks and beaches each month over the 2023/24 summer (DOC, 2021a, 2024b).
- A degraded environment affects connection to the land (whenua) for some Māori, and the foundation of tūrangawaewae (the land base, a place of belonging, standing and identity). This poses a risk to their cultural functioning capacity, and impacts quality of life (Awatere

et al, 2021; Harmsworth & Awatere, 2013; Hond et al, 2019; Reihana et al, 2023; Stewart-Harawira, 2020). For example, air pollution, including odour, at Whareroa Marae in Mount Maunganui is lowering the quality of life of those living near the marae, and community members are concerned about its effects on their cultural practices (Bay of Plenty Regional Council, nd; ESR, 2023).

- Changes in land cover and biodiversity loss have reduced people's connection to their local environment over several generations. Loss of connection is particularly pronounced in urban spaces, where the loss of native vegetation can cause disconnection from natural heritage, and a loss of identity and sense of place. Making natural heritage visible in urban areas, where most people live, can help restore our connection to nature (Hall et al, 2021; Rodgers et al, 2023; Walker et al, 2024b).

Changes to the environment impact our culture, identity and connections to place

Many important sites and infrastructure for culture and recreation are at risk from flooding, erosion and extreme weather events.

- Many sites of ecological, archaeological and recreational importance are in low-lying coastal areas at risk from coastal inundation as sea levels rise. This includes 420 archaeological sites on public conservation land (Tait, 2019).
- Severe weather has extensively damaged recreational infrastructure and tracks in recent years. For instance, the Queen Charlotte Track in the Marlborough Sounds was temporarily closed to walkers and mountain bikers for a few months in 2021. The Okura Bush walkway also remains closed following severe weather in 2023 (DOC, 2021b, 2024c).
- Culturally important sites and infrastructure, such as marae, burial grounds (urupā) and settlements (kainga), are vulnerable to damage from flooding, erosion, wildfires and other extreme weather events. Damage to these sites can affect the knowledge (mātauranga Māori) associated with them (Awatere et al, 2021; King et al, 2007). Around the country, 191 marae are within 1 kilometre of the coast, and, in the Bay of Plenty alone, 41 urupā are within 1 kilometre (Bailey-Winiata, 2021).
- Coastal erosion is a particularly serious threat to archaeological sites because it permanently removes them, erasing any evidence they could provide for archaeological investigation. Mapping indicates that the most at-risk areas are in the North Island around Taranaki, Auckland, Coromandel and northern Hawke's Bay, and in the South Island around Tasman and parts of Otago and Canterbury (Jones et al, 2023).

The ability to practise and access food-gathering (mahinga kai) and traditional plant medicine (rongoā rākau) is affected by changes to the environment.

- Changes to our terrestrial, freshwater and marine environments due to land-use change, invasive species, pollution and climate change can have direct impacts on treasured (taonga) species and the ability to carry out mahinga kai and rongoā rākau. This affects the transmission, retention and development of customs and protocols (tikanga), knowledge (mātauranga) and Māori language (te reo Māori), highlighting the importance of protecting these species and safeguarding the embedded knowledge within these practices (Awatere et al, 2021; Collier et al, 2017; Glavinovic et al, 2022; Harmsworth & Awatere, 2013; Herse et al, 2021; Noble et al, 2016; Parsons et al, 2021; Paul-Burke et al, 2020; Phillips et al, 2016; Rainforth & Harmsworth, 2019; Tipa, 2009).

- More than simply allowing for gathering kai, the ability to collect customary resources affects the authority (mana) of an iwi or hapū. These resources contribute to their capacity for manaakitanga – offering food from their land (whenua) and water (wai) to invited guests is an important part of hospitality (Rainforth & Harmsworth, 2019; Smith & Hutchings, 2024).
- Mahinga kai connects tangata with whenua (people with land), is intergenerational and is a holistic and integrated value. Mahinga kai includes the ability to access food resources, food-gathering sites, the gathering and use of food, and the abundance and health of species used for food (Awatere et al, 2018; Herse et al, 2021; Rainforth & Harmsworth, 2019; Ruru et al, 2022).
- Decreased or altered river flows, accumulation of sediment and sewage contamination in rivers, and the effects of excess nutrients in estuaries and the ocean can affect the cultural health of mahinga kai sites. These changes prevent safe access and reduce the availability of mahinga kai species (Collier et al, 2017; Hikuroa et al, 2018; Mika, 2021; Stewart-Harawira, 2020; PCE, 2020; Tipa, 2009; see [Our marine environment 2022](#)).
- Plant medicine (rongoā rākau) is integral to traditional Māori healing practices, and the plants necessary for these practices are vulnerable to changes in the landscape. Adverse effects on these plants can reduce rongoā practitioners' ability to connect with and harvest them (Awatere et al, 2021; Mark et al, 2022; Marques et al, 2023).

Changes to the environment affect traditional ways of monitoring the environment.

- Through observing the environment closely over time, Māori developed a deep knowledge of location-specific environmental indicators, or tohu. These help to monitor and forecast trends in the environment (te taiao) (Harcourt & Awatere, 2022; King et al, 2005; Matthews, 2023; Pomare et al, 2023, Wilcox et al, 2024).
- Many Māori cultural practices are based on astronomical knowledge, including those related to growing crops and fishing. Reduced visibility of the night sky forces changes to these practices (Hikuroa, 2017; Matamua, 2017; see [Environment Aotearoa 2022](#)).
- Climate change threatens the loss of treasured (taonga) species and resources. This poses risks to the maintenance and transfer of traditional skills, expertise and values relating to practices such as observing the maramataka (Awatere et al, 2021; NZAEE, 2021). Maramataka is the traditional Māori way by which time is marked by observing the phases of the moon. Mātauranga Māori, including maramataka, holds centuries of observations to understand causal effects (Hikuroa, 2017).
- Changes in local climates are causing tohu to change, which is affecting planting, daily decisions and activities such as resource gathering and hunting (Skipper, 2018). Understanding and monitoring changes to tohu can help to manage and adapt climate-sensitive activities like these (Benson et al, 2020; King et al, 2005; Nurse-Bray et al, 2022; Warbrick et al, 2023). However, the pace of climate change risks the severing of connections with taonga species and tohu, if knowledge adaptation cannot keep up with changes (Awatere et al, 2021; Bond et al, 2019; King et al, 2010; Paul et al, 2016; Penny et al, 2007a, 2007b; Warmenhoven et al, 2014).
- Taonga species are important for maintaining values such as authority (mana), knowledge (mātauranga), and passing knowledge to the next generation (whakaheke korero). The deterioration of some of these species risks disrupting the maintenance and transmission of tohu (Collier et al, 2017; Harmsworth, 2022b; Harmsworth & Awatere, 2013; Lyver et al, 2017a, 2017b, 2021; Mark et al, 2022; Taura et al, 2021).

Homes and livelihoods

The environment provides the foundation for our homes, infrastructure and livelihoods. It offers the resources and stability needed for a thriving society. However, environmental change, and in particular climate change, poses serious threats to homes, infrastructure and livelihoods. Extreme weather events, such as heavy rainfall, storms and wildfires, damage housing and infrastructure, particularly in flood-prone and drought-affected areas. Rising sea levels also threaten coastal communities through erosion and inundation, demanding costly repairs and long-term adaptation. Hydropower, which generates about 60 percent of New Zealand's electricity, is vulnerable to changing rainfall patterns and reduced snowmelt, reducing energy reliability (MBIE, 2023; MfE, 2024g).

Although some parts of New Zealand's economy, such as agriculture and forestry, are more visibly dependent on the environment, every sector relies on natural resources and ecosystems to some extent (see [Our land 2024](#)). In the year ended June 2024, primary industries contributed \$53.3 billion to exports (MPI, 2024a). In the year ended March 2024, international tourism's contribution to total exports was \$16.9 billion (Stats NZ, 2025).

Many industries – including agriculture, horticulture, forestry, tourism and fisheries – face risks from climate change (Lawrence et al, 2020). Short-term shocks, such as disrupted crop yields and damage to marine ecosystems, can require timely interventions to stabilise food production and protect vulnerable livelihoods. However, addressing the broader long-term impacts of climate change calls for more adaptive and sustainable strategies. The cumulative stress on ecosystems and decline of iconic landscapes necessitate a range of responses, including nature-based solutions. Restoring and enhancing wetlands, for instance, can provide resilient and cost-effective protection for homes, livelihoods and ecosystems. These approaches build adaptive capacity, ensuring ecosystems and communities can better withstand future climate challenges (Hobbie & Grimm, 2020).

Homes, infrastructure and energy supply

The impacts of climate change are being felt on our homes and infrastructure.

- Climate change, including more frequent and intense extreme weather, is increasingly causing daily impacts on our homes and infrastructure. Costs are rising due to disrupted supply chains, power cuts caused by extreme weather, and the need to evacuate homes due to fires or flooding (Grout et al, 2022).
- Flooding from rainfall and overflowing rivers can damage critical infrastructure including housing and transport, energy, stormwater and wastewater systems. Cyclone Gabrielle is an example of extreme weather that damaged vulnerable infrastructure, including water, transport, power and communication (Ministerial Inquiry into Land Use in Tairāwhiti and Wairoa, 2023). The wastewater treatment plant in Napier was seriously damaged and unable to operate, so that untreated sewage was released into the sea (Jones et al, 2023).
- Hydropower has provided an average of 57 percent of our electricity each year between 2010 and 2021, but this varies with rainfall. (Deep South, 2021; EECA, nd).
- In 2023, low rainfall in the South Island led to the lowest inflows to lakes Manapōuri and Te Anau since 1953. Heavy rainfall in the North Island took Lake Taupō storage to its limit, which, despite controlled release, led to minor flooding. This extreme rainfall is partially linked to La Niña and affects hydroelectricity storage and generation across the country. It may become more frequent with climate change (Deep South, 2021; Electricity Authority, 2023; see [section 6: Atmosphere and climate](#)).

Building in at-risk areas and facing more extreme weather makes us more vulnerable to climate change.

- Ongoing rural development and urban expansion expose more people to wildfire threats in some areas, due to the increasing proximity of homes to highly flammable vegetation such as ungrazed pastures or forestry plots (Huggins et al, 2020; Langer & Wegner, 2018; Langer et al, 2022). During the 2016/17 fire season, more homes were destroyed than in each of the previous 100 years, and this record was then surpassed in 2020/21 (Langer et al, 2021).
- Development near rivers restricts their natural flow, increasing flood risks to homes and infrastructure, while reducing the flexibility needed to adapt to climate change (Brierley et al, 2023; Hicks et al, 2021). Around 750,000 people and 500,000 buildings, worth more than \$145 billion, are near rivers and in coastal areas already exposed to extreme flooding in New Zealand (Awatere et al, 2021; Paulik et al, 2023; see [Our atmosphere and climate 2023](#)).
- Coastal development has increased our vulnerability to extreme wave and storm events, and to the accelerating coastal erosion, inundation and flooding caused by sea-level rise (Awatere et al, 2021; Lawrence et al, 2020; Thompson, 2022). In 2019, 2,273 kilometres of roads, 5,572 kilometres of water pipes, 2,457 square kilometres of land, and buildings with a replacement value of \$26.18 billion (2016) were assessed as vulnerable if sea levels rise by 0.6 metres (NIWA, 2019a).
- Sea-level rise will increasingly affect infrastructure in low-lying and coastal communities. This includes stormwater and wastewater services critical for health and sanitation that are also affected by extreme weather (Feng et al, 2021; Kool et al, 2020; PCE, 2015, 2023, 2024). Impacts from compromised wastewater services include odour, leaks and uncontrolled discharges that contaminate the environment, and will have a range of social, economic, health and cultural consequences (Hughes et al, 2021; Kool et al, 2020; Lawrence et al, 2020; see [section 3: Freshwater](#)).

Our livelihoods – including from primary industries and tourism – are at risk from a changing environment and climate

Climate change and extreme weather are making primary industries more vulnerable.

- Extreme weather events such as droughts and floods have cost New Zealand billions of dollars in the last five years (ICNZ, 2021), and the frequency and severity of these events are increasing (see [section 6: Atmosphere and climate](#)). Estimated damage to the food and fibre sector alone from Cyclone Gabrielle may total between \$700 million and \$1.1 billion in recovery costs (MPI, 2023g). In the lower South Island, during the flood event of February 2020, farmland and infrastructure were damaged and revenue was lost where milk tanker access was not possible (Griffin et al, 2023).
- The Māori economy is particularly vulnerable to climate change because Māori own a large share of assets in the primary sector (Awatere et al, 2021; BNZ, 2024; Haemata Limited, 2023; King et al, 2010; MFAT, 2019).
- Primary industries (eg, agriculture, horticulture, forestry, fisheries) rely on natural resources such as soil and freshwater. They are therefore expected to be highly affected by climate change. Changes in temperature, rainfall patterns and extreme weather events will affect freshwater and soil, with impacts for agriculture and horticulture (Ausseil et al, 2021; Case et al, 2023; Mourot et al, 2022; Salinger et al, 2019, 2020).

- Droughts reduce the availability of water for farming, which can negatively affect the economy. This also reduces employment and income (Bell et al, 2021; Nguyen et al, 2022). Snow and rainfall patterns are projected to shift due to climate change, with regional and seasonal variability that will affect patterns in the need and availability of water for irrigation (Mourrot et al, 2022; Purdie, 2022; Queen et al, 2023).
- Forestry plantations are vulnerable to extreme weather events such as wildfires (Villamor et al, 2023; Watt et al, 2019). High-intensity fires incur high economic costs for forests and long recovery times. However, more frequent medium-intensity fires tend to cause the most economic damage (Blanc & Noy, 2024).
- The changing climate is also having a slow-burning effect by affecting the suitability of regions for producing different crops (Ausseil et al, 2021; Clothier et al, 2012; Lilburne et al, 2024; MPI, nd-a; Rajan et al, 2024; Salinger et al, 2019, 2020). Fruit production will be affected and needing changes to cultivation practices. Impacts include changes in fruit quality and quantity, changes in flowering and fruiting periods (Ausseil et al, 2021), and increasing risk of insufficient winter chilling (Rajan et al, 2024).
- Pests and diseases are compromising productivity in land-based industries, as they become more susceptible to new invasions (Keegan et al, 2022). Intensified production systems may be more vulnerable to disruption (Meurisse et al, 2023). The total costs of pests were estimated at \$9.2 billion in 2019/20 (2.9 percent of gross domestic product), with about \$4.3 billion attributed to losses in primary production (MPI, 2021c).
- Sea-level rise is expected to impact coastal agricultural land, increasing flooding and salinisation, particularly in areas below mean sea level (Craig et al, 2023).

Fisheries and aquaculture are affected by warming seas and marine heatwaves.

- Climate change, sedimentation, diseases and invasive species pose risks for aquaculture and fishing. Commercial fishing species such as snapper, hoki, pāua and kōura are among the many at-risk species (Awatere et al, 2021; King et al, 2010; Johnson et al, 2024; PMCSA, 2021). Warming sea temperatures and ocean acidification may affect some species and ecosystems that are important for aquaculture and wild-caught fisheries. For example, they may reduce the growth rate of shellfish (including flat oysters, green-lipped mussels and pāua) and of snapper and other fish (Cummings et al, 2021; Lundquist et al, 2023). However, ocean warming could increase the catch of flatfish, trevally and jack mackerel (Mediodia et al, 2024).
- Changes in the distribution of fish stocks due to changing ocean temperatures will affect fishery interests. Quotas are tied to specific areas or zones, posing a challenge for quota management if the related fish stocks relocate. Māori commercial fisheries hold about a third of the interests in New Zealand, so would be affected as part of this (Hudson, 2022).
- Commercial fisheries are also vulnerable to increased frequency and intensity of marine heatwaves. Moderate events are associated with increased fish catches, but higher-intensity events are associated with substantially lower catches (Lacheheb et al, 2024).

Tourism is at risk from changes in the environment and climate.

- New Zealand is renowned for its beautiful landscapes, which are important for attracting tourists (DOC, 2024; PwC, nd, 2023). Climate change, biodiversity loss, coastal erosion, shorter snow seasons and melting glaciers put the tourism industry at risk (Aotearoa Circle, 2023; PwC, nd).

- The decreasing volumes of ice in glaciers affect tourism, with challenges such as alpine access and tourist safety (Purdie et al, 2020; Wang and Zhou, 2019). At the Tasman Glacier, the effects of climate change have also resulted in opportunities to adapt to changing conditions. The rapidly expanding lake means visitors take boat tours to get close to the calving ice at the glacier edge, and shorter winter freezing allows a longer tourist season (Carver & Tweed, 2021; Purdie et al, 2020).
- Engaging with the night sky is important for cultural practices, astrotourism and astronomical research, but light pollution degrades these values. The creation of dark sky reserves is helping to protect areas from light pollution. They are popular tourist destinations and foster economic, social and cultural growth by preserving night-sky views and providing educational opportunities (Patterson, 2023; South Wairarapa District Council, nd; Tapada et al, 2021; Zielinska-Dabkowska & Xavia, 2021).

8. Knowledge gaps

In previous environmental reports, the 'Knowledge gaps' section identified specific gaps in each domain. This report takes a broader approach, identifying gaps that prevent us from understanding environmental change as a whole, and its impacts on people and their quality of life.

This recognises the interrelated nature of the drivers and pressures of environmental change, and their cumulative impacts on individuals, communities and ecosystems.

This section explores five themes to describe critical knowledge gaps that are holding us back – not only in understanding the drivers and consequences of environmental change, but also in effective actions and responses. These gaps echo challenges faced globally, highlighted by international initiatives such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Knowledge Taskforce, which emphasises the need for robust, interdisciplinary insights to address shared environmental issues (see [IPBES Knowledge gaps](#)).

Learning from both local experiences and international research can better address these gaps and equip Aotearoa New Zealand to tackle the complexities of environmental change.

Theme 1: Decoding drivers of change

Environmental change is driven by many complex factors, such as international influences, human population growth, individual consumer choices, and technological and climate change (see [section 1: Drivers](#)).

These drivers create environmental pressures that are interconnected, shaped by feedback loops and evolving over time. Understanding the dynamics is further complicated by spatial variations in drivers and pressures. A key knowledge gap about drivers, therefore, is disentangling these intricate relationships to determine which factors drive specific pressures across different times and places.

Addressing this gap requires advances in modelling techniques. The models must analyse data to identify patterns and feedback processes, isolate pressures and drivers, and predict how various factors (eg, economic policies, climate conditions, technological advancements and population growth) interact over time.

However, improving predictions for issues such as global warming and biodiversity loss highlights another critical gap: understanding how societies, economies and institutions are likely to respond. This requires further research in social sciences, including psychology, political science, economics, complexity science and socio-technical transitions.

Another gap lies in the development of robust scenario-based models to explore possible futures. These models enable the testing of 'what-if' scenarios, each with distinct assumptions or conditions. This illustrates a range of possibilities rather than a single forecast. For example, they are used to examine how future urbanisation in a specific area might interact with changing climate patterns, or to predict localised effects of policy changes such as urban green design. Advancing research in predictive scenario modelling will be essential to decode environmental change and support effective decisions.

Theme 2: Harnessing data to track change

Data gaps across all the domains in this report prevent deeper understanding of environmental patterns, processes and feedback loops. These data are critical for our understanding, and for informing modelling and decision making.

Since it is not possible to collect on-the-ground observations for every location in New Zealand, modelling techniques can be used to fill gaps in unmeasured areas, using patterns across time and space. Investing in new technologies such as satellite imagery or eDNA can improve the scale and coverage of environmental data. However, it is essential to establish clear monitoring standards and methods for consistency, and to ground truth these new technologies. This is especially important as new technologies and service providers are advancing at pace.

Research on emerging pollutants and their impacts is another gap. The number of studies of microplastics, waste byproducts and liquid chemical pollutants in air, soils, and freshwater and marine environments is growing. However, we still need to quantify how widespread these are, understand their ecological impacts, and assess their role in climate change.

Monitoring and evaluating the effectiveness of policies and management interventions is another area where data are either poor or lacking. Reliable evaluation requires environmental baselines, targeted monitoring design, and robust data management. Standardising data collected at local or regional scales to measure the impact of interventions (eg, good land management practices) helps make clear links between action and response. Advances in artificial intelligence could support this by mining historical data and speeding up data cleaning and processing.

Data monitoring networks often rely on regional or local information, which may not represent national trends. Monitoring must allow for national representation, to understand the scale and extent of a problem. Global-scale models can also be used through downscaling to fit to our context. Clear data management (eg, standardisation, consistent terminology) and detailed metadata are essential to avoid misinterpretation and to facilitate greater reuse of data (eg, land use or ecosystem classification systems; Law et al, 2024; Sprague & Wiser, 2024). Many foundational datasets are curated by public organisations such as Crown research institutes or universities. Balancing open access to shared data with privacy and sovereignty protection is key to ensuring informed decisions that benefit everyone.

Theme 3: Understanding interactions and cumulative impacts

The environmental domains we report on (land, freshwater, marine, air, and atmosphere and climate) are interconnected. Ecological and social processes frequently interact, often leading to cumulative effects on ecosystems and people. For example, pollution, climate change, invasive species and land-use change combine with and amplify each other's impacts.

Understanding these dynamics requires an integrated ecosystem-level approach. This would bring together diverse data sources to reveal cause-and-effect relationships, as well as tipping points (where a small change or event causes a significant and permanent change in environmental state), and to identify opportunities for action.

There are three knowledge gaps here to overcome:

- the limited availability of data
- difficulties in integrating data as well as linking techniques, for example linking land use with water quality to identify cause and effect, and overcome complicating factors such as lag times and legacy effects
- research and models that can link this environmental change to impacts on people. For example, the development of adaptation strategies would benefit from better understanding of the interdependencies among climate, urban infrastructure (including services), financial services (including banking and insurance) and governance systems.

A similar set of challenges must be overcome to visualise interactions between climate, water, food, biodiversity and people (IPBES, 2024b). Changes to land use, for example, often affect freshwater and marine ecosystems and their services (eg, food production, and water for irrigation).

Advanced models, decision tools and even ‘digital twins’ are critical to bridging these gaps. They can help simulate the interactions across systems, understand chain reactions and evaluate the impacts and co-benefits of interventions. An integrated understanding of the processes by which one part of a social-ecological system has flow-on effects to another is vital to address both current risks and future uncertainties.

Theme 4: Mātauranga Māori and place-based knowledge

Mātauranga Māori (Māori knowledge) provides a rich and unique record of changes in the environment, and the impact on people and their quality of life. Mātauranga Māori does not separate the environment into domains, nor people from it. It therefore helps us understand the cumulative effects of environmental change on individuals, communities and ecosystems more holistically.

Despite the significance of mātauranga Māori, gaps remain in bringing it into environmental reporting and how it affects the Māori worldview (te ao Māori). The following are some of the areas that remain to be addressed.

- Systematically collect, manage and make available environmental indicators (ngā tohu o te taiao) and place-based knowledge – while respecting Māori data sovereignty.
- Interweave mātauranga Māori with conventional scientific methods. Frameworks that respect and integrate both knowledge systems can provide a more comprehensive understanding of environmental state and trends. Environmental reporting often lacks the storytelling and cultural narratives central to mātauranga Māori. Incorporating these can provide richer, more meaningful insights into environmental change and impact on the environment (te taiao), people and their quality of life.
- Actively value mātauranga Māori as a knowledge system. This creates a foundation for collaboration and mutual respect. This partnership is more likely to promote environmental stewardship.
- Acknowledge the growing economic benefits of Māori involvement in primary industries such as agriculture, forestry, aquaculture and fisheries. This provides another avenue to address gaps in the way we utilise mātauranga Māori, as well as generate new knowledge. By leveraging cultural wisdom and sustainable practices, we can enhance economic outcomes while ensuring environmental sustainability.

Addressing these gaps will not only enhance environmental reporting, but also uphold the principles of te Tiriti o Waitangi (the Treaty of Waitangi). This will foster a more inclusive and effective approach to environmental stewardship.

Theme 5: Connecting environmental change to quality of life

There is limited understanding of how environmental change affects people's quality of life. This makes it challenging to determine whether the changes have positive or negative effects. For example, ecosystems provide essential services – such as clean air, water and food – which support economic stability, health and community resilience. However, quantifying these contributions is complex, particularly with intangible benefits such as mental health support from green spaces, or cultural ties to landscapes.

Our relationships with nature vary between people and communities, and also shift over time due to social changes. This makes it difficult to assign consistent values to these benefits, and highlights a significant knowledge gap – developing robust, reliable and adaptive valuation methods for ecosystem services, especially for non-market benefits (Ausseil et al, 2021; Maechler & Boisvert, 2024). To more inclusively capture the full spectrum of effects on people's relationships with nature, these methods must account for social and cultural differences, and variations across different locations and over time.

Equally important is understanding risks and resilience in the face of environmental challenges. Predicting health impacts, such as from air pollution, requires advanced modelling to anticipate exposure levels and outcomes. Similarly, identifying the communities most at risk, whether from rising sea levels, extreme weather or resource scarcity, is vital for targeted interventions and ensuring certainty for development in lower-risk areas. To create lasting solutions, we need new methods to measure adaptation progress and resilience. With improved assessment, we can better understand trade-offs and develop strategies that not only protect ecosystems and vulnerable populations, but also enhance quality of life in a rapidly changing world.

Additional information

Environmental indicators

Below are the indicators incorporated in this report.

- [Active sand dune extent](#)
- [Air pollutant emissions](#)
- [Annual glacier ice volumes](#)
- [Atmospheric ozone](#)
- [Carbon monoxide concentrations: Data to 2023](#)
- [Coastal and estuarine water quality](#)
- [Coastal sea-level rise](#)
- [Consented freshwater takes](#)
- [Deposited sediment in rivers](#)
- [Drought](#)
- [El Niño Southern Oscillation](#)
- [Estimated long-term soil erosion: Data to 2022](#)
- [Exotic land cover](#)
- [Extinction threat to indigenous species](#)
- [Extreme rainfall](#)
- [Extreme wind](#)
- [Fertilisers – nitrogen and phosphorus](#)
- [Freshwater physical habitat](#)
- [Frost and growing degree days](#)
- [Greenhouse gas concentrations](#)
- [Ground-level ozone concentrations: Data to 2023](#)
- [Highly erodible land: Data to 2022](#)
- [Human health impacts of PM_{2.5} and NO₂](#)
- [Indigenous land cover](#)
- [Interdecadal Pacific Oscillation](#)
- [Irrigated land: Data to 2022](#)
- [Lake submerged plant index](#)
- [Lake water quality](#)
- [Land fragmentation](#)
- [Land pests](#)
- [Livestock numbers: Data to 2023](#)
- [Marine non-indigenous species: Data to 2022](#)

- [Marine primary productivity: Data to 2023](#)
- [Nitrogen dioxide concentrations: Data to 2023](#)
- [Ocean acidification](#)
- [PM₁₀ concentrations \(air quality\): Data to 2023](#)
- [PM_{2.5} concentrations \(air quality\): Data to 2023](#)
- [Predicted pre-human vegetation](#)
- [Rainfall](#)
- [River water quality – heavy metals: Data to 2022](#)
- [River water quality: clarity and turbidity](#)
- [River water quality: Escherichia coli](#)
- [River water quality: macroinvertebrate community index](#)
- [River water quality: nitrogen](#)
- [River water quality: phosphorus](#)
- [Sea-surface temperature: Data to 2023](#)
- [Soil quality and land use](#)
- [Southern Annular Mode](#)
- [Sulphur dioxide concentrations: Data to 2023](#)
- [Temperature](#)
- [Urban land cover](#)
- [Wetland area](#)
- [Wildfire risk](#)

Acknowledgements

This report was compiled by the Ministry for the Environment and Stats NZ's Environmental Reporting team.

Data providers

We would like to thank the following for providing data and advice in the development of indicators used in this report:

Cawthron Institute, Department of Conservation, district councils, Fertiliser Association of New Zealand, Fire and Emergency New Zealand, HAPINZ 3.0, Intergovernmental Panel on Climate Change Centre for Environmental Data Analysis data catalogue, Land Information New Zealand (New Zealand Hydrographic Authority), Land Water People, Manaaki Whenua – Landcare Research, Ministry for Primary Industries, NASA (National Aeronautics and Space Administration), NIWA (National Institute of Water and Atmospheric Research), NOAA (National Oceanic and Atmospheric Administration), NZOA-ON (New Zealand Ocean Acidification Observing Network) and sampling partners, regional councils, Stats NZ, unitary authorities, and Waka Kotahi – NZ Transport Agency.

Senior science and mātauranga advisors

We would like to thank the following people and organisations for providing advice and helping to shape this report:

Andrea Byrom, Independent Researcher & Consultant

Shaun Awatere, Manaaki Whenua – Landcare Research

External peer reviewers

We would like to thank the following people and organisations for providing advice and critical review of an initial draft of this report:

Adrian McDonald, University of Canterbury

Carolyn Lundquist, NIWA

Jane Kitson, Kitson Consulting

Robyn Simcock, Manaaki Whenua – Landcare Research

Infographics

The infographic (page 10) was created by Dumpark Information Design.

References

- Acaroglu L. (2019).** *The anatomy of action for sustainable living*. Nairobi: United Nations Environment Programme. https://www.oneplanetnetwork.org/sites/default/files/from-crm/anatomy_of_action_validation_full_0.pdf
- Aguilera R, Corringham T, Gershunov A, Leibel S, & Benmarhnia T. (2021).** Fine particles in wildfire smoke and pediatric respiratory health in California. *Pediatrics*, 147(4), e2020027128. <https://doi.org/10.1542/peds.2020-027128>
- AI Forum New Zealand. (2022).** *Artificial Intelligence for the Environment of Aotearoa New Zealand*. <https://aiforum.org.nz/wp-content/uploads/2022/05/AI-for-the-Environment-Report-2022-1.pdf>
- Allan S, Bell RG, Forkink A. (2023).** Coastal realignment: Another coastal challenge. *Policy Quarterly* 19(1): 50–57. <https://doi.org/10.26686/pq.v19i1.8105>
- Ammar SE, McIntyre M, Baker MG, & Hales S. (2021).** Imported arboviral infections in New Zealand, 2001 to 2017: A risk factor for local transmission. *Travel Medicine and Infectious Disease*, 41, 102047. <https://doi.org/10.1016/j.tmaid.2021.102047>
- Anderson OF, Stephenson F, Behrens E, & Rowden AA. (2022).** Predicting the effects of climate change on deep-water coral distribution around New Zealand: Will there be suitable refuges for protection at the end of the 21st century? *Global Change Biology*, 28(22), 6556–6576. <https://doi.org/10.1111/gcb.16389>
- Anderson TJ, Morrison M, MacDiarmid A, Clark M, D’Archino R, Nelson W, ... & Wadhwa S. (2019).** *Review of New Zealand’s key biogenic habitats*. National Institute of Water & Atmospheric Research report 2018139WN, prepared for the Ministry for the Environment. <https://environment.govt.nz/assets/Publications/Files/NZ-biogenic-habitat-review.pdf>
- Andrew IG, Macfarlane RP, Johns PM, Hitchmough RA, & Stringer IAN. (2012).** The conservation status of New Zealand Diptera. *New Zealand Entomologist*, 35(2). <https://doi.org/10.1080/00779962.2012.686312>
- Aotearoa Circle. (2023).** *Tourism Sector Climate Change Scenarios*. https://static1.squarespace.com/static/62439881aa935837b9ad6ac9/t/642cea446df4a245d8641bad/1680665189109/P0381992_Aotearoa+Circle+Report_Tourism_Scenarios+v07.pdf
- Asher C. (2023).** *Microplastics Pose Risk to Ocean Plankton, Climate, Other Key Earth Systems*. <https://news.mongabay.com/2023/10/microplastics-pose-risk-to-ocean-plankton-climate-other-key-earth-systems/>
- Asthma Foundation NZ. (2021).** *What is Thunderstorm Asthma?* <https://www.asthmafoundation.org.nz/stories/what-is-thunderstorm-asthma>
- Auckland Council. (nd).** *Ngā Wero Matua ki Tāmaki Makaurau | Auckland’s Key Challenges*. <https://www.aucklandcouncil.govt.nz/plans-projects-policies-reports-bylaws/our-plans-strategies/auckland-plan/about-the-auckland-plan/Pages/aucklands-key-challenges.aspx>
- Auckland Council. (2024).** *Te Whakawātea mō te Wai Making Space for Water*. <https://www.aucklandcouncil.govt.nz/environment/looking-after-aucklands-water/Pages/making-space-for-water.aspx>
- Auliagisni W, Wilkinson S, & Elkhartoutly M. (2022).** Flood risk management in New Zealand: A case study of the Northland urban community. *IOP Conference Series: Earth and Environmental Science*, 1101(2). <https://doi.org/10.1088/1755-1315/1101/2/022035>
- Ausseil AGE, Jamali H, Clarkson BR, & Golubiewski NE. (2015).** Soil carbon stocks in wetlands of New Zealand and impact of land conversion since European settlement. *Wetlands Ecology and Management*, 23, 947–961. <https://doi.org/10.1007/s11273-015-9432-4>

- Ausseil AGE, Law RM, Parker AK, & Teixeira EI. (2021).** Projected wine grape cultivar shifts due to climate change in New Zealand. *Frontiers in Plant Science*, 12, 618039.
<https://doi.org/10.3389/fpls.2021.618039>
- Awatere S, King DN, Reid J, Williams L, Masters-Awatere B, Harris P, ... & Jackson AM. (2021).** *He Huringa Āhuarangi, he Huringa Ao: A Changing Climate, a Changing World*. Contract report LC3948.
<https://www.landcareresearch.co.nz/assets/researchpubs/He-huringa-ahuarangi-he-huringa-ao-a-changing-climate-a-changing-world.pdf>
- Awatere S, Robb M, Taura Y, Reihana K, Harmsworth G, Te Maru J, & Watene-Rawiri E. (2018).** *Wai Ora Wai Māori – A kaupapa Māori Assessment Tool*.
<https://www.landcareresearch.co.nz/assets/Publications/Policy-Briefing-Guidance-Papers/Policy-Brief-19-Wai-Ora-Wai-Maori.pdf>
- Bailey-Winiata APS. (2021).** *Understanding the Potential Exposure of Coastal Marae and Urupā in Aotearoa New Zealand to Sea Level Rise*. [Master's thesis, University of Waikato].
<https://hdl.handle.net/10289/14567>
- Baker CF, Jowett IG, Allibone RM. (2003).** *Habitat use by non-migratory Otago galaxiids and implications for water management*. Science for Conservation 221, Department of Conservation.
<https://dcon01mstr0c21wprod.azurewebsites.net/globalassets/documents/science-and-technical/sfc221.pdf>
- Baker M, Prickett M, Pourzand F, Kerr J, & Hales S. (2023).** *Queenstown Outbreak Highlights Future Challenges for Clean Drinking Water*. <https://www.phcc.org.nz/briefing/queenstown-outbreak-highlights-future-challenges-clean-drinking-water>
- Barker GM, Brook FJ, Mahlfeld K, Walker K, Roscoe DJ, Hitchmough R, Edwards ED, Rolfe JR, & Michel P. (2021).** *Conservation status of New Zealand indigenous terrestrial Gastropoda (slugs and snails), 2020. Part 1, Athoracophoridae (leaf-veined slugs) and Succineidae (amber snails)*. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs32entire.pdf>
- Basher LR. (2013).** Erosion processes and their control in New Zealand. In JR Dymond (Ed), *Ecosystem Services in New Zealand: Conditions and Trends* (pp 363–374). Manaaki Whenua Press.
http://www.mwpress.co.nz/data/assets/pdf_file/0004/77053/2_7_Basher.pdf
- Basher LR, Hicks DM, Clapp B, & Hewitt T. (2011).** Sediment yield response to large storm events and forest harvesting, Motueka River, New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 45(3), 333–356. <https://doi.org/10.1080/00288330.2011.570350>
- Bay of Plenty Regional Council. (nd).** *Mount Maunganui Industrial Air Quality*.
<https://www.boprc.govt.nz/environment/air/mt-maunganui-air-project/>
- Behrens E, Rickard G, Rosier S, Williams J, Morgenstern O, & Stone D. (2022).** Projections of future marine heatwaves for the oceans around New Zealand using New Zealand's Earth System Model. *Frontiers in Climate*, 4, 798287. <https://doi.org/10.3389/fclim.2022.798287>
- Bell KM, Samarasinghe O, Riggs L, & Pourzand F. (2021).** *Empirical Effects of Drought and Climate Change on Farms and Rural Communities*. <https://deepsouthchallenge.co.nz/wp-content/uploads/2021/05/Empirical-effects-of-drought-and-climate-Final-Report.pdf>
- Bell R, Hannah J, & Andrews C. (2022).** *Update to 2020 of the Annual Mean Sea Level Series and Trends around New Zealand*. <https://environment.govt.nz/assets/publications/update-to-mean-sea-level-series-and-trends.pdf>
- Bennet MJ, & Kingston DG. (2022).** Spatial patterns of atmospheric vapour transport and their connection to drought in New Zealand. *International Journal of Climatology*, 42(11), 5661–5681.
<https://doi.org/10.1002/joc.7554>
- Bennett H, Jones R, Keating G, Woodward A, Hales S, & Metcalfe S. (2014).** Health and equity impacts of climate change in Aotearoa-New Zealand, and health gains from climate action. *New Zealand Medical*

Journal, 127(1406), 16–31. <http://www.nzma.org.nz/journal/read-the-journal/all-issues/http://www.nzma.org.nz/journal/subscribe>

Bennion M, Brough T, Leunissen E, Morrison M, Hillman JR, Rowden AA, ... & Lundquist CJ. (2024). Modelling spatial distributions of biogenic habitat-forming taxa to inform marine spatial planning. *Aquatic Conservation: Marine and Freshwater Ecosystems*, 34(3): e4079. <https://doi.org/10.1002/aqc.4079>

Benson M, McKay AM, Ruru M, Ruru I, & Ruru R. (2020). *Te Rūnanga o Ngāti Mutunga Mauri Compass Assessment of the Urenui River and the Mimitangiatua River Authors.* <https://www.trc.govt.nz/assets/Documents/Environment/Consent-applications/Remediation2019/Hearing/submitters/Remediation-NgatiMutunga-McKay-attachment.pdf>

Binns CW, Lee MK, Maycock B, Torheim LE, Nanishi K, & Duong DTT. (2021). Climate change, food supply, and dietary guidelines. *Annual review of public health*, 42, 233–255. <https://doi.org/10.1146/annurev-publhealth-012420-105044>

BirdCare Aotearoa. (2022). *Botulism.* <https://birdcareaotearoa.org.nz/botulism/>

Blanc E, & Noy I. (2024). *Damages and Costs of Forest Wildfires in New Zealand Using Satellite Data.* <https://doi.org/10.21203/rs.3.rs-4159989/v1>

Blaschke P, Pedersen Zari M, Chapman R, Randal E, Perry M, Howden-Chapman P, & Gyde E. (2024). Multiple roles of green space in the resilience, sustainability and equity of Aotearoa New Zealand's cities. *Land*, 13(7). <https://doi.org/10.3390/land13071022>

BNZ. (2024). *BNZ Māori business sentiment survey.* https://blog.bnz.co.nz/wp-content/uploads/2024/06/BNZ-Maori-Business-Sentiment-Survey_analysis.pdf

Boamponsem LK, Hopke PK, & Davy PK. (2024). Long-term trends and source apportionment of fine particulate matter (PM_{2.5}) and gaseous pollutants in Auckland, New Zealand. *Atmospheric Environment*, 322, 120392. <https://doi.org/10.1016/j.atmosenv.2024.120392>

Bodeker G, Cullen N, Katurji M, McDonald A, Morgenstern O, Noone D, ... & Tait A. (2022). *Aotearoa New Zealand Climate Change Projections Guidance: Interpreting the Latest IPCC WG1 Report Findings.* <https://environment.govt.nz/publications/aotearoa-new-zealand-climate-change-projections-guidance/>

Boehler S, Strecker R, Heinrich P, Prochazka E, Northcott GL, Ataria JM, ... & Tremblay LA. (2017). Assessment of urban stream sediment pollutants entering estuaries using chemical analysis and multiple bioassays to characterise biological activities. *Science of the Total Environment*, 593–594, 498–507. <https://doi.org/10.1016/j.scitotenv.2017.03.209>

Boffa Miskell. (2020). *The Big Dry: What Drought Means for Our Indigenous Biodiversity.* <https://www.boffamiskell.co.nz/news-insights/the-big-dry-what-drought-means-for-our-indigenous-biodiversity>

Bond MO, Anderson BJ, Henare THA, & Wehi PM. (2019). Effects of climatically shifting species distributions on biocultural relationships. *People and Nature*, 1(1), 87–102. <https://doi.org/10.1002/pan3.15>

Bond TC, Doherty SJ, Fahey DW, Forster PM, Berntsen T, DeAngelo BJ, ... & Zender CS. (2013). Bounding the role of black carbon in the climate system: A scientific assessment. *Journal of Geophysical Research: Atmospheres*, 118(11), 5380–5552. <https://doi.org/10.1002/jgrd.50171>

Booker DJ, & Snelder TH. (2023). Climate change and local anthropogenic activities have altered river flow regimes across Canterbury, New Zealand. *Water Resources Management*, 37, 2657–2674. <https://link.springer.com/article/10.1007/s11269-022-03233-x>

Booth JD. (2020). Reviewing the far-reaching ecological impacts of human-induced terrigenous sedimentation on shallow marine ecosystems in a northern-New Zealand embayment. *New Zealand Journal of Marine and Freshwater Research*, 54(4), 593–613. <https://doi.org/10.1080/00288330.2020.1738505>

- Borkin KM, O'Donnell C, & Parsons S. (2011).** Bat colony size reduction coincides with clear-fell harvest operations and high rates of roost loss in plantation forest. *Biodiversity and Conservation*, 20(14), 3537–3548. <https://doi.org/10.1007/s10531-011-0144-7>
- Boucher O, Randall D, Artaxo P, Bretherton C, Feingold G, Forster P, ... & Zhang XY. (2013).** Clouds and aerosols. In *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp 571–657). Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter07_FINAL-1.pdf
- BPAC (Best Practice Advocacy Centre New Zealand). (2020).** *Consider Blue-green Algal Blooms This Summer: Identifying and Managing Suspected Cyanotoxin Poisoning in Primary Care.* <https://bpac.org.nz/2020/docs/cyanobacteria.pdf>
- Bradshaw CJA, Giam X, & Sodhi NS. (2010).** Evaluating the relative environmental impact of countries. *PLoS ONE*, 5(5). <https://doi.org/10.1371/journal.pone.0010440>
- Brahney J, Ballantyne AP, Vandergoes M, Baisden T, & Neff JC. (2019).** Increased dust deposition in New Zealand related to twentieth century Australian land use. *Journal of Geophysical Research: Biogeosciences*, 124(5), 1181–1193. <https://doi.org/10.1029/2018JG004627>
- Brandt AJ, Bellingham PJ, Duncan RP, Etherington TR, Fridley JD, Howell CJ, ... & Peltzer DA. (2020).** Naturalised plants transform the composition and function of the New Zealand flora. *Biological Invasions*, 23(2), 351–366. <https://doi.org/10.1007/s10530-020-02393-4>
- Bridson JH, Masterton H, Knight B, Paris CF, Abbel R, Northcott GL, & Gaw S. (2024).** Quantification of additives in beached plastic debris from Aotearoa New Zealand. *Science of the Total Environment*, 949, 175251. <https://doi.org/10.1016/j.scitotenv.2024.175251>
- Brierley G, Fuller I, Williams G, Hikuroa D, & Tilley A. (2022).** Re-Imagining Wild Rivers in Aotearoa New Zealand. *Land*, 11(8), 1272. <https://doi.org/10.3390/land11081272>
- Brierley GJ, Hikuroa D, Fuller IC, Tunnicliffe J, Allen K, Brasington J, ... & Measures R. (2023).** Reanimating the strangled rivers of Aotearoa New Zealand. *Wiley Interdisciplinary Reviews: Water*, 10(2), e1624. <https://doi.org/10.1002/wat2.1624>
- Brockerhoff EG, Barbaro L, Castagneyrol B, Forrester DI, Gardiner B, González-Olabarria JR, ... & Jactel, H. (2017).** Forest biodiversity, ecosystem functioning and the provision of ecosystem services. *Biodiversity and Conservation*, 26(13), 3005–3035. <https://doi.org/10.1007/s10531-017-1453-2>
- Brownstein G, & Monks A. (2024).** Adjacent land-use intensification facilitates plant invasions into indigenous shrubland fragments. *New Zealand Journal of Ecology*, 48(1), 3569. <https://doi.org/10.20417/nzj ecol.48.3569>
- Buckley TR, Boyer S, Bartlam S, Hitchmough R, Rolfe JR, & Stringer I. (2015).** *Conservation status of New Zealand earthworms, 2014.* Department of Conservation. <https://www.doc.govt.nz/Documents/science-and-technical/nztcs10entire.pdf>
- Buckley TR, Hitchmough R, Rolfe JR, & Stringer I. (2016).** *Conservation status of New Zealand stick insects, 2014.* Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs15-entire.pdf>
- Burdon FJ, McIntosh AR, & Harding JS. (2013).** Habitat loss drives threshold response of benthic invertebrate communities to deposited sediment in agricultural streams. *Ecological Applications*, 23(5), 1036–1047. <https://doi.org/10.1890/12-1190.1>
- Burge OR, Price R, Wilmshurst JM, Blyth JM, & Robertson HA. (2023).** LiDAR reveals drains risks to wetlands have been under-estimated. *New Zealand Journal of Ecology*, 47(1), 3523. <https://doi.org/10.20417/nzj ecol.47.3523>
- Burge OR, Law R, & Wakefield S. (2025).** A spatial layer of human terrestrial pressures for New Zealand. *New Zealand Journal of Ecology*, 49(1), 3580. <https://doi.org/10.20417/nzj ecol.49.3580>

- Burkett M. (2011).** *In Search of Refuge: Pacific Islands, Climate-induced Migration, and the Legal Frontier Analysis from the East-West Center.* <https://www.eastwestcenter.org/publications/search-refuge-pacific-islands-climate-induced-migration-and-legal-frontier>
- Burns RJ, Armstrong DP, Bell BD, Haigh A, Germano J, Rawlence NJ, Thurley T, Hitchmough, RA, Makan T, & Michel P. (2025).** *Conservation status of amphibians in Aotearoa New Zealand, 2024.* <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs44entire.pdf>
- Buxton RT, Currey CA, Lyver POB, & Jones CJ. (2013).** Incidence of plastic fragments among burrow-nesting seabird colonies on offshore islands in northern New Zealand. *Marine Pollution Bulletin*, 74(1), 420–424. <https://doi.org/10.1016/j.marpolbul.2013.07.011>
- Cai W, Ng B, Geng T, Jia F, Wu L, Wang G, ... & McPhaden MJ. (2023).** Anthropogenic impacts on twentieth-century ENSO variability changes. *Nature Reviews Earth & Environment*, 4(6), 407–418. <https://doi.org/10.1038/s43017-023-00427-8>
- Campbell JR. (2010).** Climate-induced community relocation in the Pacific: The meaning and importance of land. In J McAdam (Ed), *Climate Change and Displacement: Multidisciplinary Perspectives* (pp 57–80). London: Bloomsbury Publishing.
- Cañedo-Argüelles M, Kefford BJ, Piscart C, Prat N, Schäfer RB, & Schulz CJ. (2013).** Salinisation of rivers: An urgent ecological issue. *Environmental Pollution*, 173, 157–167. <https://doi.org/10.1016/j.envpol.2012.10.011>
- Caradus JR. (2023).** Intended and unintended consequences of genetically modified crops: Myth, fact and/or manageable outcomes? *New Zealand Journal of Agricultural Research*, 66(6), 519–619. <https://doi.org/10.1080/00288233.2022.2141273>
- Carver RE, & Tweed FS. (2021).** Cover the ice or ski on grass? The dilemmas facing ski tourism in a deglaciating world. *Geography*, 106(3), 116–127. <https://doi.org/10.1080/00167487.2021.1970926>
- Case B, Hall D, Day N, Hermans S, & Buckley H. (2023).** What is the role of biodiversity in mediating the effects of climate change on New Zealand’s future agroecosystems? *New Zealand Economic Papers*, 57(2), 139–143. <https://doi.org/10.1080/00779954.2023.2191613>
- Chand SS, Walsh KJE, Camargo SJ, Kossin JP, Tory KJ, Wehner MF, ... & Murakami H. (2022).** Declining tropical cyclone frequency under global warming. *Nature Climate Change*, 12, 655–661. <https://doi.org/10.1038/s41558-022-01388-4>
- Chapman RB. (2010).** *A Review of Insecticide Use on Pastures and Forage Crops in New Zealand.* Christchurch: AgResearch. <https://environment.govt.nz/assets/publications/river-water-quality-state-and-trends.pdf>
- Chapman DF, Mackay AD, Caradus JR, Clark DA, & Goldson SL. (2024).** Pasture productivity in New Zealand 1990–2020: Trends, expectations, and key factors. *New Zealand Journal of Agricultural Research*. <https://doi.org/10.1080/00288233.2024.2425071>
- Charlson F, Ali S, Benmarhnia T, Pearl M, Massazza A, Augustinavicius J, & Scott JG. (2021).** Climate change and mental health: A scoping review. *Public Health*, 18, 4486. <https://pubmed.ncbi.nlm.nih.gov/33922573/>
- Chaseling GK, Morris NB, & Ravanelli N. (2023).** Extreme heat and adverse cardiovascular outcomes in Australia and New Zealand: What do we know? *Heart Lung and Circulation*, 32(1), 43–51. <https://doi.org/10.1016/j.hlc.2022.10.010>
- Cheriyian D, & Choi J-H. (2020).** A review of research on particulate matter pollution in the construction industry. *Journal of Cleaner Production*, 254, 120077. <https://doi.org/10.1016/j.jclepro.2020.120077>
- Ciais P, Chris S, Govindasamy B, Bopp L, Brovkin V, Canadell J, ... & Heimann M. (2013).** Carbon and other biogeochemical cycles. In Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (pp 465–570). <https://www.ipcc.ch/report/ar5/wg1/>

- Cieraad E, & Farnworth B. (2023).** Lighting trends reveal state of the dark sky cloak: Light at night and its ecological impacts in Aotearoa New Zealand. *New Zealand Journal of Ecology*, 47(1).
<https://doi.org/10.20417/nzjecol.47.3559>
- Clapcott J, Casanovas P, & Doebling K. (2019).** *Indicators of freshwater quality based on deposited sediment and rapid habitat assessment*. Cawthron Institute, Report No. 3402.
- Clapcott JE, Young RG, Harding JS, Matthaei CD, Quinn JM, & Death RG. (2011).** *Sediment assessment methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values*. Nelson, New Zealand, Cawthron Institute.
- Clark BL, Carneiro AP, Pearmain EJ, Rouyer MM, Clay TA, Cowger W, ... & Quillfeldt P. (2023).** Global assessment of marine plastic exposure risk for oceanic birds. *Nature Communications*, 14(1), 3665.
<https://doi.org/10.1038/s41467-023-38900-z>
- Clark MR, Bowden DA, Rowden AA, & Stewart R. (2019).** Little evidence of benthic community resilience to bottom trawling on seamounts after 15 years. *Frontiers in Marine Science*, 6(63), 1–16.
<https://doi.org/10.3389/fmars.2019.00063>
- Clark MR, Bowden DA, Stewart R, Rowden AA, & Goode SL. (2022a).** *Seamount recovery: Analysis of 20 years of Time-series Data from the Graveyard Knolls, Chatham Rise, New Zealand*. New Zealand Aquatic Environment and Biodiversity Report No. 292. 25 p.
<https://docs.niwa.co.nz/library/public/NZAEBR-292.pdf>
- Clark MR, Wood B, Macka K, Anderson OF, Hart A, Rickard G, & Rowden AA. (2022b).** *Underwater Topographic Features in the New Zealand Region: Development of an updated 'SEAMOUNT' database and information on the extent and intensity of deep-sea trawl fisheries on them*. New Zealand Aquatic Environment and Biodiversity Report No. 291. 28 p. <https://docs.niwa.co.nz/library/public/NZAEBR-291.pdf>
- Clarkson B, Ausseil A, & Gerbeaux P. (2013).** Wetland ecosystem services. In JR Dymond (Ed), *Ecosystem Services in New Zealand: Conditions and Trends* (pp 192–202). Manaaki Whenua Press.
<https://climateandnature.org.nz/wp-content/uploads/2021/06/Wetland-Ecosystem-Services-2013.pdf>
- Clarkson BD. (2022).** Reversing biodiversity decline in Aotearoa New Zealand. *Policy Quarterly*, 18(2), 61–70. <https://doi.org/10.26686/pq.v18i2.7576>
- Clere IK, Ahmmed F, Peter III JG, Fraser-Miller SJ, Gordon KC, Komyakova V, & Allan BJ. (2022).** Quantification and characterization of microplastics in commercial fish from southern New Zealand. *Marine Pollution Bulletin*, 184, 114121. <https://doi.org/10.1016/j.marpolbul.2022.114121>
- Climate Commission. (2021).** Chapter 7: Reducing emissions from agriculture. *Ināia tonu nei: Supporting evidence – Part 2: Sectoral challenges and opportunities*.
<https://www.climatecommission.govt.nz/public/Evidence-21/Evidence-CH-7-reducing-emissions-agriculture.pdf>
- Close M, & Banasiak L. (2023a).** *National Survey of Pesticides in Groundwater 2022*. ESR, Client Report no. CSC23010.
- Close M, & Banasiak L. (2023b).** *National Survey of Per- and Polyfluoroalkyl Substances in Groundwater 2022*. ESR, Client Report no. CSC23006. <https://www.esr.cri.nz/digital-library/national-survey-of-per-and-polyfluoroalkyl-substances-pfas-in-groundwater-2022/>
- Close ME, Humphries B, & Northcott G. (2021).** Outcomes of the first combined national survey of pesticides and emerging organic contaminants (EOCs) in groundwater in New Zealand 2018. *Science of the Total Environment*, 754, 142005. <https://doi.org/10.1016/j.scitotenv.2020.142005>
- Clothier B, Hall A, & Green S. (2012).** Chapter 6: Horticulture: Adapting the horticultural and vegetable industries to climate change. In AJ Clark, RAC Nottage, L Wilcocks, JM Lee, C Burke, E Kalaugher, ... B Cowie (Eds), *Impacts of Climate Change on Land-based Sectors and Adaptation Options*. Ministry for Primary Industries. <https://www.mpi.govt.nz/dmsdocument/26788/sitemap>

- Clough P. (2013).** The value of ecosystem services for recreation. In JR Dymond (Ed), *Ecosystem Services in New Zealand: Conditions and Trends* (pp 330–342). Manaaki Whenua Press.
https://www.landcareresearch.co.nz/_data/assets/pdf_file/0019/77050/2_4_Clough.pdf
- Collier K, Clearwater S, Harmsworth G, Taura Y, & Reihana K. (2017).** *Physical and Chemical Attributes Affecting Survival and Collection of Freshwater Mahinga Kai Species*. Environmental Research Institute report no. 106. https://webstatic.niwa.co.nz/library/ERI_106.pdf
- Collins D, Zammit C, Willsman A, & Henderson R. (2015).** *Surface Water Components of New Zealand's National Water Accounts, 1995–2014*. NIWA, Client Report no. CHC2015-013-v2.
- Craig H, Wild A, & Paulik R. (2023).** Dairy farming exposure and impacts from coastal flooding and sea level rise in Aotearoa-New Zealand. *International Journal of Disaster Risk Reduction*, 98.
<https://doi.org/10.1016/j.ijdr.2023.104079>
- Cummings VJ, Lundquist CJ, Dunn MR, Francis M, Horn P, Law C, ... & Mielbrecht E. (2021).** *Assessment of Potential Effects of Climate-related Changes in Coastal and Offshore Waters on New Zealand's Seafood Sector*. New Zealand Aquatic Environment and Biodiversity Report No. 261.
<https://www.cakex.org/sites/default/files/documents/45265-AEBR-261-Assessment-Of-Potential-Effects-Of-Climate-Change-On-Seafood-Sector-3389.pdf>
- Curran-Cournane F, & Rush E. (2021).** Feeding the New Zealand family of five million, 5+ a day of vegetables? *Earth*, 2(4), 797–808. <https://doi.org/10.3390/EARTH2040047>
- Curran-Cournane F, Carrick S, Barnes MG, Ausseil A-G, Drewry JJ, Bain IA, ... & Morell L. (2021a).** Cumulative effects of fragmentation and development on highly productive land in New Zealand. *New Zealand Journal of Agricultural Research*, 66(1), 1–24. <https://doi.org/10.1080/00288233.2021.1918185>
- Curran-Cournane F, Donovan M, Merfield C, & Taitoko M. (2021b).** *Place-based Approach to Assessing the Impact of Regenerative Agriculture in New Zealand*. <https://ourlandandwater.nz/outputs/place-based-approaches-to-assessing-the-impact-of-regenerative-agriculture-in-nz/>
- Curran-Cournane F, Golubiewski N, & Buckthought L. (2018).** The odds appear stacked against versatile land: Can we change them? *New Zealand Journal of Agricultural Research*, 61(3), 315–326.
<https://doi.org/10.1080/00288233.2018.1430590>
- D'Amato G, Annesi-Maesano I, Urrutia-Pereira M, del Giacco S, Rosario Filho NA, Chong-Neto HJ, ... & D'Amato M. (2021).** Thunderstorm allergy and asthma: State of the art. *Multidisciplinary Respiratory Medicine*, 16(1), 806. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8672486/>
- Damialis A, Smith M, & Galán C. (2021).** Editorial: Climate change and aeroallergens. *Frontiers in Allergy*, 2, 794430. <https://doi.org/10.3389/falgy.2021.794430>
- Dasgupta P. (2021).** *Economics of Biodiversity: The Dasgupta Review: Headline Messages*. https://assets.publishing.service.gov.uk/media/60182857d3bf7f70c2afe5bb/Dasgupta_Review_-_Headline_Messages.pdf
- Davis JP, & Hepburn CD. (2020).** *Southland Regional Marine Invasive Species Surveillance and Compliance Plan*. Department of Marine Science, University of Otago. Prepared for Environment Southland. <https://www.envirolink.govt.nz/assets/Envirolink/2027-ESRC292-Southland-Regional-Marine-Invasive-Species-Surveillance-and-Compliance-Plan.pdf>
- Davis S, Chen G, & Darvill N. (2023).** Housing and food production: Resident and grower perceptions of peri-urban food-production landscapes. *Land*, 12(12), 2091. <https://doi.org/10.3390/land12122091>
- Davy PK, Trompetter WJ, Revell LE, & Hardacre C. (2024).** *Evaluation of New Zealand's Background Particulate Matter Sources*. GNS Science Consultancy Report 2024/53. GNS CR 2024/53.
<https://environment.govt.nz/assets/publications/Environmental-Reporting/Evaluation-of-New-Zealands-background-particulate-matter-sources.pdf>
- De Bhowmick G, Sarmah AK, Dubey B. (2021).** Microplastics in the NZ environment: Current status and future directions. *Case Studies in Chemical and Environmental Engineering*, 3, 100076.
<https://doi.org/10.1016/j.csee.2020.100076>

- Deep South. (2021).** *National Hydrological and Water Resource Impacts of Climate Change. Compilation of Outputs.* <https://deepsouthchallenge.co.nz/wp-content/uploads/2022/03/Deep-South-Hydro-Phase-One-output-compilation-Nov2021.pdf>
- de Lange, PJ, Gosden J, Courtney SP, Fergus AJ, Barkla JW, Beadel SM, ... & Michel P. (2024).** *Conservation status of vascular plants in Aotearoa New Zealand, 2023.* <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs43entire.pdf>
- Deloitte. (2018).** *New Zealand's Food Story: The Pukekohe Hub.* <https://www.hortnz.co.nz/assets/Environment/National-Env-Policy/JR-Reference-Documents/Deloitte-Pukekohe-Food-Story-Final-Report.pdf>
- Deloitte. (2023).** *Economic uncertainty puts pressure on sustainable behavior change.* <https://www2.deloitte.com/us/en/insights/environmental-social-governance/sustainable-consumer-behaviors.html>
- Devane ML, Weaver L, Singh SK, & Gilpin BJ. (2018).** Fecal source tracking methods to elucidate critical sources of pathogens and contaminant microbial transport through New Zealand agricultural watersheds: A review. *Journal of Environmental Management*, 222, 293–303. <https://doi.org/10.1016/j.jenvman.2018.05.033>
- Diprose G, Kannemeyer R, Edwards P, & Greenaway A. (2022).** Participatory biosecurity practices: Myrtle rust an unwanted pathogen in Aotearoa New Zealand. *New Zealand Geographer*, 78(3), 175–185. <https://doi.org/10.1111/nzg.12347>
- DOC (Department of Conservation). (nd-a).** *Gold Clams.* <https://www.doc.govt.nz/nature/pests-and-threats/freshwater-pests/gold-clams/>
- DOC (Department of Conservation). (nd-b).** *Freshwater Pests.* <https://www.doc.govt.nz/nature/pests-and-threats/freshwater-pests/>
- DOC (Department of Conservation). (2011).** *Attitudes to Conservation.* <https://www.doc.govt.nz/globalassets/documents/about-doc/role/visitor-research/attitudes-to-conservation.pdf>
- DOC (Department of Conservation). (2020).** *Biodiversity in Aotearoa: An Overview of State, Trends and Pressures.* <https://www.doc.govt.nz/globalassets/documents/conservation/biodiversity/anzbs-2020-biodiversity-report.pdf>
- DOC (Department of Conservation). (2021a).** *Domestic customer segmentation research: New Zealanders engaging with the environment, biodiversity and conservation.* <https://www.doc.govt.nz/globalassets/documents/about-doc/role/visitor-research/nzers-and-the-environment.pdf>
- DOC (Department of Conservation). (2021b).** *Queen Charlotte Track Fully Reopens.* <https://www.doc.govt.nz/news/media-releases/2021-media-releases/queen-charlotte-track-fully-reopens/>
- DOC (Department of Conservation). (2023).** *Long-term Insights Briefing.* Technologies and data that can transform how we monitor and protect biodiversity. <https://www.doc.govt.nz/globalassets/documents/about-doc/long-term-insights-briefings/2023/ltib2023-doc-linz.pdf#page=19.11>
- DOC (Department of Conservation). (2024a).** *Hector's and Māui Dolphin Incident Database.* <https://www.doc.govt.nz/our-work/hectors-and-maui-dolphin-incident-database/>
- DOC (Department of Conservation). (2024b).** *Understanding summer activity. Making sense of what people did in the outdoors over the 2023.24 summer.* <https://www.doc.govt.nz/globalassets/documents/about-doc/role/visitor-research/understanding-2023-2024-summer-activity.pdf>
- DOC (Department of Conservation). (2024c).** *Ōkura Bush Walkway.* <https://www.doc.govt.nz/parks-and-recreation/places-to-go/auckland/places/okura-bush-scenic-reserve/tracks/okura-bush-walkway/>

- Donovan M. (2022).** Modelling soil loss from surface erosion at high-resolution to better understand sources and drivers across land uses and catchments: A national-scale assessment of Aotearoa, New Zealand. *Environmental Modelling and Software*, 147, 105228.
<https://doi.org/10.1016/j.envsoft.2021.105228>
- Douglas EJ, Bulmer RH, MacDonald IT, & Lohrer AM. (2022).** Estuaries as coastal reactors: Importance of shallow seafloor habitats for primary productivity and nutrient transformation, and impacts of sea level rise. *New Zealand Journal of Marine and Freshwater Research*, 56(3), 553–569.
<http://dx.doi.org/10.1080/00288330.2022.2107027>
- DPMC (Department of the Prime Minister and Cabinet Office of the Prime Minister Chief Science Advisor). (2024).** *Water-borne illnesses in Aotearoa New Zealand – past, present, future.*
<https://dpmc.govt.nz/our-programmes/special-programmes/prime-ministers-chief-science-advisor-archives/archive/gerrard-2021-2024>
- Driver T, Guenther M, & Saunders C. (2023).** *The Matrix of Drivers: 2023 Update.* Prepared for Our Land and Water National Science Challenge by Agribusiness & Economics Research Unit, Lincoln University.
https://agresearch.figshare.com/articles/report/The_Matrix_of_Drivers_2023_Update/26001613/1/file/s/46944658.pdf
- Dudley BD, Burge OR, Plew D, & Zeldis J. (2020).** Effects of agricultural and urban land cover on New Zealand’s estuarine water quality. *New Zealand Journal of Marine and Freshwater Research*, 54(3), 372–392. <https://doi.org/10.1080/00288330.2020.1729819>
- Dunn MR, Finucci B, Sutton P, & Pinkerton MH. (2022).** *Review of Commercial Fishing Interactions with Marine Reptiles.* National Institute of Water & Atmospheric research report 2022147WN, prepared for the Department of Conservation.
<https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/marine-conservation-services/reports/202122-annual-plan/int2021-03-review-of-commercial-fishing-interactions-with-marine-reptiles-final-report.pdf>
- Dymond JR, Sabetizade M, Newsome PF, Harmsworth GR, & Ausseil A-G. (2021).** Revised extent of wetlands in New Zealand. *New Zealand Journal of Ecology*, 45(2), 1–8.
<https://www.jstor.org/stable/48621882>
- Edwards P, Stahlmann-Brown P, & Thomas S. (2020).** Pernicious pests and public perceptions: Wilding conifers in Aotearoa New Zealand. *Land Use Policy*, 97, 104759.
<https://doi.org/10.1016/j.landusepol.2020.104759>
- EECA. (nd).** *Hydro.* <https://www.eeca.govt.nz/insights/energy-in-new-zealand/renewable-energy/hydroelectricity/>
- EECA. (2025).** *A deep dive into how New Zealand businesses approach energy use and climate change.*
<https://www.eeca.govt.nz/insights/eeca-insights/a-deep-dive-into-how-new-zealand-businesses-approach-energy-use-and-climate-change/>
- Egan E, Woolley JM, & Williams E. (2020).** *Assessing the Vulnerability of Taonga Freshwater Species to Climate Change.* <https://niwa.co.nz/te-kuwaha/ccva>
- EHINZ (Environmental Health Intelligence New Zealand). (nd-a).** *Population Size and Change.*
<https://www.ehinz.ac.nz/indicators/population-vulnerability/population-size-and-change/#population-size-and-change-can-affect-environmental-health>
- EHINZ (Environmental Health Intelligence New Zealand). (nd-b).** *About Air Quality and Health.*
<https://ehinz.ac.nz/indicators/air-quality/air-qual/>
- EHINZ (Environmental Health Intelligence New Zealand). (2020).** *Main Types of Heating Used to Heat Dwellings.* https://www.ehinz.ac.nz/assets/Surveillance-reports/Released_2020/19446-Types-of-Heating-FA2.pdf
- EHINZ (Environmental Health Intelligence New Zealand). (2022).** *Monitoring the Health Effects of Climate Change.* <https://www.ehinz.ac.nz/indicators/climate-change/climate-change-is-a-health-issue/>

- EHINZ (Environmental Health Intelligence New Zealand). (2023).** *Number of Motor Vehicles*. https://www.ehinz.ac.nz/assets/Factsheets/Released_2023/2023_FS_NumberOfVehicles.pdf
- EHINZ (Environmental Health Intelligence New Zealand). (2024a).** *Potentially Waterborne Disease Notification Rates*. https://ehinz.ac.nz/assets/Surveillance-reports/Released_2024/Notifications-of-potentially-waterborne-diseases.pdf
- EHINZ (Environmental Health Intelligence New Zealand). (2024b).** *Social vulnerability to the impacts of climate-related hazards in Aotearoa New Zealand*. Wellington: Environmental Health Intelligence New Zealand, Massey University. https://www.climatecommission.govt.nz/public/Monitoring-and-reporting/NAPPA-2024/3.a-EHINZ_Social-vulnerability-to-the-impacts-of-climate-related-hazards.pdf
- Ekanayake JC, & Hedley CB. (2018).** Advances in information provision from wireless sensor networks for irrigated crops. *Wireless Sensor Network*, 10(4), 71–92. <https://doi.org/10.4236/wsn.2018.104004>
- Electricity Authority. (2023).** *The Impact of Our Climate on Hydro Generation*. <https://www.ea.govt.nz/news/eye-on-electricity/the-impact-of-our-climate-on-hydro-generation/>
- ESR (Institute of Environmental Science and Research). (nd).** *Notifiable disease dashboard*. <https://www.esr.cri.nz/digital-library/notifiable-disease-dashboard/>
- ESR (Institute of Environmental Science and Research). (2023).** *Air Pollution: Health Risk Assessment Mount Maunganui*. <https://www.esr.cri.nz/digital-library/environmental-health-report-air-pollution-health-risk-assessment-mount-maunganui/>
- ESR (Institute of Environmental Science and Research). (2024).** *Microplastics in Aotearoa New Zealand: Local Sources and Broad Impacts*. <https://www.esr.cri.nz/news-publications/microplastics-in-aotearoa-new-zealand-local-sources-and-broad-impacts/>
- Etherington TR, Peltzer DA, & Wyse SV. (2022).** Future climates are predicted to alter the potential distributions of non-native conifer species in New Zealand. *New Zealand Journal of Ecology*, 46(1), 3473. <https://doi.org/10.20417/nzj ecol.46.14>
- Falcón J, Torriglia A, Attia D, Viénot F, Gronfier C, Behar-Cohen F, ... & Hicks D. (2020).** Exposure to artificial light at night and the consequences for flora, fauna, and ecosystems. *Frontiers in Neuroscience*, 14. <https://doi.org/10.3389/fnins.2020.602796>
- Fan W, Salmond JA, Dirks KN, Cabedo Sanz P, Miskelly GM, & Rindelaub JD. (2022).** Evidence and mass quantification of atmospheric microplastics in a coastal New Zealand city. *Environmental Science and Technology*, 56(24), 17556–17568. <https://doi.org/10.1021/acs.est.2c05850>
- FAO. (nd).** *Conceptual framework. Inclusive and Sustainable Territories and Landscapes Platform*. <https://www.fao.org/in-action/territorios-inteligentes/componentes/innovacion-rural/contexto-general-y-marco-conceptual/fr/>
- FAO (Food and Agriculture Organisation of the United Nations). (2024).** *The State of the World's Forests 2024: Forest-sector Innovations towards a More Sustainable Future*. <https://doi.org/10.4060/cd1211en>
- Feng B, Zhang Y, & Bourke R. (2021).** Urbanization impacts on flood risks based on urban growth data and coupled flood models. *Natural Hazards*, 106(1), 613–627. <https://doi.org/10.1007/s11069-020-04480-0>
- Fenwick G, Greenwood M, Williams E, Milne J, & Watene-Rawiri E. (2018).** *Groundwater Ecosystems: Functions, Values, Impacts and Management*. NIWA Client Report 2018184CH prepared for Horizons Regional Council. <https://www.envirolink.govt.nz/assets/Envirolink/Reports/1838-HZLC143-Groundwater-Ecosystems-Functions-values-impacts-and-management.pdf>
- FENZ (Fire and Emergency New Zealand). (2021).** *2019/2020 Wildfire Season Update*. <https://www.fireandemergency.nz/assets/Documents/Research-and-reports/NZ-wildfire-2019-2020-season-update-report.pdf>

- FENZ (Fire and Emergency New Zealand). (2022).** *2020/2021 Wildfire Season Update*. <https://www.fireandemergency.nz/assets/Documents/Research-and-reports/NZ-Wildfire-2020-21-Season-update-Scion.pdf>
- FENZ (Fire and Emergency New Zealand). (2023).** *2021/2022 Wildfire Season Update*. https://www.fireandemergency.nz/assets/Documents/Research-and-reports/Wildfire-Annual-Summary-2021_2022.pdf
- Fernandez, M. A. (2017).** Adoption of erosion management practices in New Zealand. *Land Use Policy*, 63, 236–245. <https://doi.org/10.1016/j.landusepol.2017.01.040>
- Frame DJ, Rosier SM, Noy I, Harrington LJ, Carey-Smith T, Sparrow SN, ... & Dean SM. (2020).** Climate change attribution and the economic costs of extreme weather events: A study on damages from extreme rainfall and drought. *Climatic Change*, 162(2), 781–797. <https://doi.org/10.1007/s10584-020-02729-y>
- Franklin P, Gee E, Baker C, & Bowie S. (2018).** *New Zealand Fish Passage Guidelines: For structures up to 4 metres*. NIWA Client Report 2018019HN prepared for Ministry of Business, Innovation and Employment. https://www.researchgate.net/publication/324706703_New_Zealand_Fish_Passage_Guidelines_for_structures_up_to_4_metres
- Franklin PA, Sykes J, Robbins J, Booker DJ, Bowie S, Gee E, & Baker CF. (2022).** A national fish passage barrier inventory to support fish passage policy implementation and estimate river connectivity in New Zealand. *Ecological Informatics*, 71, 101831. <https://doi.org/10.1016/j.ecoinf.2022.101831>
- Friedlingstein P, O’Sullivan M, Jones MW, Andrew RM, Hauck J, Olsen A, ... & Zaehle S. (2020).** Global carbon budget 2020. *Earth System Science Data*, 12(4), 3269–3340. <https://doi.org/10.5194/essd-12-3269-2020>
- Fritze JC, Blashki GA, Burke S, & Wiseman J. (2008).** Hope, despair and transformation: Climate change and the promotion of mental health and wellbeing. *International Journal of Mental Health Systems*, 2(1), 1–10. <https://doi.org/10.1186/1752-4458-2-13/TABLES/1>
- Froude VA. (2011).** *Wilding Conifers in New Zealand: Beyond the Status Report*. <https://www.mpi.govt.nz/dmsdocument/51016-Wilding-conifers-in-New-Zealand-Beyond-the-status-report-December-2011>
- Fuller I, Richardson J, Basher L, Dykes R, & Vale S. (2011).** Responses to river management? Geomorphic change over decadal and annual timescales in two gravel-bed rivers in New Zealand. In DA Molina (Ed), *River Channels: Types, Dynamics and Changes* (pp 137–164). Nova Science Publishers.
- Funnell GA, Gordon DP, Leduc D, Makan T, Marshall B, Mills S, Michel P, Read G, Schnabel KE, Tracey DM, & Wing S. (2023).** *Conservation status of indigenous marine invertebrates in Aotearoa New Zealand, 2021*. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs40entire.pdf>
- Gall M, & Pinkerton M. (2024).** Phytoplankton/chlorophyll a in estuary/coastal water (trophic state). In: D Lohrer et al. *Information Stocktakes of Fifty-Five Environmental Attributes across Air, Soil, Terrestrial, Freshwater, Estuaries and Coastal Waters Domains*. Prepared by NIWA, Manaaki Whenua Landcare Research, Cawthron Institute, and Environet Limited for the Ministry for the Environment. NIWA report no. 2024216HN. <https://environment.govt.nz/publications/information-stocktakes-of-fifty-five-environmental-attributes>
- Galt M, & Nees C. (2022).** *New Zealand’s Wellbeing: Is It Sustainable and What Are the Risks?* Treasury paper. <https://www.treasury.govt.nz/publications/tp/new-zealands-wellbeing-sustainable-what-are-risks>
- Galvan A, Kawana K, & Harcourt N. (2024).** The health of cultural values and mahinga kai in the Te Wairoa-Höpūpū-Hōnengenenge-Mātangirau, Wairoa river catchment and the impacts of sediment. *Australasian Journal of Water Resources* 28(4), 1–20. <http://dx.doi.org/10.1080/13241583.2024.2403814>

- Gascon M, Zijlema W, Vert C, White MP, & Nieuwenhuijsen MJ. (2017).** Outdoor blue spaces, human health and well-being: A systematic review of quantitative studies. *International Journal of Hygiene and Environmental Health*, 220(8), 1207–1221. <https://doi.org/10.1016/j.ijheh.2017.08.004>
- Gee S. (2021).** *Abundant kina damaging reefs as fish numbers dwindle*. RNZ News. <https://www.rnz.co.nz/news/national/455110/abundant-kina-damaging-reefs-as-fish-numbers-dwindle>
- Gilpin BJ, Walker T, Paine S, Sherwood J, Mackereth G, Wood T, ... Jones N. (2020).** A large scale waterborne Campylobacteriosis outbreak, Havelock North, New Zealand. *Journal of Infection*, 81(3), 390–395. <https://doi.org/10.1016/j.jinf.2020.06.065>
- Gislason MK, Kennedy AM, & Witham SM. (2021).** The interplay between social and ecological determinants of mental health for children and youth in the climate crisis. *International Journal of Environmental Research and Public Health*, 18(9), 4573. <https://doi.org/10.3390/ijerph18094573>
- Giupponi C, Ausseil AG, Balbi S, Cian F, Fekete A, Gain AK, ... & Villa F. (2022).** Integrated modelling of social-ecological systems for climate change adaptation modelling. *Socio-Environmental Systems Modelling*, vol. 3, 18161. <https://doi.org/10.18174/sesmo.18161>
- Gkargkavouzi A, & Halkos G. (2024).** *Environmentalism in the light of Behavioral Economics*. Department of Economics, University of Thessaly. https://mpira.ub.uni-muenchen.de/120752/1/MPRA_paper_120752.pdf
- Glavinovic K, Eggleton K, Davis R, Gosman K, & Macmillan A. (2022).** Understanding and experience of climate change in rural general practice in Aotearoa—New Zealand. *Family Practice*, 40(3), 442–448. <https://doi.org/10.1093/fampra/cmab107>
- Goodman J. (2018).** *Conservation, ecology and management of migratory galaxiids and the whitebait fishery. A summary of current knowledge and information gaps*. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/conservation/land-and-freshwater/freshwater/conservation-ecology-and-management-of-migratory-galaxiids.pdf>
- Goyal R, Sen Gupta A, Jucker M, & England MH. (2021).** Historical and projected changes in the southern hemisphere surface westerlies. *Geophysical Research Letters*, 48(4), e2020GL090849. <https://doi.org/10.1029/2020GL090849>
- Grandey BS, Dauwels J, Koh ZY, Horton BP, & Chew LY. (2024).** Fusion of probabilistic projections of sea-level rise. *Earth's Future*, 12(12), e2024EF005295. <https://doi.org/10.1029/2024EF005295>
- Graynoth E, Jellyman D, & Bonnett M. (2008).** *Spawning escapement of female longfin eels*. New Zealand Fisheries Assessment Report 2008/7. 57 p. <https://docs.niwa.co.nz/library/public/FAR2008-07.pdf>
- Greenhalgh S, Samarasinghe O, Curran-Cournane F, Wright W, & Brown P. (2017).** Using ecosystem services to underpin cost–benefit analysis: Is it a way to protect finite soil resources? *Ecosystem Services*, 27, 1–14. <https://doi.org/10.1016/j.ecoser.2017.07.005>
- Griffin C, Wreford A, & Cradock-Henry NA. (2023).** ‘As a farmer you’ve just got to learn to cope’: Understanding dairy farmers’ perceptions of climate change and adaptation decisions in the lower South Island of Aotearoa-New Zealand. *Journal of Rural Studies*, 98, 147–158. <https://doi.org/10.1016/j.jrurstud.2023.02.001>
- Grout L, Hales S, Thornley L, & Wilson N. (2022).** *An Exploration of the Human Health Impacts Associated with Seven Decades of Severe Weather Events in Aotearoa New Zealand: The Need for Better Data*. University of Otago Wellington. https://www.otago.ac.nz/_data/assets/pdf_file/0027/332865/an-exploration-of-the-human-health-impacts-associated-with-seven-decades-of-severe-weather-events-in-aotearoa-new-zealand-the-need-for-better-data-report-841638.pdf
- Grout L, Hales S, Baker MG, French N, & Wilson N. (2024).** Severe weather events and cryptosporidiosis in Aotearoa New Zealand: A case series of space-time clusters. *Epidemiology and Infection*, 152, e64. <https://doi.org/10.1017/S095026882400058X>
- Haemata Limited. (2023).** *Māori perspectives on resilience in response to supply chain disruptions*. Te Kōmihana Whai Hua O Aotearoa | New Zealand Productivity Commission.

<https://www.treasury.govt.nz/sites/default/files/2024-05/pc-inq-ier-haemata-maori-perspectives-on-resilience-to-supply-chain-disruptions.pdf>

Hales S. (2019). Climate change, extreme rainfall events, drinking water and enteric disease. *Reviews on Environmental Health*, 34(1), 1–3. <https://doi.org/10.1515/reveh-2019-2001>

Hall M, Wehi P, Whaanga H, Walker E, Koia J, & Wallace K. (2021). Promoting social and environmental justice to support Indigenous partnerships in urban ecosystem restoration. *Restoration Ecology*, 29(1), e13305. <https://doi.org/10.1111/rec.13305>

Hamilton DS. (2015). Natural aerosols and climate: Understanding the unpolluted atmosphere to better understand the impacts of pollution. *Weather*, 70(9), 264–268. <https://doi.org/10.1002/wea.2540>

Harding J, Clapcott J, Quinn J, Hayes J, Joy M, Storey R, ... & Boothroyd I. (2009). *Stream Habitat Assessment Protocols for Wadeable Rivers and Streams of New Zealand*. School of Biological Sciences, University of Canterbury. <https://www.envirolink.govt.nz/assets/Envirolink/Stream20Habitat20Assessment20Protocols.pdf>

Harmsworth G. (2022a). *Exploring Indigenous Māori Soil Health Concepts in Aotearoa-New Zealand*.

Harmsworth, GR. (2022b). *Soil Security: An Indigenous Māori Perspective from Aotearoa-New Zealand*. <https://www.researchgate.net/publication/367381014>

Harmsworth GR, & Awatere S. (2013). Indigenous Māori knowledge and perspectives of ecosystems. In JR Dymond (Ed), *Ecosystem Services in New Zealand*. Manaaki Whenua Press. https://www.landcareresearch.co.nz/assets/Discover-Our-Research/Environment/Sustainable-society-policy/VMO/Indigenous_Maori_knowledge_perspectives_ecosystems.pdf

Harrington LJ, Dean SM, Awatere S, Rosier S, Queen L, & Gibson PB. (2023). *The role of climate change in extreme rainfall associated with Cyclone Gabrielle over Aotearoa New Zealand's East Coast*. Grantham Institute, Imperial College London, United Kingdom. <https://doi.org/10.25561/102624>

Hart G, Rutledge D, & Price R. (2013). *Guidelines for Monitoring Land Fragmentation: Review of Knowledge, Issues, Policies, and Monitoring*. Manaaki Whenua Landcare Research.

Hawcroft A, Bellingham PJ, Jo I, Richardson SJ, & Wright EF. (2024). Are populations of trees threatened by non-native herbivorous mammals more secure in New Zealand's national parks? *Biological Conservation*, 295. <https://doi.org/10.1016/j.biocon.2024.110637>

Health Navigator New Zealand. (2022). *Climate change anxiety | Anipā o te huringa āhuarangi*. <https://healthify.nz/health-a-z/c/climate-change-anxiety>

Heath ACG, Stringer I, Hitchmough R, & Rolfe JR. (2015). *Conservation status of New Zealand fleas*, 2014. Department of Conservation. <https://www.doc.govt.nz/Documents/science-and-technical/nztcs12entire.pdf>

Heath ACG, Rolfe JR, & Michel P. (2021). *Conservation status of parasitic mites and ticks (Acari) in New Zealand*, 2021. Department of Conservation. <https://dxcprod.doc.govt.nz/globalassets/documents/science-and-technical/nztcs37entire.pdf>

Heeringa V. (2021). Troubled waters: Nick Shears appears on TVNZ talking about kina barrens. *The Noises*. <https://www.thenoises.nz/2021/04/13/troubled-waters-nick-shears-appears-on-tvzn-talking-about-kina-barrens/>

Herse MR, Tylanakis JM, Scott NJ, Brown D, Cranwell I, Henry J, ... & Lyver POB. (2021). Effects of customary egg harvest regimes on hatching success of a culturally important waterfowl species. *People and Nature*, 3(2), 499–512. <https://doi.org/10.1002/pan3.10196>

Hewitt A, Dominati E, Webb T, & Cuthill T. (2015). Soil natural capital quantification by the stock adequacy method. *Geoderma*, 241–242, 107–114. <https://doi.org/10.1016/j.geoderma.2014.11.014>

Hicks DM, Baynes ERC, Measures R, Stecca G, Tunnicliffe J, & Friedrich H. (2021). Morphodynamic research challenges for braided river environments: Lessons from the iconic case of New Zealand. *Earth Surface Processes and Landforms*, 46(1), 188–204. <https://doi.org/10.1002/esp.5014>

- Hikuroa D. (2017).** Mātauranga Māori: The ūkaipō of knowledge in New Zealand. *Journal of the Royal Society of New Zealand*, 47(1), 5–10. <https://doi.org/10.1080/03036758.2016.1252407>
- Hikuroa D, Clark J, Olsen A, & Camp E. (2018).** Severed at the head: Towards revitalising the mauri of Te Awa o te Atua. *New Zealand Journal of Marine and Freshwater Research*, 52(4), 643–656. <https://doi.org/10.1080/00288330.2018.1532913>
- Hoare RJB, Dugdale JS, Edwards ED, Gibbs GW, Patrick B, Hitchmough R, & Rolfe JR. (2017).** *Conservation status of New Zealand butterflies and moths (Lepidoptera)*, 2015. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs20entire.pdf>
- Hobbie SE, & Grimm NB. (2020).** Nature-based approaches to managing climate change impacts in cities. *Phil. Trans. R. Soc. B*, 375(1794). <https://royalsocietypublishing.org/doi/full/10.1098/rstb.2019.0124>
- Hobbs M, Bowden N, Marek L, Wiki J, Kokaua J, Theodore R, ... & Milne, B. (2023).** The environment a young person grows up in is associated with their mental health: A nationwide geospatial study using the integrated data infrastructure, New Zealand. *Social Science and Medicine*, 326, 115893. <https://doi.org/10.1016/j.socscimed.2023.115893>
- Hond R, Ratima M, & Edwards W. (2019).** The role of Māori community gardens in health promotion: A land-based community development response by Tangata Whenua, people of their land. *Global Health Promotion*, 26(3_suppl), 44–53. <https://doi.org/10.1177/1757975919831603>
- Howarth L, & Major R. (2023).** *Key Environmental Considerations for Seaweed Aquaculture in Aotearoa New Zealand*. Sustainable Seas, Ko ngā moana whakauka. <https://www.sustainableseaschallenge.co.nz/assets/dms/Reports/Key-environmental-considerations-for-seaweed-aquaculture/Key-environmental-considerations-for-seaweed-aquaculture-in-Aotearoa-New-Zealand.pdf>
- HPA (Health Promotion Agency). (2020).** *Mental Health in Aotearoa: Results from the 2018 Mental Health Monitor and the 2019/19 New Zealand Health Survey*. https://www.hpa.org.nz/sites/default/files/Mental_Health_Aotearoa_Insight_2020.pdf
- Hudson M. (2022).** Māori hold a third of NZ's fishing interests, but as the ocean warms and fish migrate, these rights don't move with them. *The Conversation*. <https://theconversation.com/maori-hold-a-third-of-nzs-fishing-interests-but-as-the-ocean-warms-and-fish-migrate-these-rights-dont-move-with-them-186284>
- Huggins TJ, Langer L, McLennan J, Johnston DM, & Yang L. (2020).** The many-headed beast of wildfire risks in Aotearoa-New Zealand. *Australian Journal of Emergency Management*, 35(3), 48–53. <https://knowledge.aidr.org.au/resources/ajem-july-2020-the-many-headed-beast-of-wildfire-risks-in-aotearoa-new-zealand/>
- Hughes J, Cowper-Heays K, Olesson E, Bell R, & Stroomborgen A. (2021).** Impacts and implications of climate change on wastewater systems: A New Zealand perspective. *Climate Risk Management*, 31, 100262. <https://doi.org/10.1016/j.CRM.2020.100262>
- Hulme PE. (2020).** Plant invasions in New Zealand: Global lessons in prevention, eradication and control. *Biological Invasions*, 22(5), 1539–1562. <https://doi.org/10.1007/s10530-020-02224-6>
- ICNZ (Insurance Council of New Zealand). (2021).** *Cost of Natural Disasters*. <https://www.icnz.org.nz/industry/cost-of-natural-disasters/>
- IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). (2018).** *The IPBES Regional Assessment Report on Biodiversity and Ecosystem Services for Asia and the Pacific* (Vol. 612). https://files.ipbes.net/ipbes-web-prod-public-files/2018_asia_pacific_full_report_book_v3_pages.pdf
- IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). (2019).** *The global assessment report of the Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services*. <https://zenodo.org/records/6417333>

- IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). (2022).** *Methodological Assessment Report on the Diverse Values and Valuation of Nature of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* <https://doi.org/10.5281/zenodo.6522522>
- IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). (2024a).** *Summary for Policymakers of the Thematic Assessment Report on the Underlying Causes of Biodiversity Loss and the Determinants of Transformative Change and Options for Achieving the 2050 Vision for Biodiversity of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* <https://doi.org/10.5281/zenodo.11382230>
- IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). (2024b).** *Summary for Policymakers of the Thematic Assessment Report on the Interlinkages among Biodiversity, Water, Food and Health of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* <https://zenodo.org/records/13850290>
- IPCC (Intergovernmental Panel on Climate Change). (2021).** *Regional Fact Sheet: Urban Areas.* https://www.ipcc.ch/report/ar6/wg1/downloads/factsheets/IPCC_AR6_WGI_Regional_Fact_Sheet_Urban_areas.pdf
- IPCC (Intergovernmental Panel on Climate Change). (2022).** *Chapter 11: Australasia. Climate change 2022: Impacts, adaptation and vulnerability.* Working Group II contribution to the sixth assessment report of the Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/report/ar6/wg2/>
- IPCC (Intergovernmental Panel on Climate Change). (2023).** *Climate Change 2023: Synthesis Report.* Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Lee H and Romero J (Eds)]. IPCC, Geneva, Switzerland, 184 pp. <https://doi.org/10.1016/j.ijheh.2017.08.004https://doi.org/10.59327/IPCC/AR6-9789291691647>
- Jarvie S, Ingram T, Chapple DG, Hitchmough RA, Nielson SV, & Monks JM. (2022).** Variable vulnerability to climate change in New Zealand lizards. *Journal of Biogeography*, 49(2). <https://doi.org/10.1111/jbi.14314>
- Jiang LQ, Dunne J, Carter BR, Tjiputra JF, Terhaar J, Sharp JD, ... & Ziehn T. (2023).** Global surface ocean acidification indicators from 1750 to 2100. *Journal of Advances in Modeling Earth Systems*, 15(3), e2022MS003563. <https://doi.org/10.1029/2022MS003563>
- Johnson KS, Gadd J, Bian R, Noll B, Pinkerton MH, Taylor R, Madden B, & Parsons DM. (2024).** *Distribution and potential causes of milky fleshed snapper in SNA 1.* New Zealand Fisheries Assessment Report 2024/25. <https://www.mpi.govt.nz/dmsdocument/62775/direct>
- Jones AG, Cridge A, Fraser S, Holt L, Klinger S, McGregor KF, ... & Dickinson Y. (2023).** Transitional forestry in New Zealand: Re-evaluating the design and management of forest systems through the lens of forest purpose. *Biological Reviews*, 98(4), 1003–1015. <https://doi.org/10.1111/brv.12941>
- Jones HF, Hunt S, Kamke J, & Townsend M. (2022).** Historical data provides context for recent monitoring and demonstrates 100 years of declining estuarine health. *New Zealand Journal of Marine and Freshwater Research*, 56(3), 371–388. <https://doi.org/10.1080/00288330.2022.2086588>
- Jones R, Bennett H, Keating G, & Blaiklock A. (2014).** Climate change and the right to health for Māori in Aotearoa/New Zealand. *Health and Human Rights: An International Journal*, 16(1), 54–68. <https://www.hhrjournal.org/2014/07/01/climate-change-and-the-right-to-health-for-maori-in-aotearoanew-zealand/>
- Kamish W, Hansford J, & Cochrane P. (2020).** *Water availability under climate change.* Deep South National Science Challenge Final report. <https://deepsouthchallenge.co.nz/wp-content/uploads/2021/01/Water-availability-under-climate-change-Final-Report.pdf>
- Kāpiti Coast District Council. (2024).** *Avian Botulism.* <https://www.kapiticoast.govt.nz/environment/biodiversity/sustaining-and-restoring-our-environment/avian-botulism/>

- Keane-Tuala K. (2015).** *Ngā manu – birds*. <https://teara.govt.nz/en/nga-manu-birds/print>
- Keegan LJ, White RSA, & Macinnis-Ng C. (2022).** Current knowledge and potential impacts of climate change on New Zealand’s biological heritage. *New Zealand Journal of Ecology*, 46(1), 3467. <https://doi.org/10.20417/nzj ecol.46.10>
- Key IB, Smith AC, Turner B, Chausson A, Girardin CAJ, Macgillivray M, & Seddon N. (2022).** Biodiversity outcomes of nature-based solutions for climate change adaptation: Characterising the evidence base. *Frontiers in Environmental Science*, 10, 905767. <https://doi.org/10.3389/fenvs.2022.905767>
- King C. (1983).** The relationships between beech (*Nothofagus* sp) seedfall and populations of mice (*Mus musculus*), and the demographic and dietary response of stoats (*Mustela erminea*) in three New Zealand forests. *Journal of Animal Ecology*, 52, 141–166. <https://doi.org/10.2307/4593>
- King DN, Penny G, & Severne C. (2010).** *The climate change matrix facing Māori society*. https://www.researchgate.net/publication/273737386_The_climate_change_matrix_facing_Maori_society
- King DNT, Goff J, & Skipper A. (2007).** Māori environmental knowledge and natural hazards in Aotearoa-New Zealand. *Journal of the Royal Society of New Zealand*, 37(2), 59–73. <https://doi.org/10.1080/03014220709510536>
- King D, Tawhai W, & Iti W. (2005).** *Anticipating Local Weather and Climate Outcomes Using Māori Environmental Indicators*. NIWA Client Report AKL-2005-129.
- King J, Anchukaitis KJ, Allen K, Vance T, & Hessler A. (2023).** Trends and variability in the Southern Annular Mode over the Common Era. *Nature Communications*, 14(1), 2324. <https://doi.org/10.1038/s41467-023-37643-1>
- Kool R, Lawrence J, Drews M, & Bell R. (2020).** Preparing for sea-level rise through adaptive managed retreat of a New Zealand stormwater and wastewater network. *Infrastructures*, 5(92). <https://doi.org/10.3390/infrastructures5110092>
- Koot EM, Morgan-Richards M, & Trewick SA. (2022).** Climate change and alpine-adapted insects: Modelling environmental envelopes of a grasshopper radiation. *Royal Society Open Science*, 9(3), 211596. <https://doi.org/10.1098/rsos.211596>
- Kuczynski A, Smith RG, Fraser CE, & Larned ST. (2024).** Environmental indicators of lake ecosystem health in Aotearoa New Zealand: Current state and trends. *Ecological Indicators*, 165, 112185. <https://doi.org/10.1016/j.ecolind.2024.112185>
- Kunak. (2023).** *Air Pollution from Construction Sites, Analysing the Environmental Impact of Construction*. <https://kunakair.com/air-pollution-from-construction-sites/>
- Kuschel G, Metcalfe J, Sridhar S, Davy P, Hastings K, Denne T, ... & Bell S. (2022).** *Health and Air Pollution in New Zealand 2016 (HAPINZ 3.0): Volume 1: Findings and Implications*. <https://environment.govt.nz/assets/publications/HAPINZ/HAPINZ-3.0-Findings-and-implications.pdf>
- Lacheheb M, Noy I, & Kahui V. (2024).** Marine heatwaves and commercial fishing in New Zealand. *Science of the Total Environment*, 954, 176558. <https://doi.org/10.1016/j.scitotenv.2024.176558>
- Lai H, Hales S, Woodward A, Walker C, Marks E, Pillai A, ... & Morton SM. (2020).** Effects of heavy rainfall on waterborne disease hospitalizations among young children in wet and dry areas of New Zealand. *Environment International*, 145, 106136. <https://doi.org/10.1016/j.envint.2020.106136>
- Lai H, Lee JE, Harrington LJ, Ahuriri-Driscoll A, Newport C, Bolton A, ... & Hales S. (2024).** Daily temperatures and child hospital admissions in Aotearoa New Zealand: case time series analysis. *International journal of environmental research and public health*, 21(9), 1236. <https://doi.org/10.3390/ijerph21091236>
- Lambie SM, Awatere S, Daigneault A, Kirschbaum MUF, Marden M, Soliman T, ... & Walsh PJ. (2021).** Trade-offs between environmental and economic factors in conversion from exotic pine production to natural regeneration on erosion prone land. *New Zealand Journal of Forestry Science*, 51. <https://doi.org/10.33494/nzjfs512021x163x>

- Lane HS, Brosnahan CL, & Poulin R. (2022).** Aquatic disease in New Zealand: Synthesis and future directions. *New Zealand Journal of Marine and Freshwater Research*, 56(1), 1–42. <https://doi.org/10.1080/00288330.2020.1848887>
- Langer L, & Wegner S. (2018).** Wildfire risk awareness, perception and preparedness in the urban fringe in Aotearoa/New Zealand: Public responses to the 2017 Port Hills wildfire. *Australasian Journal of Disaster and Trauma Studies*, 22, 75–84. https://www.massey.ac.nz/~trauma/issues/2018-2/AJDTs_22_2_Langer.pdf
- Langer L, Wegner S, Pearce G, Melia N, Luff N, & Palmer D. (2021).** *Adapting and Mitigating Wildfire Risk due to Climate Change: Extending Knowledge and Best Practice*. Scion report for Ministry for Primary Industries. https://www.ruralfireresearch.co.nz/_data/assets/pdf_file/0003/80922/SLMACC-Contract-Final-report-submitted-to-MPI-linked.pdf
- Langer L, Wegner S, & Grant A. (2022).** Risk perception and preparedness in a high-wildfire risk community: Case study of northern Wānaka/Albert Town, Otago. *Scion Fire Technology Transfer Note* (Vol. 46). <https://resiliencechallenge.nz/outputs/risk-perception-and-preparedness-in-a-high-wildfire-risk-community-case-study-of-northern-wanaka-albert-town-otago/>
- Larned ST, Moores J, Gadd J, Baillie B, & Schallenberg M. (2020).** Evidence for the effects of land use on freshwater ecosystems in New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 54(3), 551–591. <https://doi.org/10.1080/00288330.2019.1695634>
- Law CS, Bell JJ, Bostock HC, Cornwall CE, Cummings VJ, Currie K, ... & Tracey DM. (2018).** Ocean acidification in New Zealand waters: Trends and impacts. *New Zealand Journal of Marine and Freshwater Research*, 52(2), 155–195. <https://doi.org/10.1080/00288330.2017.1374983>
- Law R, Whitehead B, Cavanagh J, Ardo J, Harmsworth G, & Harris L. (2024).** *Land Use Information System – Land Use Classification Framework*. Manaaki Whenua – Landcare Research contract report LC4488 for Ministry for the Environment. <https://environment.govt.nz/publications/land-use-information-system-land-use-classification-framework/>
- LAWA (Land Air Water Aotearoa). (2021).** *Factsheet: Faecal Indicators*. <https://www.lawa.org.nz/learn/factsheets/faecal-indicators/>
- LAWA (Land Air Water Aotearoa). (2022).** *Factsheet: Faecal Indicators*. <https://www.lawa.org.nz/learn/factsheets/faecal-indicators/>
- LAWA (Land Air Water Aotearoa). (2023a).** *Factsheet: Toxic Algae*. <https://www.lawa.org.nz/learn/factsheets/can-i-swim-here/toxic-algae>
- LAWA (Land Air Water Aotearoa). (2023b).** *Factsheet: Monitoring Air Quality in New Zealand*. <https://www.lawa.org.nz/learn/factsheets/air-quality-topic/air-pollutants-particulate-matter>
- Lawrence J, Blackett P, & Cradock-Henry NA. (2020).** Cascading climate change impacts and implications. *Climate Risk Management*, 29, 100234. <https://doi.org/10.1016/j.crm.2020.100234>
- Lawrence J, Mackey B, Chiew F, Costello MJ, Hennessy K, Lansbury N, ... & Wreford A. (2022).** *Australasia*. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H-O Pörtner, DC Roberts, M Tignor, ES Poloczanska, K Mintenbeck, A Alegría, ... B Rama (Eds.)]. *Cambridge University Press, Cambridge, UK and New York, NY, USA*, pp. 1581–1688, <https://doi.org/10.1017/9781009325844.013>
- Lee JE, Gorkowski K, Meyer AG, Benedict KB, Aiken AC, & Dubey MK. (2022).** Wildfire smoke demonstrates significant and predictable black carbon light absorption enhancements. *Geophysical Research Letters*, 49(14), e2022GL099334. <https://doi.org/10.1029/2022GL099334>
- Leonard M, & Eaton C. (2021).** *Recreational Water Quality Guidelines Update*. Environmental Science and Research Institute Client Report FWWF21029 for Ministry of Health. <https://www.esr.cri.nz/media/seap4u1y/recreational-water-quality-guidelines-update.pdf>

- Leschen RAB, Marris J,WM, Emberson RM, Nunn J, Hitchmough RA, & Stringer IAN. (2012).** The conservation status of New Zealand Coleoptera. *New Zealand Entomologist*, 35(2), 91–98. <https://doi.org/10.1080/00779962.2012.686311>
- Li G, Wan L, Cui M, Wu B, & Zhou J. (2019).** Influence of canopy interception and rainfall kinetic energy on soil erosion under forests. *Forests*, 10(6), 509. <https://doi.org/10.3390/f10060509>
- Li G, Chen Z, Bowen M, & Coco G. (2024).** Transport and retention of sinking microplastics in a well-mixed estuary. *Marine Pollution Bulletin*, 203, 116417. <https://doi.org/10.1016/j.marpolbul.2024.116417>
- Lilburne L, Ausseil A-G, Sood A, Guo J, Teixeira E, Vetharaniam I, ... & Dynes R. (2024).** Modelling to identify direct risks for New Zealand agriculture due to climate change. *Journal of the Royal Society of New Zealand*. <https://doi.org/10.1080/03036758.2024.2393295>
- Lindsey R. (2023).** *Climate Change: Global Sea Level*. NOAA Climate.gov. <https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level>
- Lindsey R, & Dahlman L. (2023).** *Climate Change: Ocean Heat Content*. NOAA Climate.gov. <https://www.climate.gov/news-features/understanding-climate/climate-change-ocean-heat-content#>
- Litter Intelligence. (nd).** *Data, Insights and Action for a Litter-free World*. <https://litterintelligence.org/>
- Lohrer D, Lam-Gordillo O, Hewitt J, Holmes S, & Dudley B. (2023).** *Exposure of Estuarine Sites to Freshwater Contaminants: Influences on Estuarine Macrofauna Time-series Data*. NIWA report no. 2023089HN (MFE22204).
- Lorrey AM, Vargo L, Purdie H, Anderson B, Cullen NJ, Sirguy P, ... & Chinn W. (2022).** Southern Alps equilibrium line altitudes: Four decades of observations show coherent glacier-climate responses and a rising snowline trend. *Journal of Glaciology*, 68(272), 1127–1140. <https://doi.org/10.1017/jog.2022.27>
- Lowe M, Morrison M, & Taylor R. (2015).** Harmful effects of sediment-induced turbidity on juvenile fish in estuaries. *Marine Ecology Progress Series*, 539, 241–254. <https://doi.org/10.3354/meps11496>
- Lundquist CJ, Brough T, Hume T, Rowden A, & Nelson W. (2024).** *Roadmap to an Updated Ecosystem Typology for the Marine and Estuarine Domain*. NIWA Client Report 2024230HN prepared for Ministry for the Environment.
- Lundquist CJ, Burgess-Jones T, Parkes SM., & Bulmer R. (2018).** Changes in benthic community structure and sediment characteristics after natural recolonisation of the seagrass *Zostera muelleri*. *Scientific Reports*, 8, 13250. <https://doi.org/10.1038/s41598-018-31398-2>
- Lundquist C, Cummings V, Hansen L, & Mielbrecht E. (2023).** *State of Knowledge: Climate Change and New Zealand's Seafood Sector*. <https://www.mpi.govt.nz/dmsdocument/56242-Climate-change-and-NZs-seafood-sector-2023>
- Lyver PO, Timoti P, Gormley AM, Jones CJ, Richardson SJ, Tahi BL., & Greenhalgh S. (2017a).** Key Māori values strengthen the mapping of forest ecosystem services. *Ecosystem Services*, 27, 92–102. <https://doi.org/10.1016/j.ecoser.2017.08.009>
- Lyver PO, Timoti P, Jones CJ, Richardson SJ, Tahi BL, & Greenhalgh S. (2017b).** An indigenous community-based monitoring system for assessing forest health in New Zealand. *Biodiversity and Conservation*, 26, 3183–3212. <https://doi.org/10.1007/s10531-016-1142-6>
- Lyver POB, Timoti P, Richardson SJ, & Gormley AM. (2021).** Alignment of ordinal and quantitative species abundance and size indices for the detection of shifting baseline syndrome. *Ecological Applications*, 31(4), 1–14. <https://doi.org/10.1002/eap.2301>
- Ma T, Moore J, & Cleary A. (2022).** Climate change impacts on the mental health and wellbeing of young people: A scoping review of risk and protective factors. *Social Science and Medicine*, 301, 114888. <https://doi.org/10.1016/j.socscimed.2022.114888>
- MacGibbon DJ, Mules R, & Goode S. (2024).** *Extent and Intensity of Bottom Contact by Commercial Trawling in New Zealand Waters, 1990–2022*. New Zealand Aquatic Environment and Biodiversity

Report No. 344. 80 p. <https://fs.fish.govt.nz/Doc/25805/AEBR-344-2024-Extent-and-intensity-of-bottom-contact-by-commercial-trawling-in-New-Zealand-waters-1990-2022.pdf.ashx>

Macinnis-Ng C, & Schwendenmann L. (2015). Litterfall, carbon and nitrogen cycling in a southern hemisphere conifer forest dominated by kauri (*Agathis australis*) during drought. *Plant Ecology*, 216(2), 247–262. <http://dx.doi.org/10.1007/s11258-014-0432-x>

Macintosh KA, McDowell RW, & Thiange CXO. (2025). A 10-year evaluation of management practices and nutrient losses from dairy farms in New Zealand – Trends and drivers. *Agriculture, Ecosystems and Environment*, 377. <https://doi.org/10.1016/j.agee.2024.109261>

Maddock I. (1999). The importance of physical habitat assessment for evaluating river health. *Freshwater Biology*, 41(2), 373–391. <https://doi.org/10.1046/j.1365-2427.1999.00437.x>

Maechler S, & Boisvert V. (2024). Valuing Nature to Save It? The Centrality of Valuation in the New Spirit of Conservation. *Global Environmental Politics*, 24(1), 10–30. https://doi.org/10.1162/glep_a_00734

Mahlfield K, Brook FJ, Roscoe DJ, Hitchmough RA, & Stringer IAN. (2012). The conservation status of New Zealand terrestrial Gastropoda excluding Powelliphanta. *New Zealand Entomologist*, 35(2), 103–109. <https://doi.org/10.1080/00779962.2012.686313>

Manderson A. (2020). *Scoping a National Land-use Intensity Indicator*. <https://environment.govt.nz/assets/Publications/Files/scoping-a-national-land-use-intensity-indicator.pdf>

Manktelow D, Stevens P, Walker J, Gurnsey S, Park N, Zabkiewicz, J, ... & Rahman A. (2005). *Trends in Pesticide Use in New Zealand: 2004*. HortResearch, Client Report no. 17962.

Marden M, & Seymour A. (2022). Effectiveness of vegetative mitigation strategies in the restoration of fluvial and fluvio-mass movement gully complexes over 60 years, East Coast region, North Island, New Zealand. *New Zealand Journal of Forestry Science*, 52. <https://doi.org/10.33494/nzjfs522022x226x>

Marden M, Rowan D, & Watson A. (2023). Effect of changes in forest water balance and inferred root reinforcement on landslide occurrence and sediment generation following *Pinus radiata* harvest on Tertiary terrain, eastern North Island, New Zealand. *New Zealand Journal of Forestry Science*, 53. <https://doi.org/10.33494/nzjfs532023x216x>

Marine Biosecurity Porthole. (nd). *Marine biosecurity in New Zealand*. <https://www.marinebiosecurity.org.nz/new-page-11/>

Mark G, Boulton A, Allport T, Kerridge D, & Potaka-Osborne G. (2022). “Ko au te whenua, ko te whenua ko au: I am the land, and the land is me”: Healer/patient views on the role of rongoā Māori (traditional Māori healing) in healing the land. *International Journal of Environmental Research and Public Health*, 19(14). <https://doi.org/10.3390/ijerph19148547>

Marques B, McIntosh J, & Hall C. (2023). Cross-cultural Rongoā healing: A landscape response to urban health. *Landscape Research*, 48(8), 1091–1107. <https://doi.org/10.1080/01426397.2023.2230909>

Marshall GR, Wyse SV, Manley BR, & Forbes AS. (2023). International use of exotic plantations for native forest restoration and implications for Aotearoa New Zealand. *New Zealand Journal of Ecology*, 47(1). <https://doi.org/10.20417/nzjecol.47.3516>

Mason K, Lindberg K, Haenfling C, Schori A, Marsters H, Read D, & Borman B. (2021). Social vulnerability indicators for flooding in Aotearoa New Zealand. *International Journal of Environmental Research and Public Health*, 18(8). <https://doi.org/10.3390/ijerph18083952>

Masters-Awatere B, Howard D, & Young P. (2023). Haumanu hauora: Refining public health institution policy to include Māori and climate change. *Climatic Change*, 176(5), 1–15. <https://doi.org/10.1007/S10584-023-03534-Z>

Mastrandrea MD, Field CB, Stocker TF, Edenhofer O, Ebi KL, Frame DJ, ... & Zwiers FW. (2010). *Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of*

Uncertainties. Intergovernmental Panel on Climate Change (IPCC).

<https://www.ipcc.ch/site/assets/uploads/2018/05/uncertainty-guidance-note.pdf>

Matamua R. (2017). *Matariki: The Star of the Year*. Huia Publishers.

Matthews N. (2023). *Huringa o te taiao: Tūhoe environmental and ecological changes through the lens of the Maramataka*. Doctoral dissertation, Te Herenga Waka Victoria University of Wellington.

https://openaccess.wgtn.ac.nz/articles/thesis/Huringa_o_te_taiiao_T_hoe_environmental_and_ecological_changes_through_the_lens_of_the_Maramataka/23579220

Mavoa S, Lucassen M, Denny S, Utter J, Clark T, & Smith M. (2019). Natural neighbourhood environments and the emotional health of urban New Zealand adolescents. *Landscape and Urban Planning*, 191. <https://doi.org/10.1016/j.landurbplan.2019.103638>

Mazlan NA, Lin L, & Park HE. (2022). Microplastics in the New Zealand environment. *Processes*, 10(2), 265. <https://doi.org/10.3390/pr10020265>

MBIE (Ministry of Business, Innovation and Employment). (2023). *Economic Context Briefing*.

<https://www.mbie.govt.nz/dmsdocument/28132-economic-context-briefing-november-2023>

McAlpine KG, & Howell CJ. (2024). *List of Environmental Weeds in New Zealand 2024*.

<https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc340.pdf>

McCormick R. (2017). Does access to green space impact the mental well-being of children: A systematic review. *Journal of Pediatric Nursing*, 37, 3–7. <https://doi.org/10.1016/j.pedn.2017.08.027>

McDonald VM, Archbold G, Beyene T, Brew BK, Franklin P, Gibson PG, ... & Abramson, MJ. (2023). Asthma and landscape fire smoke: A Thoracic Society of Australia and New Zealand position statement. *Respirology*, 28(11), 1023–1035. <https://doi.org/10.1111/resp.14593>

McDowall, RM. (2000). *The Reed Field Guide to New Zealand Freshwater Fishes*. Dunedin: Reed.

McDowell RW, Dodd R, Pletnyakov P, & Noble A. (2020). The ability to reduce soil legacy phosphorus at a country scale. *Frontiers in Environmental Science*, 8, 6. <https://doi.org/10.3389/fenvs.2020.00006>

McGovern H. (2024). *Conservation Services Programme Annual Research Summary*. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/marine-conservation-services/reports/202122-annual-plan/csp-annual-research-summary-2021-22.pdf>

McMillan A, Dymond J, Jolly B, Shepherd J, Sutherland A, & Belliss S. (2023). *Rapid Assessment of Land Damage – Cyclone Gabrielle*. Manaaki Whenua Landcare Research.

<https://environment.govt.nz/assets/Rapid-assessment-of-land-damage-Cyclone-Gabrielle-Manaaki-Whenua-Landcare-Research-report.pdf>

McNaughton EJ, Gaston KJ, Beggs J, Jones DN, & Stanley MC. (2022). Areas of ecological importance are exposed to risk from urban sky glow: Auckland, Aotearoa-New Zealand as a case study. *Urban Ecosystems*, 25(1), 273–284. <https://doi.org/10.1007/s11252-021-01149-9>

Mediodia HJ, Noy I, & Kahui V. (2024). The impact of ocean warming on selected commercial fisheries in New Zealand. *Australian Journal of Agricultural and Resource Economics*, 68(3), 587–607.

<https://doi.org/10.1111/1467-8489.12564>

Meeuwen-Dijkgraaf A. (2021). *Effects of Artificial Light on Urban Wildlife within the Lower Hutt District*. Photobiology Assessment.

https://hccpublicdocs.azurewebsites.net/api/download/d764466f20cf454ba1010adf695ed15f/_dplanreview/2cf3cfdb31922664af4a854197e3e360880

Melia N, Dean S, Pearce HG, Harrington L, Frame DJ, & Strand T. (2022). Aotearoa New Zealand's 21st-century wildfire climate. *Earth's Future*, 10(6), e2022EF002853. <https://doi.org/10.1029/2022EF002853>

Messier C, Bauhus J, Sousa-Silva R, Auge H, Baeten L, Barsoum N, ... & Zemp DC. (2022). For the sake of resilience and multifunctionality, let's diversify planted forests! *Conservation Letters*, 15(1).

<https://doi.org/10.1111/conl.12829>

- Metcalf J, & Kuschel G. (2022).** *Estimating the Impacts of Introducing Euro 6/VI Vehicle Emission Standards for New Zealand: Final Report.* <https://www.transport.govt.nz/assets/MoT-Euro-6-modelling-final-report-4-July.pdf>
- Metcalf J, & Kuschel G. (2023).** *Public Health Risks Associated with Transport Emissions in NZ: Part 2 Road Transport Emission Trends.* <https://www.esr.cri.nz/media/edmf0i4c/esr-environmental-health-report-public-health-risks-transport-emissions.pdf>
- Metcalf J, Powell J, & Wickham L. (2022).** *Public Health Risks Associated with Discharges to Air from Agriculture in New Zealand: Scoping Review.* <https://www.esr.cri.nz/media/a3uien2s/esr-environmental-health-report-agriculture-air-discharges.pdf>
- Meurisse N, Kean J, Vereijssen J, & Phillips C. (2023).** *Global change and NZ biosecurity: Risks and economics of future climates and trade patterns. B3: Science Solutions for Better Border Security.* <https://www.b3nz.org.nz/projects/global-change-and-nz-biosecurity-risks-and-economics-of-future-climates-and-trade-patterns/>
- MFAT (Ministry of Foreign Affairs and Trade). (2019).** *Te Ōhanga Māori: The Māori Economy.* https://www.mfat.govt.nz/assets/Trade-agreements/UK-NZ-FTA/The-Maori-Economy_2.pdf
- MFAT (Ministry of Foreign Affairs and Trade). (2023a).** *Navigating a Shifting World Te Whakatere i Tētahi Ao Hurihuri.* <https://www.mfat.govt.nz/assets/About-us-Corporate/MFAT-strategies-and-frameworks/MFATs-2023-Strategic-Foreign-Policy-Assessment-Navigating-a-shifting-world-June-2023.pdf>
- MFAT (Ministry of Foreign Affairs and Trade). (2023b).** *Cyclone Gabrielle's impact on the New Zealand economy and exports.* <https://www.mfat.govt.nz/en/trade/mfat-market-reports/cyclone-gabrielles-impact-on-the-new-zealand-economy-and-exports-march-2023>
- MfE (Ministry for the Environment). (2004).** *Module 2. Hazardous Waste Guidelines: Landfill Waste Acceptance Criteria and Landfill Classification.* <https://environment.govt.nz/assets/Publications/Files/haz-waste-guide-module-2-may04.pdf>
- MfE (Ministry for the Environment). (2006).** *Using the Cultural Health Index: How to Assess the Health of Streams and Waterways.* <https://environment.govt.nz/assets/Publications/Files/chi-for-streams-and-waterways-feb06-full-colour.pdf>
- MfE (Ministry for the Environment). (2019).** *Kigali Amendment to the Montreal Protocol.* <https://environment.govt.nz/what-government-is-doing/international-action/vienna-convention-and-montreal-protocol/kigali-amendment-to-the-montreal-protocol/>
- MfE (Ministry for the Environment). (2020).** *National Climate Change Risk Assessment for New Zealand.* Ministry for the Environment. <https://environment.govt.nz/assets/Publications/Files/national-climate-change-risk-assessment-main-report.pdf>
- MfE (Ministry for the Environment). (2021a).** *What Is contaminated land?* <https://environment.govt.nz/facts-and-science/land/contaminated-land/>
- MfE (Ministry for the Environment). (2021b).** *Ozone depleting substances.* <https://environment.govt.nz/acts-and-regulations/acts/ozone-layer-protection-act-1996/ozone-depleting-substances>
- MfE (Ministry for the Environment). (2022).** *Value of nature for wellbeing during times of crisis: COVID-19 case study.* <https://environment.govt.nz/publications/value-of-nature-for-wellbeing-during-times-of-crisis/>
- MfE (Ministry for the Environment). (2023a).** *The science linking extreme weather and climate change.* <https://environment.govt.nz/news/the-science-linking-extreme-weather-and-climate-change>
- MfE (Ministry for the Environment). (2023b).** *Where to from here? How we ensure the future wellbeing of land and people: The Ministry for the Environment's Long-term Insights Briefing 2023.* <https://environment.govt.nz/assets/publications/Long-term-Insights-Briefing-final-report-2023.pdf>

- MfE (Ministry for the Environment). (2023c).** *Waste facilities and disposal*. <https://environment.govt.nz/facts-and-science/waste/waste-facilities-and-disposal/>
- MfE (Ministry for the Environment). (2024a).** *Waste disposal and diversion*. <https://environment.govt.nz/facts-and-science/waste/waste-facilities-and-disposal/#waste-disposal-and-diversion>
- MfE (Ministry for the Environment). (2024b).** *Climate projections insight*. <https://environment.govt.nz/facts-and-science/climate-change/climate-change-projections/climate-projections-insights-and-publications/>
- MfE (Ministry for the Environment). (2024c).** *New Zealand's Greenhouse Gas Inventory 1990-2022*. <https://environment.govt.nz/publications/new-zealands-greenhouse-gas-inventory-1990-2022/>
- MfE (Ministry for the Environment). (2024d).** *New Zealand's Greenhouse Gas Inventory 1990-2022: Snapshot*. <https://environment.govt.nz/publications/new-zealands-greenhouse-gas-inventory-19902022-snapshot/>
- MfE (Ministry for the Environment). (2024e).** *New Zealand's first Biennial Transparency Report*. <https://environment.govt.nz/publications/new-zealands-first-biennial-transparency-report-under-the-paris-agreement/>
- MfE (Ministry for the Environment). (2024f).** *National Policy Statement for Freshwater Management 2020*. <https://environment.govt.nz/publications/national-policy-statement-for-freshwater-management-2020-amended-october-2024/>
- MfE (Ministry for the Environment). (2024g).** *Coastal hazards and climate change guidance*. <https://environment.govt.nz/assets/publications/Coastal-hazards-and-climate-change-guidance-2024-ME-1805.pdf>
- MfE (Ministry for the Environment). (2024h).** *National monitoring system 2022/23 [dataset]*. <https://environment.govt.nz/assets/NMS-complete-dataset-2022-23.xlsx>
- MfE (Ministry for the Environment). (2024i).** *Erosion*. <https://environment.govt.nz/facts-and-science/land/erosion/>
- MfE (Ministry for the Environment). (2024j).** *New Zealand's projected greenhouse gas emissions to 2050*. <https://environment.govt.nz/facts-and-science/climate-change/new-zealands-projected-greenhouse-gas-emissions-to-2050/>
- Mika JP. (2021).** *Māori Perspectives on the Environment and Wellbeing*. <https://pce.parliament.nz/media/llxjl5ay/mika-maori-perspectives-on-the-environment-and-wellbeing.pdf>
- Miller S, Driver T, Saunders C, Tait P, & Rutherford P. (2017).** *New Zealand food and beverage consumer preferences for product attributes and alternative retailers, and in-market use of digital media and smart technology*. Research Report No, 342. Lincoln University: Agribusiness and Economics Research Unit. <https://researcharchive.lincoln.ac.nz/server/api/core/bitstreams/9491c41c-1b77-4e4d-9bf5-c165cea0f506/content>
- Mills JA, Yarrall JW, Bradford-Grieve JM, Uddstrom MJ, Renwick JA, & Merilä J. (2008).** The impact of climate fluctuation on food availability and reproductive performance of the planktivorous red-billed gull *Larus novaehollandiae scopulinus*. *Journal of Animal Ecology*, 77(6), 1129–1142. <https://doi.org/10.1111/j.1365-2656.2008.01383.x>
- Ministerial Inquiry into Land Uses in Tairāwhiti and Wairoa. (2023).** *Outrage to Optimism: Report for the Ministerial Inquiry into Land Uses Associated with the Mobilisation of Woody Debris and Sediment in Tairāwhiti/Gisborne District and Wairoa District*. <https://environment.govt.nz/what-government-is-doing/areas-of-work/land/ministerial-inquiry-into-land-use/>
- Moloney PD, Forsyth DM, Ramsey DSL, Perry M, McKay M, Gormley AM, Kappers B, & Wright EF. (2021).** Occupancy and relative abundances of introduced ungulates on New Zealand's public conservation land 2012–2018. *New Zealand Journal of Ecology*, 45(1), 1–16. <https://doi.org/10.20417/nzj ecol.45.21>

- Monaghan R, Manderson A, Basher L, Spiekermann R, Dymond J, Smith C, ..., & McDowell R. (2021).** Quantifying contaminant losses to water from pastoral landuses in New Zealand II. The effects of some farm mitigation actions over the past two decades. *New Zealand Journal of Agricultural Research*, 64(3), 365–389. <https://doi.org/10.1080/00288233.2021.1876741>
- Montie S, Thoralf F, Smith RO, Cook F, Tait LW, Pinkerton MH, ... & Thomsen MS. (2024).** Seasonal trends in marine heatwaves highlight vulnerable coastal ecoregions and historic change points in New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 58(2), 274–299. <https://doi.org/10.1080/00288330.2023.2218102>
- Mora-Teddy AK, & Matthaei CD. (2020).** Microplastic pollution in urban streams across New Zealand: concentrations, composition and implications. *New Zealand Journal of Marine and Freshwater Research*, 54(2), 233–250. <https://doi.org/10.1080/00288330.2019.1703015>
- Moreau M, Herpe M, & Santamaria Cerrutti ME. (2025).** *2024 Update of the National Groundwater Quality Indicator*. GNS Science, Consultancy Report 2024/90.
- Morgenstern O. (2021).** The southern annular mode in 6th Coupled Model Intercomparison Project models. *Journal of Geophysical Research: Atmospheres*, 126(5). <https://doi.org/10.1029/2020JD034161>
- Morrison M, Jones EG, Consalvey M, & Berkenbusch K. (2014).** *Linking Marine Fisheries Species to Biogenic Habitats in New Zealand: A Review and Synthesis of Knowledge*. Prepared for the Ministry for Primary Industries. <https://deepwatergroup.org/wp-content/uploads/2015/11/GEN2015A19-7516259-AEBR-130-Linking-marine-fisheries-species-to-biogenic-habitats-in-New-Zealand.pdf>
- Morrison M, Hughes A, Kainamu A, & Williams E. (2023).** *Land-based Effects on Coastal Fisheries and Kaimoana and Their Habitats: A Review*. <https://www.mpi.govt.nz/dmsdocument/56425/direct>
- Morrison MA, Lowe ML, Parsons DM, Usmar NR, & McLeod IM. (2009).** *A Review of Land-based Effects on Coastal Fisheries and Supporting Biodiversity in New Zealand*. New Zealand Aquatic Environment and Biodiversity Report, no. 37. <https://healthyharbour.org.nz/wp-content/uploads/2016/08/Morrison-et-al-2009-Land-based-effects-on-coastal-fisheries.pdf>
- MOT (Ministry of Transport). (nd-a).** *Annual Fleet Statistics*. <https://www.transport.govt.nz/statistics-and-insights/fleet-statistics/sheet/annual-fleet-statistics>
- MOT (Ministry of Transport). (nd-b).** *MARPOL Annex VI Treaty*. <https://www.transport.govt.nz/area-of-interest/maritime-transport/marpol>
- MOT (Ministry of Transport). (2022).** *Te Tatauranga Rāngi Waka a Tau 2021 | Annual Fleet Statistics 2021*. <https://www.transport.govt.nz/assets/Uploads/Report/AnnualFleetStatistics.pdf>
- Mourot FM, Westerhoff RS, White PA, & Cameron SG. (2022).** Climate change and New Zealand's groundwater resources: A methodology to support adaptation. *Journal of Hydrology: Regional Studies*, 40, 101053. <https://doi.org/10.1016/j.ejrh.2022.101053>
- Mouton TL, Leprieur F, Flourey M, Stephenson F, Verburg P, & Tonkin JD. (2022).** Climate and land-use driven reorganisation of structure and function in river macroinvertebrate communities. *Ecography*, e06148. <https://doi.org/10.1111/ecog.06148>
- MPI (Ministry for Primary Industries). (nd-a).** *Adapting the Horticulture Industries to Climate Change*. <https://www.mpi.govt.nz/dmsdocument/26788-adapting-the-horticulture-industries-to-climate-change-2012>
- MPI (Ministry for Primary Industries). (nd-b).** *Freshwater Pests and Diseases*. <https://www.mpi.govt.nz/biosecurity/freshwater-pests/>
- MPI (Ministry for Primary Industries). (nd-c).** *The marine pest management system*. <https://www.mpi.govt.nz/biosecurity/exotic-pests-and-diseases-in-new-zealand/marine-pest-disease-management/marine-pest-management-system/>
- MPI (Ministry for Primary Industries). (2013).** *Overview of Ecological Effects of Aquaculture*. <https://www.mpi.govt.nz/dmsdocument/4300-Overview-of-ecological-effects-of-Aquaculture>

- MPI (Ministry for Primary Industries). (2014).** *The Right Tree in the Right Place: New Zealand Wilding Conifer Management Strategy 2015–2030.* <https://www.mpi.govt.nz/dmsdocument/51013-The-wilding-conifer-management-strategy-20152030>
- MPI (Ministry for Primary Industries). (2017).** *Primary Sector Science Roadmap Te Ao Tūroa. Strengthening New Zealand's bioeconomy for future generations.* <https://www.mpi.govt.nz/dmsdocument/18383-Primary-Sector-Science-Roadmap-Te-Ao-Turoa-Strengthening-New-Zealands-bioeconomy-for-future-generations>
- MPI (Ministry for Primary Industries). (2019a).** *Spatial risk assessment of threats to Hector's and Māui dolphins (Cephalorhynchus hectori).* <https://www.mpi.govt.nz/dmsdocument/35007-AEBR-214-Spatial-risk-assessment-of-threats-to-HectorsMaui-dolphins-Cephalorhynchus-hectori>
- MPI (Ministry for Primary Industries). (2019b).** *Valuing Highly Productive Land: A Discussion Document on a Proposed National Policy Statement for Highly Productive Land.* <https://www.mpi.govt.nz/dmsdocument/36624-discussion-document-on-a-proposed-national-policy-statement-for-highly-productive-land>
- MPI (Ministry for Primary Industries). (2021a).** *AEBAR 2019–20: Ecosystem effects: NZ climate and oceanic setting (Chapter 12).* <https://www.mpi.govt.nz/dmsdocument/42141-Chapter-12-NZ-Climate-and-Ocean-Aquatic-environment-and-biodiversity-annual-review-AEBAR-201920>
- MPI (Ministry for Primary Industries). (2021b).** *Aquatic environment and biodiversity annual review (AEBAR) report, Chapter 9 - Non-Target Fish and Invertebrate Catch.* <https://www.mpi.govt.nz/dmsdocument/51676-Chapter-9-Non-target-fish-and-invertebrate-catch>
- MPI (Ministry for Primary Industries). (2021c).** *Economic costs of pests to New Zealand.* <https://www.mpi.govt.nz/dmsdocument/48496-Economic-costs-of-pests-to-New-Zealand-Technical-report>
- MPI (Ministry for Primary Industries). (2022).** *National Direction for Plantation and Exotic Carbon Afforestation.* <https://www.mpi.govt.nz/dmsdocument/53623-National-direction-for-plantation-and-exotic-carbon-afforestation>
- MPI (Ministry for Primary Industries). (2023a)** *The Future of Aotearoa New Zealand's food sector: Exploring global demand opportunities in the year 2050.* <https://www.mpi.govt.nz/dmsdocument/56350-The-Future-of-Aotearoa-New-Zealands-Food-SectorExploring-Global-Demand-Opportunities-in-the-Year-2050>
- MPI (Ministry for Primary Industries). (2023b).** *National exotic forest description: As at 1 April 2022.* <https://www.mpi.govt.nz/dmsdocument/55996/direct>
- MPI (Ministry for Primary Industries). (2023c).** *Wilding conifer control in NZ.* <https://www.mpi.govt.nz/biosecurity/exotic-pests-and-diseases-in-new-zealand/long-term-biosecurity-management-programmes/wilding-conifers/>
- MPI (Ministry for Primary Industries). (2023d).** *Technical Advisory Group report: Biosecurity response to Corbicula fluminea in the Waikato river.* <https://www.mpi.govt.nz/dmsdocument/59086-Technical-Advisory-Group-Report-Biosecurity-Response-to-Corbicula-fluminea-in-the-Waikato-River>
- MPI (Ministry for Primary Industries). (2023e).** *Quarterly report of investigation of suspected exotic diseases. Surveillance, 50(2), 7–19.* <https://www.mpi.govt.nz/dmsdocument/57736-Surveillance-Magazine-Vol-50-No-2-June-2023>
- MPI (Ministry for Primary Industries). (2023f).** *Bottom trawling.* <https://www.mpi.govt.nz/fishing-aquaculture/sustainable-fisheries/strengthening-fisheries-management/bottom-trawling/>
- MPI (Ministry for Primary Industries). (2023g).** *Situation and outlook for primary industries. December 2023.* <https://www.mpi.govt.nz/dmsdocument/60526-Situation-and-Outlook-for-Primary-Industries-SOPI-December-2023>
- MPI (Ministry for Primary Industries). (2024a).** *Situation and outlook for primary industries. December 2024.* <https://www.mpi.govt.nz/dmsdocument/66648-Situation-and-Outlook-for-Primary-Industries-SOPI-December-2024>

- MPI (Ministry for Primary Industries). (2024b).** *The status of New Zealand's fisheries 2023.* <https://www.mpi.govt.nz/fishing-aquaculture/fisheries-management/fish-stock-status/>
- MPI (Ministry for Primary Industries). (2024c).** *National survey of recreational fishers.* <https://www.mpi.govt.nz/fishing-aquaculture/recreational-fishing/national-survey-of-recreational-fishers/>
- MPI (Ministry for Primary Industries). (2024d).** *About exotic Caulerpa and where it's been found in NZ.* <https://www.mpi.govt.nz/biosecurity/exotic-pests-and-diseases-in-new-zealand/active-biosecurity-responses-to-pests-and-diseases/exotic-caulerpa-seaweeds-caulerpa-brachypus-and-caulerpa-parvifolia-in-new-zealand/about-exotic-caulerpa-and-where-its-been-found-in-nz/>
- Munsterman F, Allan BJ, & Johnson SL. (2024).** The availability and ingestion of microplastics by an intertidal fish is dependent on urban proximity. *New Zealand Journal of Marine and Freshwater Research*, 1–14. <https://doi.org/10.1080/00288330.2024.2365272>
- MWLR (Manaaki Whenua Landcare Research). (2018).** *Conserving Indigenous Fauna within Production Forestry Landscapes.* Contract Report: LC3216. <https://www.waikatoregion.govt.nz/assets/EnviroLink/Reports/1854-GSDC150-Conserving-indigenous-fauna-within-production-forestry-landscapes.pdf>
- NASA (National Aeronautics and Space Administration). (2024).** *2024 Ozone Report.* <https://www.nasa.gov/earth/climate-change/ozone-layer/nasa-noaa-rank-2024-ozone-hole-as-7th-smallest-since-recovery-began/>
- Neubauer SC, Franklin RB, & Berrier DJ. (2013).** Saltwater intrusion into tidal freshwater marshes alters the biogeochemical processing of organic carbon. *Biogeosciences*, 10(12), 8171–8183. <https://doi.org/10.5194/bg-10-8171-2013>
- Neverman AJ, Donovan M, Smith HG, Ausseil A-G, & Zammit C. (2023).** Climate change impacts on erosion and suspended sediment loads in New Zealand. *Geomorphology* 427(15), 108607. <https://doi.org/10.1016/j.geomorph.2023.108607>
- New Zealand Infrastructure Commission, Te Waihangā. (2024).** *Paying It Forward: Understanding Our Long-term Infrastructure Needs.* <https://media.umbraco.io/te-waihangā-30-year-strategy/43ikcme0/paying-it-forward-understanding-our-long-term-infrastructure-needs.pdf>
- Newnham RM. (2017).** High levels of allergenic tree pollen in southern New Zealand. *Biomedical Journal of Scientific & Technical Research*, 1(4). <https://doi.org/10.26717/bjstr.2017.01.000376>
- Newnham RM. (2021).** Monitoring airborne pollen in New Zealand. *Journal of the Royal Society of New Zealand*, 52(2), 192–211. <https://doi.org/10.1080/03036758.2021.1967414>
- Nguyen HD, Riley M, Leys J, & Salter D. (2019).** Dust storm event of February 2019 in Central and East Coast of Australia and evidence of long-range transport to New Zealand and Antarctica. *Atmosphere*, 10(11), 653. <https://doi.org/10.3390/atmos10110653>
- Nguyen TM, Stahlmann-Brown P, & Noy I. (2022).** Past experience of drought, drought risk perception, and climate mitigation and adaptation decisions by farmers in New Zealand. *Environmental Hazards*, 22(3), 264–284. <https://doi.org/10.1080/17477891.2022.2141179>
- NIWA (National Institute for Water and Atmospheric Research). (nd-a).** *El Niño and La Niña.* https://niwa.co.nz/climate/information-and-resources/el_nino
- NIWA (National Institute for Water and Atmospheric Research). (nd-b).** *Sediment and Forestry.* <https://niwa.co.nz/freshwater/kaitiaki-tools/what-proposed-activity-or-industry/forestry/impacts-forestry-activities/sediment-and-forestry>
- NIWA (National Institute for Water and Atmospheric Research). (2019a).** *Coastal Flooding Exposure under Future Sea-level Rise for New Zealand.* NIWA Client Report No. 2019119WN prepared for The Deep South Challenge. <https://deepsouthchallenge.co.nz/wp-content/uploads/2021/01/Exposure-to-Coastal-Flooding-Final-Report.pdf>

- NIWA (National Institute for Water and Atmospheric Research). (2019b).** *Koi Carp, Common Carp* *Cyprinus carpio* Linnaeus. <https://niwa.co.nz/freshwater/nz-freshwater-fish-database/niwa-atlas-nz-freshwater-fishes/koi-carp-common-carp>
- NIWA (National Institute for Water and Atmospheric Research). (2020).** *Freshwater Invasive Species of New Zealand*. <https://docs.niwa.co.nz/library/public/FreInSpec.pdf>
- Nizzetto L, Futter M, & Langaas S. (2016).** Are agricultural soils dumps for microplastics of urban origin? *Environmental Science and Technology*, 50(20), 10777–10779. <https://doi.org/10.1021/acs.est.6b04140>
- Noble M, Duncan P, Perry D, Prosper K, Rose D, Schnierer S, ... & Pittock J. (2016).** Culturally significant fisheries keystones for management of freshwater social-ecological systems. *Ecology and Society*, 21(2), 22. <https://doi.org/10.5751/ES-08353-210222>
- Norton DA, Suryaningrum F, Buckley HL, Case BS, Hamish Cochrane C, Forbes AS, & Harcombe M. (2020).** Achieving win-win outcomes for pastoral farming and biodiversity conservation in New Zealand. *New Zealand Journal of Ecology*, 44(2). <https://doi.org/10.20417/nzj ecol.44.15>
- Nurse-Bray M, Palmer R, Chischilly AM, Rist P, & Yin L. (2022).** Responding to climate change: Why does it matter? The impacts of climate change. In *Old Ways for New Days: Indigenous Survival and Agency in Climate Changed Times* (pp 11–24). Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-97826-6_2
- Nutsford D, Pearson AL, & Kingham S. (2013).** An ecological study investigating the association between access to urban green space and mental health. *Public Health*, 127(11), 1005–1011. <https://doi.org/10.1016/j.puhe.2013.08.016>
- NZ SeaRise. (nd).** *Predicting sea-level rise for Aotearoa New Zealand*. <https://www.searise.nz/>
- NZAAE (New Zealand Association for Environmental Education). (2021).** *Climate Change and Mātauranga Māori*. <https://www.nzaee.org.nz/resources/the-impact-of-climate-change-and-matauranga-maori>
- NZAGRC (New Zealand Agricultural Greenhouse Gas Research Centre). (2021).** *Celebrating the Contribution of the Pastoral Greenhouse Gas Research Consortium 2003–2021*. https://www.pggrc.co.nz/files/1671050487_PGgRc%20Summary%20Dec22%20final%20121222v2.pdf
- NZLRI (New Zealand Land Resource Inventory). (2021).** *LCDB v5.0: New Zealand Land Cover Database Version 5.0*. Manaaki Whenua Landcare Research. <http://lris.scinfo.org.nz/#/layer/304-lcdb-v30-land-cover-database-version-3/comments/>
- NZTA (New Zealand Transport Agency | Waka Kotahi). (2023).** *Ambient Air Quality (Nitrogen Dioxide) Monitoring Programme: Annual Report 2007–2022*. <https://www.nzta.govt.nz/assets/resources/air-quality-monitoring/docs/ambient-air-quality-monitoring-programme-annual-report-2007-2022.pdf>
- NZTCS (New Zealand Threat Classification System). (2025).** *Searching the NZTCS database*. <https://nztc.org.nz/home>
- O'Donnell, CFJ, Pryde MA, van Dam-Bates P, & Elliott GP. (2017).** Controlling invasive predators enhances the long-term survival of endangered New Zealand long-tailed bats (*Chalinolobus tuberculatus*): Implications for conservation of bats on oceanic islands. *Biological Conservation*, 214, 156–167. <https://doi.org/10.1016/j.biocon.2017.08.015>
- O'Donnell CFJ, Borkin K, Christie JE, Davidson-Watts I, Dennis G, Pryde MA, & Michel P. (2023).** *Conservation status of bats in Aotearoa New Zealand, 2022*. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs41entire.pdf>
- O'Meara TA, Hillman JR, & Thrush SF. (2017).** Rising tides, cumulative impacts and cascading changes to estuarine ecosystem functions. *Scientific Reports*, 7(1), 10218. <https://doi.org/10.1038/s41598-017-11058-7>
- Ockenden A, Northcott GL, Tremblay LA, & Simon KS. (2022).** Disentangling the influence of microplastics and their chemical additives on a model detritivore system. *Environmental Pollution*, 307, 119558. <https://doi.org/10.1016/j.envpol.2022.119558>

- Ockenden A, Tremblay LA, Dikareva N, & Simon KS. (2021). Towards more ecologically relevant investigations of the impacts of microplastic pollution in freshwater ecosystems. *Science of the Total Environment*, 792, 148507. <https://doi.org/10.1016/j.scitotenv.2021.148507>
- OECD (Organisation for Economic Co-operation and Development). (2024). *Waste: Waste – municipal waste: Generation and treatment*. OECD Environment Statistics (Database). https://www.oecd-ilibrary.org/environment/data/oecd-environment-statistics/municipal-waste_data-00601-en
- OECD-FAO (Organisation for Economic Co-operation and Development-Food and Agriculture Organization of the United Nations). (2023). *OECD-FAO Agricultural Outlook 2023–2032*. Paris: OECD Publishing. <https://doi.org/10.1787/08801ab7-en>
- Otago Regional Council. (2024). *Joint Media Release: ORC and Fish and Game Addressing Otago Galaxiid's 'Slide into Extinction'*. <https://www.orc.govt.nz/your-council/latest-news/news/2023/june/orc-and-fish-and-game-addressing-otago-galaxiid-s-slide-into-extinction/>
- Parfitt RL, Stevenson BA, Dymond JR, Schipper LA, Baisden WT, & Ballantine DJ. (2012). Nitrogen inputs and outputs for New Zealand from 1990 to 2010 at national and regional scales. *New Zealand Journal of Agricultural Research*, 55(3), 241–262. <https://doi.org/10.1080/00288233.2012.676991>
- Parsons M, Fisher K, & Crease RP. (2021). A history of the settler-colonial freshwater impurement: Water pollution and the creation of multiple environmental injustices along the Waipā River. In *Decolonising Blue Spaces in the Anthropocene* (pp 181–234). Palgrave Studies in Natural Resource Management. https://doi.org/https://doi.org/10.1007/978-3-030-61071-5_5
- Pasanen TP, White MP, Wheeler BW, Garrett JK, & Elliot LR. (2019). Neighbourhood blue space, health and wellbeing: The mediating role of different types of physical activity. *Environment International*, 141, 105016. <https://doi.org/https://doi.org/10.1016/j.envint.2019.105016>
- Patterson, B. (2023). *Economic Impacts of a Proposed Waimakariri Dark Sky Reserve Centred on Oxford*. https://www.benjepatterson.co.nz/wp-content/uploads/2023/12/Economic-impacts-of-a-proposed-Waimakariri-dark-sky-reserve-centred-on-Oxford_FINAL.pdf
- Paul CM, Potter D, & Peterson A. (2016). *Statement of Claim – Waitangi Tribunal, 30 May 2016*. https://forms.justice.govt.nz/search/Documents/WT/wt_DOC_106784185/Wai%202607%2C%201.1.001.pdf
- Paul-Burke K, O'Brien T, Burke J, & Bluett C. (2020). Mapping Māori knowledge from the past to inform marine management futures. *New Zealand Science Review*, 76(1–2), 31–40. <https://hdl.handle.net/10289/14324>
- Paulik R, Zorn C, Wotherspoon L, & Sturman J. (2023). Modelling national residential building exposure to flooding hazards. *International Journal of Disaster Risk Reduction*, 94. <https://doi.org/10.1016/j.ijdrr.2023.103826>
- Pawson SM, Ecroyd CE, Seaton R, Shaw WB, & Brockerhoff EG. (2010). New Zealand's exotic plantation forests as habitats for threatened indigenous species. *New Zealand Journal of Ecology*, 34(3), 342–355. <https://www.jstor.org/stable/i24060694>
- PCE (Parliamentary Commissioner for the Environment). (2015). *Preparing New Zealand for Rising Seas: Certainty and Uncertainty*. <https://www.pce.parliament.nz/publications/preparing-new-zealand-for-rising-seas-certainty-and-uncertainty>
- PCE (Parliamentary Commissioner for the Environment). (2020). *Managing our estuaries*. <https://www.pce.parliament.nz/publications/managing-our-estuaries>
- PCE (Parliamentary Commissioner for the Environment). (2021). *Space Invaders: A Review of How New Zealand Manages Weeds that Threaten Native Ecosystems*. <https://pce.parliament.nz/publications/space-invaders-managing-weeds-that-threaten-native-ecosystems/>
- PCE (Parliamentary Commissioner for the Environment). (2022). *Knowing What's Out There: Regulating the Environmental Fate of Chemicals*. <https://pce.parliament.nz/publications/regulating-the-environmental-fate-of-chemicals/>

- PCE (Parliamentary Commissioner for the Environment). (2023).** *Are We Building Harder, Hotter Cities?* <https://pce.parliament.nz/publications/are-we-building-harder-hotter-cities-the-vital-importance-of-urban-green-spaces/>
- PCE (Parliamentary Commissioner for the Environment). (2024).** *Urban Ground Truths: Valuing Soil and Subsoil in Urban Development.* <https://pce.parliament.nz/publications/urban-ground-truths/>
- Peled R. (2011).** Air pollution exposure: Who is at high risk? *Atmospheric Environment*, 45(10), 1781–1785. <https://doi.org/10.1016/j.atmosenv.2011.01.001>
- Peltzer DA. (2018).** Ecology and consequences of invasion by non-native (wilding) conifers in New Zealand. *Journal of New Zealand Grasslands*, 80, 39–46. <https://doi.org/10.33584/jnzg.2018.80.359>
- Penny G, Baker M, Skipper A, & Iti W. (2007a).** *Environmental Values and Observations of Change: A Survey with Ngati Whanaunga of Manaia.* NIWA Client Report AQCC042. Wellington: Aranovus Research and NIWA.
- Penny G, Thorne F, & Iti W. (2007b).** *Environmental Values and Observations of Change: A Survey of Ngati Hikairo ki Kawhia.* NIWA Client Report AQCC042. Wellington: Aranovus Research and NIWA.
- Perry GLW, Wilmshurst JM, & McGlone MS. (2014).** Ecology and long-term history of fire in New Zealand. *New Zealand Journal of Ecology*, 38(2). <https://newzealandecology.org/nzje/3198>
- Phillips C, Betts H, Smith HG, & Tsyplenkov A. (2024).** Exploring the post-harvest ‘window of vulnerability’ to landslides in New Zealand steep-land plantation forests. *Ecological Engineering*, 206. <https://doi.org/10.1016/j.ecoleng.2024.107300>
- Phillips C, Bloomberg M, Marden M, & Lambie S. (2023).** Tree root research in New Zealand: A retrospective ‘review’ with emphasis on soil reinforcement for soil conservation and wind firmness. *New Zealand Journal of Forestry Science*, 53. <https://doi.org/10.33494/nzjfs532023x177x>
- Phillips C, Jackson A-M, & Hakopa H. (2016).** Creation narratives of mahinga kai: Māori customary food-gathering sites and practices. *MAI Journal* 5(1): 63–75. <https://doi.org/10.20507/MAIJournal.2016.5.1.5>
- Phillips C, Marden M, & Basher L. (2017).** Geomorphology and forest management in New Zealand’s erodible steep-lands: An overview. *Geomorphology*, 307, 107–121. <https://doi.org/10.1016/j.geomorph.2017.07.031>
- Phillips CJ, Marden M, & Basher L. (2015).** Inter-rotational forest planning forests and erosion protection: Getting to the root of the matter. *New Zealand Journal of Forestry*, 60(2). <https://www.researchgate.net/publication/281411384>
- Phillips N. (2007).** *Review of the Potential for Biomanipulation of Phytoplankton Abundance by Freshwater Mussels (Kakahi) in the Te Arawa Lakes.* NIWA Client Report HAM2006-125 for Environment Bay of Plenty. <https://www.boprc.govt.nz/media/34446/TechReports-070101-Reviewpotentialbiomanipulationphytoplanktonabundance.pdf>
- Pinkerton M, Gall M, Throal F, Sutton P, & Wood S. (2023).** *Monitoring Ocean Health: 2023 Update on Satellite Indicators for Surface Temperature, Productivity and Suspended Solids.* <https://environment.govt.nz/publications/monitoring-ocean-health-2023-update-on-satellite-indicators-for-surface-temperature-productivity-and-suspended-solids/>
- Plew DR, Zeldis JR, Dudley BD, Whitehead AL, Stevens LM, Robertson BM, & Robertson BP. (2020).** Assessing the eutrophic susceptibility of New Zealand estuaries. *Estuaries and Coasts*, 43, 2015–2033. <https://doi.org/10.1007/s12237-020-00729-w>
- PMCSA (Office of the Prime Minister’s Chief Science Advisor). (2019).** *Rethinking Plastics in Aotearoa New Zealand.* <https://www.pmcsa.ac.nz/topics/rethinking-plastics/>
- PMCSA (Office of the Prime Minister’s Chief Science Advisor). (2021).** *The Future of Commercial Fishing in Aotearoa New Zealand.* <https://www.pmcsa.ac.nz/topics/fish/>
- PMCSA (Office of the Prime Minister’s Chief Science Advisor). (2023).** *Nitrates in Drinking Water.* <https://www.pmcsa.ac.nz/topics/nitrates/>

- Pomare P, Tassell-Matamua N, Lindsay N, Masters-Awatere B, Dell K, Erueti B, & Te Rangi M. (2023).** Te Mauri o te Kauri me te Ngahere: indigenous knowledge, te Taiao (the environment) and wellbeing. *Knowledge cultures*, 11(1), 55-83. <https://doi.org/10.22381/kc11120234>
- Pourzand F, Bolton A, Salter C, Hales S, & Woodward A. (2023).** Health and climate change: Adaptation policy in Aotearoa New Zealand. *The Lancet Regional Health—Western Pacific*, 40. <https://doi.org/10.1016/j.lanwpc.2023.100954>
- Prein AF, Mooney PA, & Done J. (2023).** The multi-scale interactions of atmospheric phenomenon in extreme and mean precipitation. *Earth's Future*, 11, e2023EF003534. <https://doi.org/10.1029/2023EF003534>
- Pronger J, Price R, Schindler J, Roberston H, & West D. (2024).** *Estimating Carbon Emissions from Peatland Fires at Kaimaumu—Motutangi and Awarua Wetlands*. Prepared for the Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/conservation/land-and-freshwater/wetlands/estimating-carbon-emissions-from-peatland-fires.pdf>
- Protected species bycatch. (nd).** *Summary of observed captures*. <https://protectedspeciescaptures.nz/PSCv7/released/summary/>
- Public Health Agency. (2022).** *Principles for Healthy Urban Development*. Wellington, Ministry of Health. <https://www.health.govt.nz/system/files/2022-09/principles-for-healthy-urban-development-1sept.pdf>
- Puddick J, Kelly L, & Wood S. (2022).** *Climate Change and Toxic Freshwater Cyanobacteria in Aotearoa New Zealand*. <https://www.esr.cri.nz/assets/Environmental-reports/Climate-Change-and-ToxicFreshwater-Cyanobacteria-in-Aotearoa-NZ-Cawthron-Report-3765.pdf>
- Purdie H, Hughes J, Stewart E, & Espiner S. (2020).** Implications of a changing alpine environment for geotourism: A case study from Aoraki/Mount Cook, New Zealand. *Journal of Outdoor Recreation and Tourism*, 29, 100235. <https://doi.org/10.1016/j.jort.2019.100235>
- Purdie J. (2022).** Modelling climate change impacts on inflows, lake storage and spill in snow-fed hydroelectric power catchments, Southern Alps, New Zealand. *Journal of Hydrology (NZ)* 61(2), 151–178. <https://www.hydrologynz.org.nz/journal/volume-61-2022>
- PwC (PricewaterhouseCoopers). (nd).** *Future-proofing Sustainable Tourism in New Zealand Interview with: Vicki Watson, Chief Executive, The Aotearoa Circle*. <https://www.pwc.com/gx/en/issues/esg/esg-asia-pacific/publications-and-case-studies/future-proofing-sustainable-tourism-in-new-zealand.html>
- PwC (PricewaterhouseCoopers). (2023).** *Tourism Sector Climate Change Scenarios*. <https://www.pwc.co.nz/assets/2023-assets/insights-and-publications/aotearoa-circle-report-tourismscenarios.pdf>
- Queen LE, Dean S, Stone D, Henderson R, & Renwick J. (2023).** Spatiotemporal trends in near-natural New Zealand river flow. *Journal of Hydrometeorology*, 24(2), 241–255. <https://doi.org/10.1175/JHM-D-22-0037.1>
- Rainforth H, & Harmsworth G. (2019).** *Kaupapa Māori Freshwater Assessments: A Summary of Iwi and Hapū-based Tools, Frameworks and Methods for Assessing Freshwater Environments*. Perception Planning Ltd. <https://www.nrc.govt.nz/media/n0ip2ksp/kaupapa-maori-assessments-final-jan-2019.pdf>
- Rajan P, Natraj P, Kim M, Lee M, Jang YJ, Lee YJ, & Kim SC. (2024).** Climate change impacts on and response strategies for kiwifruit production: A comprehensive review. *Plants*, 13(17), 2354. <https://doi.org/10.3390/plants13172354>
- Rapson GL, Murphy AL, & Smith AR. (2023).** Invasive species over-stabilise the vegetation of a mobile dunefield, Manawatū, New Zealand, disrupting natural succession. *Vegetation Classification and Survey*, 4, 343–360. <https://doi.org/10.3897/VCS.98391>
- Regional Public Health. (2010).** *Healthy Open Spaces: A Summary of the Impact of Open Spaces on Health and Wellbeing*. <https://www.rph.org.nz/resources/publications/healthy-open-spaces-a-summary-of-the-impact-of-open-spaces-on-health-and-wellbeing.pdf>

- Reid J, & Castka P. (2023).** The impact of remote sensing on monitoring and reporting - The case of conformance systems. *Journal of Cleaner Production*, 393. <https://doi.org/10.1016/j.jclepro.2023.136331>
- Reid KJ, Rosier SM, Harrington LJ, King AD, & Lane TP. (2021).** Extreme rainfall in New Zealand and its association with atmospheric rivers. *Environmental Research Letters*, 16(4), 044012. <https://doi.org/10.1088/1748-9326/abeae0>
- Reihana KR, Lyver PO, Gormley A, Younger M, Harcourt NA, Cox M, ... & Innes J. (2023).** Me ora te Ngāhere: Visioning forest health through an Indigenous biocultural lens. *Pacific Conservation Biology*, 30, PC22028. <https://doi.org/10.1071/PC22028>
- Renwick A. (2023).** *Climate extremes make NZ's supply chains highly vulnerable – it's time to rethink how we grow and ship food.* The conversation. <https://theconversation.com/climate-extremes-make-nzs-supply-chains-highly-vulnerable-its-time-to-rethink-how-we-grow-and-ship-food-209023>
- Reserve Bank of New Zealand. (nd).** *Economic indicators.* <https://www.rbnz.govt.nz/statistics/series/economic-indicators>
- Resilience to Nature's Challenges. (2024).** *Policy Brief: Food Systems Security and Disaster Recovery.* <https://resiliencechallenge.nz/wp-content/uploads/Food-Security-and-Disaster-Recovery-Policy-Brief-FINAL.pdf>
- Revell LE, Edkins NJ, Venugopal AU, Bhatti YA, Kozyniak KM, Davy PK, ... & Coulson G. (2024).** Marine aerosol in Aotearoa New Zealand: Implications for air quality, climate change and public health. *Journal of the Royal Society of New Zealand*, 1–23. <https://doi.org/10.1080/03036758.2024.2319753>
- Rey F. (2021).** Harmonizing erosion control and flood prevention with restoration of biodiversity through ecological engineering used for co-benefits nature-based solutions. *Sustainability (Switzerland)*, 13(20). <https://doi.org/10.3390/su132011150>
- Richardson SJ, King S, Rose AB, McGlone MS, & Holdaway RJ. (2018).** Post-fire recovery of a dryland forest remnant in the Wither Hills, Marlborough. *New Zealand Journal of Ecology*, 42(2), 222–228. <https://doi.org/10.20417/nzjecol.42.16>
- RNZ (Radio New Zealand). (2024).** *Pollen, Asthma and Allergies.* <https://www.rnz.co.nz/national/programmes/ourchangingworld/audio/2018923999/pollen-asthma-and-allergies>
- Roberts JO, & Hendriks HR. (2022).** *Potential Climate Change Effects on New Zealand Marine Mammals: A Review.* Prepared by the Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/drds366entire.pdf>
- Roberts MJ, Camp J, Seddon J, Vidale PL, Hodges K, Vannière B, ... & Wu L. (2020).** Projected future changes in tropical cyclones using the CMIP6 HighResMIP Multimodel Ensemble. *Geophysical Research Letters*, 47(14). <https://doi.org/10.1029/2020GL088662>
- Rodgers M, Mercier OR, Kiddle R, Pedersen Zari M, Neuhaus F, & Robertson N. (2023).** Plants of place: Justice through (re)planting Aotearoa New Zealand's urban natural heritage. *Architecture_MPS*, 25(1). <https://doi.org/10.14324/111.444.amps.2023v25i1.001>
- Rolando C, Baillie B, Withers T, Bulman L, & Garrett L. (2016).** Pesticide use in planted forests in New Zealand. *New Zealand Journal of Forestry*, 61(2), 3–10. <https://nzif.org.nz/nzif-journal/publications/downloadfulltext/22884>
- Roques S, Martinez-Fernandez G, Ramayo-Caldas Y, Popova M, Denman S, Meale SJ, & Morgavi DP. (2024).** Recent advances in enteric methane mitigation and the long road to sustainable ruminant production. *Annual Review of Animal Biosciences*, 12(1), 321–343. <https://doi.org/10.1146/annurev-animal-021022-024931>
- Rowe DK. (2007).** Exotic fish introductions and the decline of water clarity in small North Island, New Zealand lakes: A multi-species problem. *Hydrobiologia*, 583(1), 345–358. <https://doi.org/10.1007/s10750-007-0646-1>

- Royal Society | Te Apārangi. (2014).** *Challenges for Pest Management in New Zealand*. <https://www.royalsociety.org.nz/assets/documents/Challenges-for-pest-management-in-NZ.pdf>
- Royal Society | Te Apārangi. (2016).** *Climate Change Implications for New Zealand*. <https://www.royalsociety.org.nz/assets/documents/Climate-change-implications-for-NZ-2016-report-web3.pdf>
- Royal Society | Te Apārangi. (2017).** *Human Health Impacts of Climate Change for New Zealand*. <https://www.royalsociety.org.nz/assets/documents/Report-Human-Health-Impacts-of-Climate-Change-for-New-Zealand-Oct-2017.pdf>
- Ruffell H, Pantos O, Robinson B, & Gaw S. (2021).** Wastewater treatment plant effluents in New Zealand are a significant source of microplastics to the environment. *New Zealand Journal of Marine and Freshwater Research*, 57(3). <https://doi.org/10.1080/00288330.2021.1988647>
- Ruffell H, Pantos O, Robinson B, & Gaw S. (2025).** Quantification of microplastics in biowastes including biosolids, compost, and vermicompost destined for land application. *Water Emerging Contaminants and Nanoplastics*, 4(1). <https://doi.org/10.20517/wecn.2024.65>
- Ruiz-Arias, JA. (2021).** Aerosol transmittance for clear-sky solar irradiance models: Review and validation of an accurate universal parameterization. *Renewable and Sustainable Energy Reviews*, 145, 111061. <https://doi.org/10.1016/j.rser.2021.111061>
- Ruru I, Shivan S, Clarke C, Farrant S, Lowe M, Afoa E, ... & Farmer, R. (2022).** *Implementing Mahinga Kai as a Māori Freshwater Value*. <https://environment.govt.nz/assets/publications/Implementing-mahinga-kai-as-a-Maori-freshwater-value.pdf>
- Rutledge DT, Price R, Ross C, Hewitt A, Webb T, & Briggs C. (2010).** Thought for food: Impacts of urbanisation trends on soil resource availability in New Zealand. *Proceedings of the New Zealand Grassland Association*, 72, 241–246. <https://doi.org/10.33584/jnzg.2010.72.2789>
- Sabetian A, Zhang J, Campbell M, Walter R, Allen H, Reid M, Wijenayake M, & Lilkendey J. (2021).** Fish nearshore habitat-use patterns as ecological indicators of nursery quality. *Ecological Indicators*, 131(108225). <https://doi.org/10.1016/j.ecolind.2021.108225>
- Sabih A, Russell C, & Chang CL. (2020).** Thunderstorm-related asthma can occur in New Zealand. *Respirology Case Reports*, 8(7). <https://doi.org/10.1002/rcr2.655>
- Sakai T, Uchino O, Nagai T, Liley B, Morino I, & Fujimoto T. (2016).** Long-term variation of stratospheric aerosols observed with lidars over Tsukuba, Japan, from 1982 and Lauder, New Zealand, from 1992 to 2015. *Journal of Geophysical Research: Atmospheres*, 121, 10283–10293. <https://doi.org/10.1002/2016JD025132>
- Salinger MJ, Diamond HJ, Behrens E, Fernandez D, Fitzharris BB, Herold N, ... & Trought MCT. (2020).** Unparalleled coupled ocean-atmosphere summer heatwaves in the New Zealand region: Drivers, mechanisms and impacts. *Climatic Change*, 162(2), 485–506. <https://doi.org/10.1007/s10584-020-02730-5>
- Salinger MJ, Diamond HJ, Bell J, Behrens E, Fitzharris BB, Herod N, ... & Trought MCT. (2023).** Coupled ocean-atmosphere summer heatwaves in the New Zealand region: An update. *Weather & Climate*, 42(1), 18–41. <https://doi.org/10.2307/27226713>
- Salinger MJ, Renwick J, Behrens E, Mullan AB, Diamond HJ, Sirguey P, ... & Sutton PJ. (2019).** The unprecedented coupled ocean-atmosphere summer heatwave in the New Zealand region 2017/18: Drivers, mechanisms and impacts. *Environmental Research Letters*, 14(4). <https://doi.org/10.1088/1748-9326/ab012a>
- Salmond NH, & Wing SR. (2022).** Sub-lethal and lethal effects of chronic and extreme multiple stressors on a critical New Zealand bivalve under hypoxia. *Marine Ecology Progress Series*, 703, 81–93. <https://doi.org/10.1016/j.jembe.2022.151696>
- Schallenberg M, De Winton MD, Verburg P, Kelly DJ, Hamill KD, & Hamilton DP. (2013).** Ecosystem services of lakes. In JR Dymond (Ed), *Ecosystem Services in New Zealand: Conditions and Trends* (pp 203–225). Manaaki Whenua Press.

- Schallenberg M, Hall CJ, & Burns CW. (2003).** Consequences of climate-induced salinity increases on zooplankton abundance and diversity in coastal lakes. *Marine Ecology Progress Series*, 173, 157–167. <https://doi.org/10.3354/meps251181>
- Schofield, J. (2021).** *Effects of LED light on adult caddisflies at two rivers in Canterbury, New Zealand.* [Master's thesis, University of Canterbury]. <http://dx.doi.org/10.26021/11154>
- Semadeni-Davies A, Coulson G, Gadd J, Somervell E, Longely I, & Olivares G. (2021).** *Determining the Ecological and Air Quality Impacts of Particulate Matter from Brake and Tyre Wear and Road Surface Dust: Stage 1 – Literature Review and Recommendations for Developing New Emission Factors for New Zealand.* New Zealand Transport Agency | Waka Kotahi Research Report 683. <https://www.nzta.govt.nz/assets/resources/research/reports/683/683-determining-the-ecological-and-air-quality-impacts-of-particulate-matter-from-brake-and-tyre-wear-and-road-surface-dust-summary.pdf>
- Shears NT, Bowen MM, & Thoralf F. (2024).** Long-term warming and record-breaking marine heatwaves in the Hauraki Gulf, northern New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 1–12. <https://doi.org/10.1080/00288330.2024.2319100>
- Shi J, Yan J, Wang S, Zhao S, Zhang M, Xu S, ... & Yang H. (2022).** Determinant of sea salt aerosol emission in the southern hemisphere in summer time. *Earth and Space Science*, 9(11). <https://doi.org/10.1029/2022EA002529>
- Siddiqua A, Hahladakis JN, & Al-Attia WAKA. (2022).** An overview of the environmental pollution and health effects associated with waste landfilling and open dumping. *Environmental Science and Pollution Research*, 29(39), 58514–58536. <https://doi.org/10.1007/s11356-022-21578-z>
- Sirvid P, Vink CJ, Fitzgerald BM, Wakelin MD, Rolfe JR, & Michel P. (2021).** *Conservation status of New Zealand Araneae (spiders), 2020.* Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs34entire.pdf>
- Skilling D. (2022).** *Supply chains to the last bus stop on the planet: an international perspective on strengthening New Zealand's supply chain resilience.* Landfall Strategy Group. <https://www.treasury.govt.nz/sites/default/files/2024-05/pc-inq-ier-supply-chains-to-the-last-bus-stop-on-the-planet.pdf>
- Skipper A. (2018).** Ka taki mai te māuru: When the nor'wester howls. *Te Karaka*, 78. <https://deepsouthchallenge.co.nz/research-project/forecasting-weather-and-climate-extremes/>
- Smith J & Hutchings J. (2024).** Feeding indigenous Aotearoa better. *Journal of the Royal Society of New Zealand*, 1-19. <https://doi.org/10.1080/03036758.2024.2327420>
- Smith HG, Neverman AJ, Betts H, & Spiekermann R. (2023).** The influence of spatial patterns in rainfall on shallow landslides. *Geomorphology*, 437, 108795. <https://doi.org/10.1016/j.geomorph.2023.108795>
- Snelder TH, Whitehead AL, Fraser C, Larned ST, & Schallenberg M. (2020).** Nitrogen loads to New Zealand aquatic receiving environments: Comparison with regulatory criteria. *New Zealand Journal of Marine and Freshwater Research*, 54(3), 527–550. <https://doi.org/10.1080/00288330.2020.1758168>
- Snelder TH, Fraser C, Larned ST, Monaghan R, De Malmanche S, & Whitehead AL. (2021).** Attribution of river water-quality trends to agricultural land use and climate variability in New Zealand. *Marine and Freshwater Research*, 73, 1–19. <https://doi.org/10.1071/MF21086>
- Snelder T, Fraser C, & Whitehead A. (2022).** *Spatial modelling of lake water quality state: Incorporating monitoring data for the period 2016 to 2020 (No. 2021-15).* LWP client report prepared for Ministry for the Environment. LWP, Christchurch. <https://environment.govt.nz/assets/publications/spatial-modelling-lake-water-quality.pdf>
- South Wairarapa District Council. (nd).** *Wairarapa International Dark Sky Reserve.* <https://swdc.govt.nz/wairarapa-international-dark-sky-reserve/>
- Spada M, Jorba O, Pérez García-Pando C, Janjic Z, & Baldasano JM. (2015).** On the evaluation of global sea-salt aerosol models at coastal/orographic sites. *Atmospheric Environment*, 101, 41–48. <https://doi.org/10.1016/j.atmosenv.2014.11.019>

- Sprague EI, & Wiser SK. (2024).** Investigating a unifying ecosystem typology for all of New Zealand. *Manaaki Whenua Landcare Research Client Report No. LC4514 prepared for the Ministry for the Environment*. <https://environment.govt.nz/assets/Investigating-a-unifying-ecosystem-typology-for-all-of-New-Zealand.pdf>
- Stats NZ. (nd).** Aotearoa Data Explorer. <https://explore.data.stats.govt.nz/>
- Stats NZ. (2021a).** Imports account for half of New Zealand's carbon footprint. <https://www.stats.govt.nz/news/imports-account-for-half-of-new-zealands-carbon-footprint/>
- Stats NZ. (2021b).** Environmental-economic accounts: Water physical stocks, year ended June 1995-2020. [Environmental-economic accounts: Water physical stocks, year ended June 1995-2020/](https://www.stats.govt.nz/information-releases/environmental-economic-accounts-water-physical-stocks-year-ended-june-1995-2020/)
- Stats NZ (2022a).** National population projections: 2022(base)–2073. <https://www.stats.govt.nz/information-releases/national-population-projections-2022base2073/>
- Stats NZ. (2022b).** Building consents issued: May 2022. <https://www.stats.govt.nz/information-releases/building-consents-issued-may-2022>
- Stats NZ. (2024a).** National population estimates: At 31 December 2023. <https://www.stats.govt.nz/information-releases/national-population-estimates-at-31-december-2023>
- Stats NZ. (2024b).** Building consents issued: January 2024. <https://www.stats.govt.nz/information-releases/building-consents-issued-january-2024/>
- Stats NZ. (2024c).** 2023 Census population, dwelling, and housing highlights. <https://www.stats.govt.nz/information-releases/2023-census-population-dwelling-and-housing-highlights>
- Stats NZ. (2024d).** Subnational population estimates: At 30 June 2024 (2018-base). <https://www.stats.govt.nz/information-releases/subnational-population-estimates-at-30-june-2024-2018-base/>
- Stats NZ. (2025).** Tourism Satellite Account: Year ended March 2024. <https://www.stats.govt.nz/information-releases/tourism-satellite-account-year-ended-march-2024/>
- Sterup KL. (2024).** The nature of coastal light pollution and its relationship with morphological variation in a larval fish around Wellington, New Zealand. [Master's thesis, Victoria University of Wellington]. <https://doi.org/10.26686/wgtn.25130843>
- Stevens HR, Beggs PJ, Graham PL, & Chang H-C. (2019).** Hot and bothered? Associations between temperature and crime in Australia. *International Journal of Biometeorology*, 63, 747–762. <https://doi.org/10.1007/s00484-019-01689-y>
- Stevenson B. (2022).** *Soil Health Indicators*. Report prepared for the Ministry of Business, Innovation and Employment. https://www.landcareresearch.co.nz/assets/Discover-Our-Research/Land/Soil-health-resilience/Report_soil-health-indicators.pdf
- Stewart M, Coe I, Taylor L, Watchorn C, Simmons W. (2020).** *Quick Pass Dune Vulnerability Assessment*. Prepared for Christchurch city Council and Environment Canterbury. <https://www.canterbury.ac.nz/content/dam/uoc-main-site/documents/pdfs/see-2023-geography-engagement-/Quick%20Pass%20Dune%20Vulnerability%20Assessment.pdf>
- Stewart C, Young N, Kim N, Johnston D, & Turner R. (2022).** Thunderstorm asthma: A review, risks for Aotearoa New Zealand, and health emergency management considerations. *New Zealand Medical Journal*, 135(1557), 49–63. <https://pubmed.ncbi.nlm.nih.gov/35772112/>
- Stewart-Harawira MW. (2020).** Troubled waters: Māori values and ethics for freshwater management and New Zealand's freshwater crisis. *Wiley Interdisciplinary Reviews: Water*, 7(5). <https://doi.org/10.1002/wat2.1464>
- Stone DA, Rosier SM, Bird L, Harrington LJ, Rana S, Stuart S, & Dean SM. (2022).** The effect of experiment conditioning on estimates of human influence on extreme weather. *Weather and Climate Extremes*, 36, 100427. <https://doi.org/10.1016/j.wace.2022.100427>

- Stone DA, Noble CJ, Bodeker GE, Dean SM, Harrington LJ, Rosier SM, ... & Tradowsky JS. (2024).** Cyclone Gabrielle as a design storm for northeastern Aotearoa New Zealand under anthropogenic warming. *Earth's Future*, 12(9). <https://doi.org/10.1029/2024EF004772>
- Stringer IAN, Hitchmough RA, Larivière M-C, Eyles AC, Teulon DAI, Dale PJ, & Henderson RC. (2012).** The conservation status of New Zealand Hemiptera. *New Zealand Entomologist*, 35(2), 110–115. <https://doi.org/10.1080/00779962.2012.686314>
- Strom J, Te Ao B, Rush E, & Mackay S. (2024).** How has the cost of feeding New Zealand children well changed from 2018 to 2023? Monthly price changes of a modelled lower-cost healthy diet. *Journal of the Royal Society of New Zealand*, 1–15. <https://doi.org/10.1080/03036758.2024.2370882>
- Su T, Li Z, Henao NR, Luan Q, & Yu F. (2024).** Constraining effects of aerosol-cloud interaction by accounting for coupling between cloud and land surface. *Science Advances*, 10(21), ead15044. <https://doi.org/10.1126/sciadv.adl5044>
- Sun D, Li F, Jing Z, Hu S, & Zhang B. (2023).** Frequent marine heatwaves hidden below the surface of the global ocean. *Nature Geoscience*, 16(12), 1099–1104. <https://doi.org/10.1038/s41561-023-01325-w>
- Tait A. (2019).** Risk-exposure assessment of Department of Conservation (DOC) coastal locations to flooding from the sea. In *Science for Conservation* (Vol. 332). <https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc332entire.pdf>
- Talbot N. (2019).** *Air Quality and Societal Impacts from Predicted Climate Change in Auckland*. <https://knowledgeauckland.org.nz/media/1079/tr2019-013-air-quality-and-societal-impacts-climatechange-auckland-final.pdf>
- Tapada A, Marques CS, Marques CP, & Costa C. (2021).** Astrotourism: A literature review and framework for future research. *Enlightening Tourism: A Pathmaking Journal*, 11(2), 291–331. <http://dx.doi.org/10.33776/et.v11i2.5189>
- Tasman District Council. (nd).** *Protect. Coastal Management Options*. <https://www.tasman.govt.nz/my-council/projects/coastal-management/coastal-management-options/protect>
- Taumata Arowai. (2024).** *Drinking Water Regulation Report 2023*. https://www.taumataarowai.govt.nz/assets/Water-services-insights-and-performance/Taumata-Arowai-Drinking-Water-Regulation-Report-2023_online.pdf
- Taura Y, van Schravendijk-Goodman C, & Clarkson B. (2017).** *Te reo o te repo: The voice of the wetland*. <https://www.landcareresearch.co.nz/uploads/public/Publications/Te-reo-o-te-repo/Te-Reo-o-Te-Repo-Voice-of-the-Wetland-complete-book.pdf>
- Taura Y, van Schravendijk-Goodman C, & Clarkson B. (2021).** *Te Reo o te Repo – Kei Konei Tonu Au | The Voice of the Wetland – I Am Still Here*. <https://www.landcareresearch.co.nz/uploads/public/Publications/Te-reo-o-te-repo-vol-2/TRoTR-kei-konei-tonu-au-complete-handbook.pdf>
- Te Manahuna Aoraki Project. (2022).** *Annual Report 2022*. [Te Manahuna Aoraki Project]. <https://www.temanahunaoraki.org/wp-content/uploads/2022/12/Te-Manahuna-Aoraki-Project-Annual-Report-2022-screen.pdf>
- Teen R. (2024).** *Water-borne illnesses in Aotearoa New Zealand—past, present, future*. <https://www.dpmc.govt.nz/sites/default/files/2024-07/PMCSA-24-06-04-V1-OPMCSA-Internship-report-Water-borne-illnesses-in-Aotearoa-R-Teen-20-Jun-2024-V1-wcs.pdf>
- Telfar-Barnard L, & Zhang J. (2021).** *The Impact of Respiratory Disease in New Zealand: 2020 Update*. <https://www.asthmafoundation.org.nz/assets/documents/Respiratory-Impact-report-final-2021Aug11.pdf>
- The Treasury. (2023).** *Impacts from the North Island weather events. Information release*. <https://www.treasury.govt.nz/sites/default/files/2023-04/impacts-from-the-north-island-weather-events.pdf>

- Thomas A, McDonald A, Renwick J, Tradowsky JS, Bodeker GE, & Rosier S. (2023).** Increasing temperature extremes in New Zealand and their connection to synoptic circulation features. *International Journal of Climatology*, 43(3), 1251–1272. <https://doi.org/10.1002/joc.7908>
- Thomas A, McDonald A, Renwick J, Rosier S, Tradowsky JS, & Bodeker GE. (2024).** Anthropogenic influence on precipitation in Aotearoa New Zealand with differing circulation types. *Weather and Climate Extremes*, 46, 100727. <https://doi.org/https://doi.org/10.1016/j.wace.2024.100727>
- Thompson DWJ, Solomon S, Kushner PJ, England MH, Grise KM, & Karoly DJ. (2011).** Signatures of the Antarctic ozone hole in southern hemisphere surface climate change. *Nature Geoscience*, 4(11), 741–749. <https://doi.org/10.1038/ngeo1296>
- Thompson K. (2022).** *Valuing coastal blue-green infrastructure: Development of a dune system assessment methodology, Ōtautahi Christchurch, New Zealand*. [Master's thesis, University of Canterbury]. <http://dx.doi.org/10.26021/14266>
- Thomsen MS, Mondardini L, Alestra T, Gerrity S, Tait L, South PM, ... & Schiel DR. (2019).** Local extinction of bull kelp (*Durvillaea* spp.) due to a marine heatwave. *Frontiers in Marine Science*, 6, 84. <https://doi.org/10.3389/fmars.2019.00084>
- Thrush SF, Hewitt JE, Gladstone-Gallagher RV, Savage C, Lundquist C, O'Meara T, ... & Pilditch C. (2021).** Cumulative stressors reduce the self-regulating capacity of coastal ecosystems. *Ecological Applications*, 31(1). <https://doi.org/10.1002/eap.2223>
- Tiatia-Seath J, Tupou T, & Fookes I. (2020).** Climate change, mental health, and well-being for Pacific peoples: A literature review. *Contemporary Pacific*, 32(2), 400–430. <https://doi.org/10.1353/cp.2020.0035>
- Timoti P, Lyver PO, Matamua R, Jones CJ, & Tahi BL. (2017).** A representation of a Tuawhenua worldview guides environmental conservation. *Ecology and Society*, 22(4), 20. <https://doi.org/10.5751/ES-09768-220420>
- Tipa G. (2009).** Exploring indigenous understandings of river dynamics and river flows: A case from New Zealand. *Environmental Communication*, 3(1), 95–120. <https://doi.org/10.1080/17524030802707818>
- Tremblay LA, Pochon X, Baker V, Northcott GL, & Cahill P. (2019).** *A Review of Microplastics Risk: Implications for Environment Southland*. <https://www.envirolink.govt.nz/assets/Envirolink/Reports/1902-ESRC207-A-review-of-microplastics-risk-implications-for-environment-southland-.pdf>
- Trewick S, Hitchmough R, Rolfe JR, & Stringer I. (2018).** *Conservation status of New Zealand Onychophora ('peripatus' or velvet worm), 2018*. Department of Conservation. <https://www.doc.govt.nz/Documents/science-and-technical/nztcs26entire.pdf>
- Trewick S, Hegg D, Morgan-Richards M, Murray T, Watts C, Johns PM, & Michel P. (2022).** *Conservation status of Orthoptera (wētā, crickets and grasshoppers) in Aotearoa New Zealand, 2022*. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs39entire.pdf>
- Tzoulas K, Korpela K, Venn S, Yli-Pelkonen V, Kaźmierczak A, Niemela J, & James P. (2007).** Promoting ecosystem and human health in urban areas using Green Infrastructure: A literature review. *Landscape and Urban Planning*, 81(3), 167–178. <https://doi.org/10.1016/j.landurbplan.2007.02.001>
- UCAR Center for Science Education. (nd).** *How Weather Affects Air Quality*. <https://scied.ucar.edu/learning-zone/air-quality/how-weather-affects-air-quality>
- Ummenhofer CC, Gupta AS, & England MH. (2009).** Causes of late twentieth-century trends in New Zealand precipitation. *Journal of Climate*, 22(1), 3–19. <https://doi.org/10.1175/2008JCLI2323.1>
- Underwood LH, van der Reis A, & Jeffs AG. (2023).** Diet of snapper (*Chrysophrys auratus*) in green-lipped mussel farms and adjacent soft-sediment habitats. *Aquaculture, Fish and Fisheries*, 3(3), 268–286. <https://doi.org/10.1002/aff2.113>

- van Hamelsveld S, Kurenbach B, Paull DJ, Godsoe WA, Ferguson GC, & Heinemann JA. (2023).** Indigenous food sources as vectors of *Escherichia coli* and antibiotic resistance. *Environmental Pollution*, 334. <https://doi.org/10.1016/j.envpol.2023.122155>
- Vatsa P, & Renwick A. (2024).** Food prices in New Zealand: Implications for feeding people better. *Journal of the Royal Society of New Zealand*, 1–14. <https://doi.org/10.1080/03036758.2024.2368788>
- Vega E. (2024).** *The Abyss of Abundance: Consumer Overconsumption and the Road to Environmental Collapse*. [Thesis, Fordham University]. https://research.library.fordham.edu/cgi/viewcontent.cgi?article=1162&context=environ_2015
- Venegas RM, Acevedo J, & Trembl EA. (2023).** Three decades of ocean warming impacts on marine ecosystems: A review and perspective. *Deep-Sea Research Part II: Topical Studies in Oceanography*, 212. <https://doi.org/10.1016/j.dsr2.2023.105318>
- Villamor GB, Wakelin SJ, Dunningham A, & Clinton PW. (2023).** Climate change adaptation behaviour of forest growers in New Zealand: An application of protection motivation theory. *Climatic Change*, 176(2). <https://doi.org/10.1007/s10584-022-03469-x>
- Vishwanathan G, McDonald AJ, Noble C, Stone DA, Rosier S, Schuddeboom A, ... & Bodeker G. (2024).** Regional characteristics of extreme precipitation events over Aotearoa New Zealand. *Weather and Climate Extremes*, 44, 100687. <https://doi.org/10.1016/j.wace.2024.100687>
- Waikato Regional Council. (nd).** *Weather and air quality*. <https://www.waikatoregion.govt.nz/environment/air/weather-and-air/>
- Waikato Regional Council. (2023).** *Response to Whangamarino Avian Botulism*. <https://www.waikatoregion.govt.nz/community/whats-happening/news/media-releases/response-to-whangamarino-avian-botulism/>
- Walker S, Price R, & Rutledge DT. (2008).** *New Zealand's Remaining Indigenous Cover: Recent Changes and Biodiversity Protection Needs*. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc284entire.pdf>
- Walker K, Brook FJ, Barker GM, Roscoe DJ, Edwards E, Hitchmough RA, Rolfe JR, & Michel P. (2021).** *Conservation status of New Zealand indigenous terrestrial Gastropoda (slugs and snails), 2020 Part 2. Achatinellidae, Bothriembryontidae (pūpūharakeke), Euconulidae, Helicarionidae, Pupinidae and Vertiginidae*. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs33entire.pdf>
- Walker S, Harding MAC, & Loh G. (2023).** The pattern of declines and local extinctions of endemic inland *Lepidium* species in the eastern South Island. *New Zealand Journal of Ecology* 47(1): 3547. <https://doi.org/10.20417/nzjecol.47.3547>
- Walker K, Walton K, Edwards ED, Hitchmough R, Payton IJ, Barker GM, & Michel P. (2024a).** *Conservation status of New Zealand indigenous terrestrial Gastropoda (slugs and snails). Part 3, Rhytididae (carnivorous snails), 2022*. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs42entire.pdf>
- Walker E, Jowett T, Whaanga H, & Wehi PM. (2024b).** Cultural stewardship in urban spaces: Reviving Indigenous knowledge for the restoration of nature. *People and Nature*, 6(4), 1696-1712. <https://besjournals.onlinelibrary.wiley.com/doi/pdf/10.1002/pan3.10683>
- Wang S-J., & Zhou L-Y. (2019).** Integrated impacts of climate change on glacier tourism. *Advances in Climate Change Research*, 10(2), 71–79. <https://doi.org/10.1016/j.accr.2019.06.006>
- Warbrick I, Makiha R, Heke D, Hikuroa D, Awatere S, & Smith V. (2023).** Te Maramataka: An indigenous system of attuning with the environment, and its role in modern health and well-being. *International Journal of Environmental Research and Public Health*, 20(3). <https://doi.org/10.3390/ijerph20032739>
- Ward D, Early JW, Schnitzler FR, Hitchmough R, Rolfe JR, & Stringer I. (2017).** *Conservation status of New Zealand hymenoptera, 2014*. Department of Conservation. <https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs18entire.pdf>

- Warmenhoven T, Barnard T, Pohatu P, Garrett L, Porou T, Fitzgerald G, ... & Ruru W. (2014).** *Climate Change and Community Resilience in the Waiapu Catchment*. <http://www.mpi.govt.nz/news-resources/publications.aspx>
- Water NZ (Water New Zealand). (2024).** *National Performance Review 2021/2022*. <https://www.waternz.org.nz/NationalPerformanceReview>
- Watkins L, Aitken R, Robertson K, Thyne M, Williams J, & van Kerkhof R. (2021).** *Challenges, constraint and commitment to change. A New Zealand Consumer Lifestyles Study*. University of Otago. https://www.otago.ac.nz/_data/assets/pdf_file/0026/330947/challenge-constraint-and-commitment-to-change-a-new-zealand-consumer-lifestyles-study-832662.pdf
- Watt MS, Kirschbaum MUF, Moore JR, Pearce HG, Bulman LS, Brockerhoff EG, & Melia N. (2019).** Assessment of multiple climate change effects on plantation forests in New Zealand. *Forestry*, 92(1), 1–15. <https://doi.org/10.1093/forestry/cpy024>
- Weinhäupl C, & Devenish-Nelson ES. (2024).** Potential impacts of climate change on terrestrial Aotearoa New Zealand's birds reveal high risk for endemic species. *Biological Conservation*, 296. <https://doi.org/10.1016/j.biocon.2024.110668>
- White MP, Elliott LR, Gascon M, Roberts B, & Fleming LE. (2020).** Blue space, health and well-being: A narrative overview and synthesis of potential benefits. *Environmental Research*, 191, 110169. <https://doi.org/10.1016/j.envres.2020.110169>
- Whitehead AL, Fraser C, Snelder TH, Walter K, Woodward S, & Zammit C. (2022).** *Water Quality State and Trends in New Zealand Rivers: Analyses of National Data Ending in 2020*. NIWA Client Report 2021296CH prepared for Ministry for the Environment. <https://environment.govt.nz/assets/publications/river-water-quality-state-and-trends.pdf>
- WHO (World Health Organization). (2021).** *WHO Global Air Quality Guidelines: particulate matter (PM_{2.5} and PM₁₀), ozone, nitrogen Dioxide, sulfur dioxide and carbon monoxide*. <https://iris.who.int/handle/10665/345329>
- Wickham L, Metcalfe J, Mason K, Science JP, Director KM, Woodward A, ... & Nicoll R. (2023).** *Air Quality and Social Inequity in Aotearoa: A Preliminary Assessment*. <https://www.esr.cri.nz/digital-library/environmental-health-report-air-quality-and-social-inequity-in-aotearoa-a-preliminary-assessment/>
- Wilcox M, McKay AM, Clifton TA, Marshall A. (2024).** *Te Tirohanga o Ngā Tohu: Taranaki Climate Resilience Tool Development*. Manaaki Whenua – Landcare Research report LC4441. <https://deepsouthchallenge.co.nz/wp-content/uploads/2024/06/Te-Tirohanga-o-Nga-Tohu-Taranaki-Climate-Resilience-Tool-Development.pdf>
- Winkelmann, H., Glazebrook, S., & France, E. (2019).** *Climate Change and the Law*. <https://www.courtsofnz.govt.nz/publications/speeches-and-papers/climate-change-and-the-law>
- WMO (World Meteorological Organization). (2017).** *WMO Guidelines on the Calculation of Climate Normals* (WMO-No. 1203). <https://library.wmo.int/records/item/55797-wmo-guidelines-on-the-calculation-of-climate-normals>
- WMO (World Meteorological Organization). (2022).** *Scientific Assessment of Ozone Depletion: 2022*. <https://csl.noaa.gov/assessments/ozone/2022/>
- WMO (World Meteorological Organization). (2024).** *WMO Global Annual to Decadal Climate Update (2024-2028)*. <https://wmo.int/publication-series/wmo-global-annual-decadal-climate-update-2024-2028>
- WMO (World Meteorological Organization). (2025).** WMO confirms 2024 as warmest year on record at about 1.55°C above pre-industrial level. <https://wmo.int/news/media-centre/wmo-confirms-2024-warmest-year-record-about-155degc-above-pre-industrial-level>
- Wood SA, Vandergoes MJ, Atalah J, Howarth JD, Waters S, Thomson-Laing G, ... & Pearman JK. (2023).** A national-scale trophic state analysis to prioritize lakes for restoration in Aotearoa New Zealand. *Inland Waters*, 13(3), 303–315. <https://doi.org/10.1080/20442041.2023.2257457>

- Wynyard M. (2016).** *The price of milk: Primitive accumulation and the New Zealand dairy industry.* [PhD thesis, University of Auckland]. <https://researchspace.auckland.ac.nz/handle/2292/29483>
- Wyse SV, Macinnis-Ng CMO, Burns BR, Clearwater MJ, & Schwendenmann L. (2013).** Species assemblage patterns around a dominant emergent tree are associated with drought resistance. *Tree Physiology*, 33(12), 1269–1283. <https://doi.org/10.1093/treephys/tpt095>
- Yan H, Li Q, Feng K, & Zhang L. (2023).** The characteristics of PM emissions from construction sites during the earthwork and foundation stages: An empirical study evidence. *Environmental Science and Pollution Research*, 30(22), 62716–62732. <https://doi.org/10.1007/s11356-023-26494-4>
- Yeates GW, Zhao ZQ, Hitchmough RA, & Stringer IAN. (2012).** The conservation status of New Zealand Nematoda. *New Zealand Entomologist*, 35(2), 128–130. <https://doi.org/10.1080/00779962.2012.686317>
- Zhang Y, Zhao, J, Mavoa, S, & Smith M. (2024).** Inequalities in urban green space distribution across priority population groups: Evidence from Tāmaki Makaurau Auckland, Aotearoa New Zealand. *Cities*, 149, 104972. <https://doi.org/10.1016/j.cities.2024.104972>
- Zielinska-Dabkowska KM, & Xavia K. (2021).** Looking up to the stars. A call for action to save New Zealand’s dark skies for future generations to come. *Sustainability (Switzerland)*, 13(23). <https://doi.org/10.3390/su132313472>
- Zimmermann L, Gottlich S, Oehlmann J, Wagner M, & Volker, C. (2020).** What are the drivers of microplastic toxicity? Comparing the toxicity of plastic chemicals and particles to *Daphnia magna*. *Environmental Pollution*, 267, 115392. <https://doi.org/10.1016/j.envpol.2020.115392>



Ministry for the
Environment
Manatū Mō Te Taiao



Te Kāwanatanga o Aotearoa
New Zealand Government

Our environment, our lives: The stories behind the numbers

Tō tātou taiao, ō tātou ora: Ngā kōrero mō ngā tau

Our environment 2025 | Tō tātou taiao



Published in April 2025 by the
Ministry for the Environment
Manatū mō te Taiao

environment.govt.nz

Publication number: INFO 1292

© Crown copyright New Zealand 2025

Cover: Ahipara Bay, Te Taitokerau Northland.

Photo: Laura Evans, truestock.

Infographic (page 3): Dumpark Information Design.

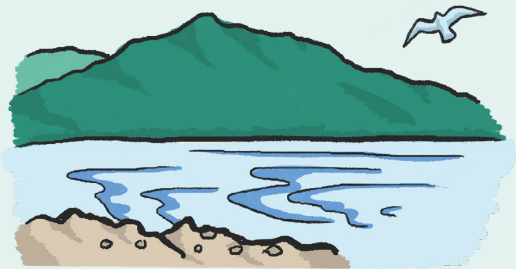
Our environment is changing Kei te hurihuri tō tātou taiao

Our environment 2025

Aotearoa New Zealand's environment is continually changing due to natural events, human activities over time, and a changing climate.

People have shaped our natural and urban places as we've grown food and fibre, built homes and businesses, and strived to improve life for our families, communities and our future.

Our environment 2025 shows cause for concern. It indicates that the ways we choose to live are changing the built and natural environment, and affecting our health, quality of life, homes, livelihoods and connection to place in both positive and negative ways.



The three-yearly update on the state of the environment, produced by the Ministry for the Environment and Stats NZ, collates key findings and data across environmental domains – land, freshwater, marine, climate and atmosphere, and air.

Our environment, our lives: The stories behind the numbers is the Ministry's companion document to the *Our environment 2025* report. It highlights how we rely on the environment in many ways, whether we live in a city, rurally or along the coast. It outlines some of the risks the changing environment and climate pose to people and places, and what enables us to thrive.

This document also casts light on some of the many positive actions New Zealanders are taking to reverse some of the damage and build greater resilience, whether at community, iwi, business or government level.

This shows how, with access to comprehensive evidence and data today, we can make informed choices that drive better outcomes tomorrow. This way, New Zealand can reap the social, environmental and economic benefits of being as prepared as possible for the future.

Environmental data to support informed decisions

The Ministry for the Environment, in partnership with Stats NZ, reports on different aspects of our environment every six months and provides an overview of the whole environment every three years.

These reports draw on data from Crown research institutes, regional and district councils, mātauranga Māori (Māori knowledge), research literature, and government reports. This comprehensive body of evidence allows us to track human impacts, identify emerging challenges, and support informed decision-making for managing natural resources and adapting to environmental change.

This companion document to *Our environment 2025* delves into some of the stories behind the numbers.

How our environment is connected

He pēhea tō tātou taiao e honoa ai

Our environment is made up of many interconnected parts – air, water, soil, plants, animals and people. The decisions people make drive changes in these, which in turn shape our health, livelihoods and quality of life.

At a global level, decisions influence the political, social, economic and environmental forces that shape our country. On a personal level, the choices we make in our daily lives impact the environment, ecosystems and species, which in turn affect us and the world around us.

For example, how we use land impacts the plants and animals living there. From land, these effects spread to water – pollution and run-off can harm rivers, lakes and groundwater. The effects don't stop there; flowing to the sea, and putting marine life at risk. Air quality is also affected by activities such as transport, home heating, farming and industry which can harm people's health.

Climate change amplifies these pressures. Rising temperatures and extreme weather put even more strain on our ecosystems, species and the environment.

Because we are all part of the environment, it comes full circle. When the environment we depend on for our health, homes and livelihoods is changing, we feel these impacts too. Change is inevitable, even as we protect ourselves with sea walls, or build wind turbines for cleaner energy, we are altering our environment.

Evidence and data help us understand this connection, driving better decisions that grow resilient communities, and build prosperity that lasts into the future.

Preparing for a resilient future

Our environment 2025 shows how important it is to build resilience into how we plan, invest and make other decisions, so New Zealand can be best prepared for the future. Robust evidence and data about our changing environment helps New Zealanders make the most informed decisions.

Initiatives led by individuals or communities, by iwi, business or by central and local government, are providing examples of positive action which inspire hope for the future of people and the environment on which we depend.

Native forest project aims to protect drinking water

- ▶ Iwi, local government and central government are working together on a native forest project that will boost biodiversity in Tairāwhiti and help to protect Gisborne's water supply. **Read about this project on page 5.**

Using nature to protect homes

- ▶ Auckland Council is establishing a network of waterways and parks in Auckland to give stormwater a place to flow and to protect homes from flooding. **Read about this project on page 7.**

Driving technological progress to protect our livelihoods

- ▶ A company based in New Zealand has developed technology that will help to reduce methane emissions from livestock. **Read about this project on page 9.**

Iwi-led project aims for a thriving estuary

- ▶ Iwi, land owners, local government and central government are working together to restore one of the most degraded estuaries in New Zealand. **Read about this project on page 11.**

Our environment Tō tātou taiao

All parts of the environment are connected to each other, and to people.



People

We are part of the environment. Our activities and decisions drive changes in the environment, and these changes shape our quality of life.



Land

How we use the land begins a cycle of environmental impacts and brings changes to our lives and livelihoods.



Freshwater

What happens on land flows into our lakes, rivers and groundwater, affecting ecosystems and biodiversity as well as our health.



Atmosphere and climate

Climate change amplifies changes to other parts of the environment. Warming temperatures and more extreme weather affect our lives in many ways.



Air

Transport, home heating, agriculture and industry can lower air quality, which impacts our health.



Marine

Rivers and streams affect water quality at our coasts. Combined with our fishing practices, this impacts marine habitats and the people who rely on them.

Our health and quality of life Tō tātou hauora me te āhua o te noho

We depend on a healthy environment to thrive

We rely on the environment for access to nutritious food, clean air, and safe water. When ecosystems are healthy, they can support these needs. But when they are unhealthy, they are less able to provide the things we need to thrive.



Poor air quality, contaminated water, and the effects of climate change can threaten our lives and livelihoods. These consequences are not felt equally, with some population groups more at risk than others.



Climate change and extreme weather also impact our health, increasing the risks of disease, interrupted food supply, poor air quality, and water contamination, as well as causing mental health issues.



How we live will always have an impact on the environment. Even as we protect ourselves from natural hazards, we are changing our natural and urban places.



Depending on the choices we make, we can have a positive impact too. *Our environment 2025* shows how cleaner cars and heating have improved air quality.

What *Our environment 2025* tells us

Urban development and land fragmentation are decreasing the availability of highly productive land for fruit and vegetable growing.

Agriculture, forest harvesting, urban growth, and wastewater infrastructure failures can pollute our waterways, harming ecosystems and making water unsafe for drinking and recreation.

Events, such as extreme weather, can disrupt access to affordable and nutritious food and cause price changes.



Air pollution from motor vehicles is reducing due to stronger emission standards, more people choosing to use lower emission vehicles, and improvements to engines and fuel. However, road transport continues to be the main source of nitrogen oxides pollution.

In 2019, it was estimated that human-made air pollution in the form of PM_{2.5} and NO₂ was a factor in 3,239 premature deaths, 13,237 hospitalisations, and 12,653 cases of childhood asthma. It is estimated that air pollution from motor vehicles was associated with 71 percent of these hospitalisations and 69 percent of premature deaths.



At least 49 drinking water illness outbreaks have been reported since 1980. These include the 2016 campylobacteriosis outbreak in Havelock North, which made an estimated 6,000–8,000 people ill, hospitalised 42 people, and led to at least four deaths.

Native forest project aims to protect drinking water

Local and central government, together with iwi, communities and business, have been the driving force behind a range of projects that benefit the environment, people and the regions.

Many of these projects aim to reduce the impacts we are having on our freshwater by how we use our land.

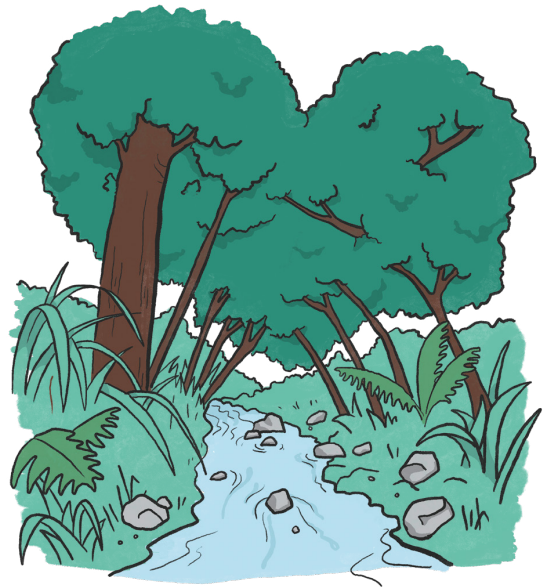
Case study: Te Ara Whakahou o Waingake

A native forest restoration project in Tairāwhiti will help to protect Gisborne's water supply, as well as boost biodiversity.

Gisborne District Council and mana whenua Maraetaha Incorporated (supported by Ngāi Tāmanuhiri) are converting 1,100 hectares of pine plantation at Waingake to indigenous forest, working together for the whenua, for whānau, and for the future.

Tairāwhiti has lost many of its original natural ecosystems, including native bush. The Waingake block currently consists of about 1,100 hectares of commercial pine forestry and 500 hectares of native vegetation in various stages of regeneration and maturity. Staged harvest of the pine plantation began in 2018. The last pine trees are likely to be harvested by 2027.

Plantation forestry activities in highly erodible hill country can impact drinking water if they occur in catchments where dams that supply drinking water are located. There is the potential for sediment to wash into streams, particularly if there are storms during harvesting and replanting.



Converting the Waingake block to native forest, and undertaking weed and pest control, will help to:

- protect highly erodible land against extreme weather
- stabilise land that a water supply pipeline crosses
- filter run-off to three dams that supply drinking water to Gisborne.

The regenerating forest will connect with Waingake Waterworks Bush, which is the largest and most significant coastal lowland forest in Tairāwhiti, as well as home to several rare and threatened flora and fauna.

Native species that will benefit from this programme include long-tailed bats, North Island rifleman, New Zealand falcon, *Hebe tairāwhiti* and two species of mistletoe (*Peraxilla tetrapetala* and *Tupeia antarctica*).



Our homes and property Ō tātou kāinga me ō tātou papanoho

Environmental change creates risk to communities

Our homes are the places where we live, grow up and spend time with those we love. Often, they are also the biggest investment many of us will make in our lifetimes.



We should all feel safe and secure where we live. But often, where communities are located can put homes, businesses and infrastructure at risk of flooding or wave and storm damage. Climate change has increased the frequency and intensity of extreme weather events, making their effects worse. Meanwhile, sea-level rise is increasing risks to coastal communities.



Over the years more and more New Zealanders are living in towns and cities. These are intrinsically linked to natural places. Urban densification done well can take the pressure off the built and natural environment and contribute to quality of life.



Large numbers of us also live on or near coastlines. New Zealand will face tough decisions about how or whether to modify the natural landscape to protect communities from sea-level rise and climate disruption. How we respond to these challenges will also change the environment.

What *Our environment 2025* tells us

84%

84 percent of people in New Zealand live in cities and many people live on or near the coast.

Development in our towns and cities can displace or degrade 'natural infrastructure' that acts as a buffer against extreme weather. However, more innovative and nature-based infrastructure (eg, re-establishing floodplains and restoring streams and wetland sponges) can conserve and improve ecosystems.

Developing near rivers and on floodplains can increase the flood risk to homes and infrastructure during heavy rain.



In 2019, 2,273 kilometres of roads, 5,572 kilometres of water pipes, and buildings with a replacement value of \$26.18 billion were assessed as vulnerable if sea levels rise by 0.6 metres.



\$145b

About 750,000 people and 500,000 buildings worth more than \$145 billion are near rivers and in coastal areas already exposed to extreme flooding.

Coastal communities are vulnerable to extreme wave and storm events, as well as erosion and flooding caused by sea-level rise.

Using nature to protect our homes

After the devastating storms in early 2023, Auckland Council launched a \$760 million, 10-year flood mitigation programme.

The Making Space for Water programme extends the 'blue-green' network of waterways and parks that give stormwater space to flow and help to reduce flooding where people live. In dry weather, the community can enjoy these parks. During storms, the parks may flood, moving water away from people's homes. The network includes Te Auaunga Oakley Creek.

Case study: Te Auaunga – Making space for water in Auckland



Te Auaunga, also known as Oakley Creek, is Auckland's longest urban river, stretching 15 kilometres. Two hundred years ago, it was part of a wetland, Te Wai-inu-roa o Rakataura, which was rich in native flora and fauna. The wetland also played an important role in drainage and flood mitigation.

Settlers in the 19th century drained the wetland and cleared the forests for farmland which was later developed into a residential area. By the mid-1950s, Te Auaunga was confined in concrete pipes. These were unable to cope with stormwater when further houses were built in the 20th and 21st centuries. Also, the creek had been much reduced, and it was unable to support the rich ecosystems of the wetland.

Flooding in the area was managed with a fast-flowing culvert which often failed to protect nearby houses from flooding. The concrete flood management system was not only inadequate, but also unlikely to cope with increased volumes of stormwater caused by climate change.

Above: Te Auaunga, Oakley Creek.
Photo: Jolisa Gracewood.

In 2015/16, Healthy Waters Auckland and six iwi authority groups started a restoration project to reduce flooding in the area, restore ecological health, and improve community engagement. Works involved:

- ▶ widening Te Auaunga to increase water-carrying capacity
- ▶ removing basalt and realigning the stream
- ▶ replacing road culverts with bridges
- ▶ planting thousands of native shrubs and trees to absorb stormwater and provide natural water filtration
- ▶ developing cycle paths, walking trails and recreational spaces.

The project has helped to reduce flooding in the area. Also, more people now use the park and they report that the stream appears to be healthier.

Green-grey infrastructure projects like Te Auaunga can have economic benefits too. While sometimes having higher upfront costs than 'grey' infrastructure, they can be more cost-effective over time. The restoration of Te Auaunga employed 30 young people to construct and maintain the new infrastructure. It costs less to insure green than grey infrastructure and costs associated with damage from flooding are lower.



Our livelihoods Ō tātou oranga

Our economy depends on the environment

The economy in New Zealand relies heavily on the natural environment, with our primary industries and tourism sector generating much of the revenue that sustains our way of life. In a world and environment that continues to change, it is critical we build our environmental, social and economic resilience, so we can be prepared for the future.



The sectors we most rely on in New Zealand, such as agriculture, depend on the environment to remain profitable. They are also highly vulnerable to environmental and climate change, including extreme weather events and rising sea levels, and can have significant impacts on the natural environment.



Our fisheries depend on resilient ecosystems and biodiversity. However, many commercial species are at risk due to threats that include climate change, sedimentation, diseases and invasive species.

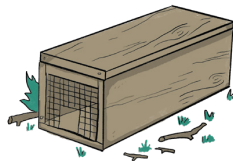


To safeguard our livelihoods and maintain market access, industries must adapt to and prepare for disruptions caused by a changing climate. Additionally, reducing pollution and emissions is crucial, not only to protect the environment, but also to preserve our market access and global reputation.

What *Our environment 2025* tells us

57%

Hydroelectricity provided an average of 57 percent of our electricity each year between 2010 and 2021, but is vulnerable to changes in rainfall.



The total cost of pests to New Zealand was estimated at \$9.2 billion in 2019/20, including primary sector losses of \$4.3 billion.

Climate change, environmental degradation, biodiversity loss, and shorter snow seasons put our tourism industry at risk.



\$700m

The cost for our food and fibre sectors to recover from Cyclone Gabrielle is estimated to be between \$700 million and \$1.1 billion.

Extreme weather and climate change affect the viability of food crops, make forest plantations vulnerable to wildfires, and increase the risk of pests and diseases.



Driving technological progress to protect our livelihoods

New Zealand farmers are among the most climate efficient producers in the world. Nevertheless, agriculture makes up more than half of the country's gross emissions.

The Government aims to reduce agricultural emissions in a way that does not compromise exports or reduce the sector's competitiveness. It is taking a technology-led approach to managing agricultural emissions and has invested more than \$400 million to speed up the development and use of tools and technologies to reduce emissions.

Case study: Ruminant BioTech – New Zealand company develops world-leading methane inhibitor technology



New Zealand-based Ruminant BioTech has developed world-leading methane inhibitor technology that can reduce daily methane emissions in cattle by more than 70 percent for up to 100 days.

The long-duration bolus platform will be the first commercially viable product for beef and dairy producers in New Zealand. It is aimed at providing a simple, practical and effective methane reduction solution designed for grass-fed pastoral farming operations.

The technology involves giving a bolus by mouth with a special applicator. The bolus moves through the digestive tract and sits in the animal's rumen where it releases a dose of active ingredient over a prolonged period.

Farmers in New Zealand have used boluses safely for more than 50 years, most commonly to deliver medicines and trace elements or minerals. In recent years, Ruminant BioTech's research and development programme has focused on fine-tuning this technology and undertaking extensive testing to ensure it is safe for animals and has no adverse impact on the quality or safety of the food produced.

The company has concentrated on delivering a bolus for beef cattle weighing over 350 kilograms, with plans to expand this solution to all beef and dairy cattle. Broad adoption of the bolus platform will significantly reduce greenhouse gas emissions from the agriculture sector.

Projections released with the Government's second emissions reduction plan 2026–30, published in December 2024, suggest that New Zealand is on track to meet net zero emissions by 2050. The projections suggest the country can also achieve its 2030 and 2050 biogenic methane targets, through implementing the policies in the second emissions reduction plan. That means reducing biogenic methane emissions by 10 percent below 2017 levels in 2030 and by 24–47 percent below 2017 levels in 2050.

Key facts

- Agriculture makes up 81 percent of merchandise exports and provides nearly 13 percent of all our jobs.
- 78.2 percent of gross agricultural emissions in New Zealand are methane produced by the digestive process of ruminant animals such as cattle, sheep and goats.

Above: Cattle at Timaru, Canterbury.
Photo: Kathryn Taylor, truestock.

Our connection to place

Tō tātou toiwhenua

Our special places are at risk

New Zealand's natural landscapes and ecosystems are unique in the world and central to our culture and national identity. This is where we walk, swim, connect with nature and have fun, in ways that keep us happy and healthy and connected to each other. For some Māori, land, water and the environment are inseparable from identity as iwi, hapū and whānau.



Land-use activities have polluted many of our rivers and lakes, making some unsafe for swimming or collecting food. Introduced predators and pest plants are contributing to the loss of native species.



Many of our special places are in low-lying or coastal areas, putting them at risk of floods and sea-level rise. These include places important in te ao Māori, such as marae, mahinga kai (food gathering) sites, urupā (burial grounds), and kainga (settlements).

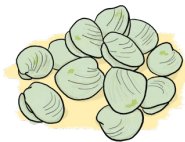


What *Our environment 2025* tells us

In some major cities (eg, Auckland and Hamilton), the availability of parks and reserves is not keeping pace with urban growth. Private green space is also declining, and this trend is accelerating.

78%

In 2021, 78 percent of indigenous terrestrial bird species were threatened with extinction or at risk of becoming threatened.



A survey of five mahinga kai (food gathering) sites in coastal North Canterbury in 2019–21 detected *E. coli* on watercress and in cockles at levels that exceeded health guidelines for human consumption.



191

420 archaeological sites on public conservation land are at risk of coastal inundation with rising sea levels, while 191 marae in New Zealand are within one kilometre of the coast.

55%

Models based on communities of macroinvertebrates (eg, freshwater crayfish) indicate that, between 2016 and 2020, 55 percent of river length had moderate or severe organic pollution or nutrient enrichment. Trends at 56 percent of monitoring sites were worsening.

Iwi-led project aims for a thriving estuary

The way we use our land and water impacts our natural landscapes and continues to threaten our unique and fragile biodiversity. It also impacts places and taonga of historical and cultural value. While change to the environment is continual, people are showing how some of the damage can be prevented or reversed, by looking at the environment as a system.

Iwi collective Te Wahapū o Waihi and Toi Moana Bay of Plenty Regional Council have a shared vision of creating a 'korowai around the Waihi Estuary' – a protective buffer of wetlands designed to help restore the health of this highly degraded area.

Case study: Te Wahapū o Waihi



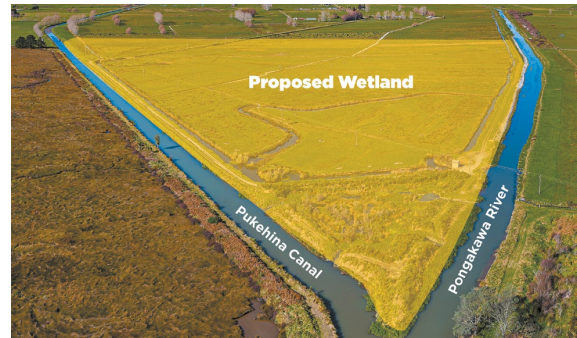
Wahapū o Waihi (Waihi Estuary) in the Bay of Plenty is a significant mahinga kai (food gathering) area.

It has been identified as one of the most degraded in the country, due to decades of wetland drainage, river channelisation, land-use change, and contaminated run-off throughout the 35,000-hectare catchment. Monitoring and modelling work shows that it needs 40–60 percent reductions of sediment, nutrients and pathogens (disease-causing organisms), as well as in-estuary interventions, to achieve a state of moderate health.

In June 2023, iwi Ngāti Whakahemo, Ngāti Whakaue ki Maketū, Ngāti Mākino, Ngāti Pikiao, and Tapuika joined forces on a restoration project supported by Toi Moana Bay of Plenty Regional Council, the Ministry for the Environment, Ministry for Primary Industries and local land owners.

At the end of 2024, the project had:

- ▶ planted 7.71 hectares of land for erosion control
- ▶ planted 83,893 trees and shrubs
- ▶ fenced 11.26 kilometres of land
- ▶ completed 22 farm environmental plans.



Restoration plan

This project aims to create a thriving Waihi Estuary, catchment and community by:

- ▶ converting at least 64 hectares of farmland into wetlands that will help to restore the health and mauri (life principle, life force, vital essence) of the estuary
- ▶ working with landowners in the catchment who share the same aspirations for the estuary
- ▶ using mātauranga Māori and data sciences to monitor and report on water quality and taonga species
- ▶ undertaking wānanga (meet and discuss, forum), haerenga (trip, journey), and education programmes for rangatahi, whānau and the community to build connection with the estuary.

*He oranga te wahapū, he oranga te iwi.
The health of the estuary is a metaphor
for the health of the people.*

Above left: An aerial view of Wahapū o Waihi (Waihi Estuary) near Maketū in the western Bay of Plenty. Photo: Andy Belcher.

Above right: Construction of a wetland started in November 2024 and tuna (eel) in farm drains were relocated to the wetland site in February 2025. Photo: Toi Moana Bay of Plenty Regional Council.

Government advice and action

Ngā tohutohu me ngā mahi a te kāwanatanga

This document outlines only some of the issues raised in [Our environment 2025](#). If you want a fuller picture of how environmental change is impacting people and nature, head to the report on our website.

The resources below provide information about issues raised in *Our environment 2025*, and highlight some of the ways the Government is addressing them.

How are we limiting warming?

The **second emissions reduction plan**, released in December 2024, has actions for sectors that produce the most emissions: agriculture, transport, energy and waste. [Read this plan on the Ministry for the Environment's website.](#)

How are we measuring progress?

The Ministry for the Environment publishes a **New Zealand Greenhouse Gas Inventory** each year. This is the official annual report of all human-induced emissions and removals in New Zealand. [Read the latest inventory on the Ministry for the Environment's website.](#)

How are we building resilience?

The first **national adaptation plan**, adopted in 2022, sets out how New Zealand will build resilience for an uncertain future. [Read this plan on the Ministry for the Environment's website.](#)

How are we improving freshwater?

The Ministry for the Environment provides updates on its website about projects it has funded to improve the health of rivers, lakes and estuaries in New Zealand under the **Freshwater Improvement Fund**. Find out more [on the Ministry for the Environment website.](#)

How are we fixing infrastructure?

The **Rautaki Hanganga o Aotearoa New Zealand Infrastructure Strategy** sets a pathway to transform our infrastructure over the next 30 years. [Read the strategy on the Infrastructure Commission's website.](#)

How are we protecting exports?

The Ministry for Primary Industries has developed an **MPI action plan 2025–26** that aims to double exports, help farmers to reduce emissions, and protect New Zealand from harmful pests and diseases. [Read the action plan on MPI's website.](#)

How are we reducing waste?

Businesses and organisations based in New Zealand can **apply for funds to finance projects** that stop certain waste materials from going to landfill. [Get more information on the Ministry for the Environment's website.](#)

How are we helping biodiversity?

Te Mana o te Taiao – Aotearoa New Zealand Biodiversity Strategy 2020 outlines how we will protect, restore and sustainably use biodiversity in New Zealand between 2020 and 2050. [Read the strategy on Department of Conservation's website.](#)

How are we improving energy use?

The **Energy Efficiency and Conservation Authority** (EECA) subsidises Kiwi households to insulate their homes and install efficient heaters. [Go to EECA's website for information about the Warmer Kiwi Homes scheme.](#)



Date: 29 April 2025

Subject: Replacement of the Resource Management Act

Author: F Kiddle, Strategy Lead

Approved by: A D McLay, Director - Resource Management

Document: TRCID-1492626864-580

Purpose

1. To provide an overview of recent Government announcements regarding the replacement of the Resource Management Act 1991 (RMA).

Executive summary

2. The Government has announced details on its approach to replacing the RMA. It will see the creation of a new Planning Act (to cover land use and development issues) and a Natural Environment Act to cover environmental issues.
3. Both regional councils and territorial authorities will need to collaborate on the creation of a joint spatial plan. The new regime involves a shift towards stronger national direction and greater recognition of private property rights. Greater centralization is also proposed with the creation of a national compliance, enforcement and perhaps environmental monitoring body.
4. While there are significant details still to be developed and potential for some policy direction to shift, the new regime will change how Taranaki Regional Council (Council) operates. Council officers will report back as more information emerges.

Recommendations

That the Taranaki Regional Council:

- a) receives the memorandum titled *Replacement of the Resource Management Act*
- b) notes the presentation in Attachment 1 that provides an overview of the proposed new regime.

Background

5. The Government has released details on its planned replacement of the RMA. The core of the regime are two new acts. The Natural Environment Act will manage environmental protection and limits. The Planning Act will manage land use, development and infrastructure delivery. A suite of national direction will sit under each Act. The intent is that this national direction is more comprehensive and directive than that currently under the RMA.
6. Each region will be required to create one spatial plan. Details on what will need to be in a spatial plan is still under development. However, it is reasonable to expect that there will be a strong focus on the provision of infrastructure and identification of areas for growth. This will also likely include identifying

areas for development to avoid, for example due to natural hazard risk or areas of significant ecological value.

7. There will be a single plan for a region. It will comprise of a spatial plan jointly prepared by all councils, a chapter related to the Natural Environment Act prepared by the regional council, and a chapter for each territorial authority related to the Planning Act.
8. Under the new regime there will be more direction regarding the setting of environmental limits. Limits related to human health will be set at the national level. Regional councils will still set limits to protect the natural environment based on overall direction and methodologies set at the national level.
9. Overall, the new regime will place a greater focus on private property rights. This will be primarily through two avenues. First, a greater focus on utilizing permitted activities, backed up by a strengthened monitoring and compliance regime to ensure the appropriate standards are met. The increased use of a permitted activity status will reduce the number of resource consents required. Second, potential provisions regarding regulatory takings. A regulatory taking is where a regulation from central or local government negatively impacts the expression of a private property right. Under, such a regime there could be a level of compensation provided to the property owner for such a taking.
10. The Government is also proposing to centralize all resource management related compliance and enforcement activity. This would see these functions taken away from councils and placed into a national entity with a "regional presence". Cabinet will also consider if this new entity should take over the environmental monitoring functions currently done by regional councils.
11. The RMA reform process has the potential to significantly change the range of functions currently undertaken by local government, which could have flow-on implications for organisational form. Cabinet has asked that the Minister for RMA Reform and Minister for Local Government report back *"...by July 2025 with an update on whether local government reforms should be progressed as a consequence of changes to the resource management system."*
12. A new Planning Tribunal will also provide faster access to lower-level dispute resolution than the Environment Court currently provides. This would cover matters such as contesting a notification decision or challenging the interpretation of a consent condition.
13. There will also be some shifts in roles and responsibilities between regional councils and territorial authorities. Regional councils will take responsibility for significant natural areas and outstanding natural landscapes and features. Territorial authorities will likely take over the identification and mapping of highly productive land. Responsibility for natural hazards remains a matter to be determined through agreement amongst the councils in a region.
14. A key change in direction is the proposal to not have a "generic" clause referring to the principles of te Tiriti o Waitangi / Treaty of Waitangi. Instead, the intent is to have a 'prescriptive' clause that specifically sets out how the rest of the act recognizes the te Tiriti / the Treaty and upholds settlement legislation. For comparison, the RMA currently requires "all persons exercising functions and powers under [the RMA], in relation to managing the use, development, and protection of natural and physical resources, shall take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi)."
15. The Government intends to introduce legislation to the House by the end of the year. This would then see a select committee process running for up to six months mainly over the first half of next year. The Government intends to pass the two acts before the election. They have signaled implementation by councils will be expected from mid-2027. The potential establishment of a national compliance, enforcement and perhaps monitoring agency is being progressed in a slower timeframe via a separate process.

Discussion

16. There is considerable detail to still emerge on the shape of the replacement legislation. However, several key shifts are clear that will require consideration by Council as more detail on the new legislation and how it is to be implemented emerges.
17. The removal of compliance, enforcement functions and perhaps monitoring functions would represent a significant change in the functions currently performed by territorial and regional councils. Decisions in this area are to be progressed via a separate process and timeline to that being pursued for the new Planning Act and Natural Environment Act. Council officers will monitor and engage with the policy development process in this area as the Government work progresses. Te Uru Kahika is also progressing work in this area.
18. The new regime will require much closer collaboration with other councils in Taranaki on policy development, likely requiring a joint committee to deliver at least the spatial plan. This work can build on the 'lessons learnt' from the early work progressed under the previous Spatial Planning Act 2023.
19. The Government has signaled its intent to require that implementation of the new planning regime should proceed 'at pace'. Proactive planning will be needed to manage this implementation process once further detail on the new requirements emerges.
20. Council officers will report back to the Policy & Planning Committee as more information emerges. We will also continue to engage with Te Uru Kahika, the three district councils, and central Government on the reforms.

Appendices/Attachments

Document TRCID-1492626864-600: [RM Reform Presentation for P&P](#)



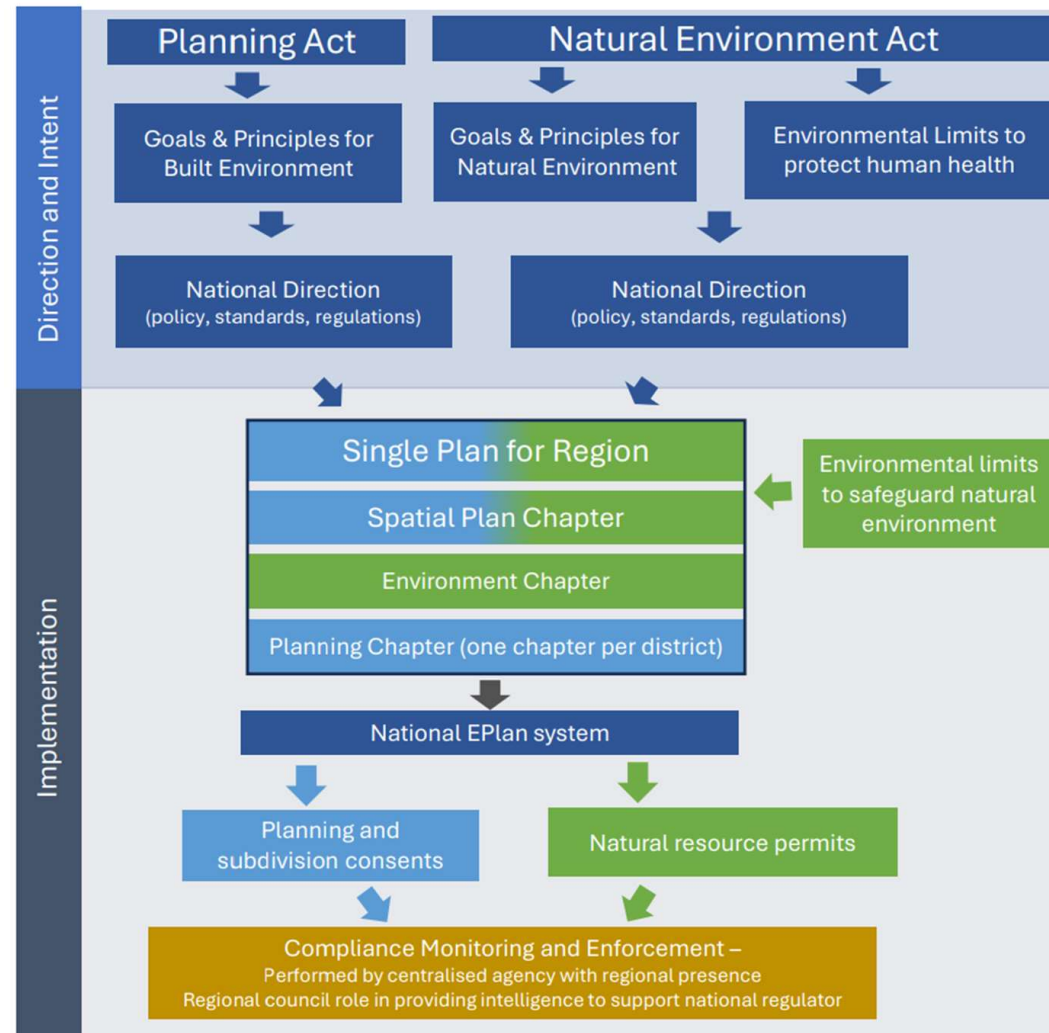
Resource Management Reform

An overview

Working with people | caring for Taranaki



Structure of the new system



Roles and responsibilities

Central Government

- Legislative design
- Setting of environmental limits to protect human health
- Setting of national direction, standards and regulations
- System monitoring and oversight

Environmental Protection Agency

- Development of national limits to protect human health
- Development of methods to support limit-setting by regional councils
- Establishment of a centre of excellence to support regional councils in environmental monitoring

Regional Councils

- Mapping environmental constraints for spatial planning
- Identifying and managing risks of natural hazards, and protection of SNAs and ONLs
- Development of spatial chapter of regulatory plan (jointly with territorial authorities)
- Setting of environmental limits to safeguard the environment
- Setting of allocation limits
- Issuing of natural resource permits
- Environmental monitoring

Territorial authorities

- Development of spatial chapter of regulatory plan (jointly with regional council)
- Development of planning chapter for each district.
- Issuing of planning and subdivision consents

National Compliance Regulator (EPA-like entity)

- Compliance monitoring and enforcement
- Complaint and incident response
- Enforcement of national standards, plan rules, resource consents.

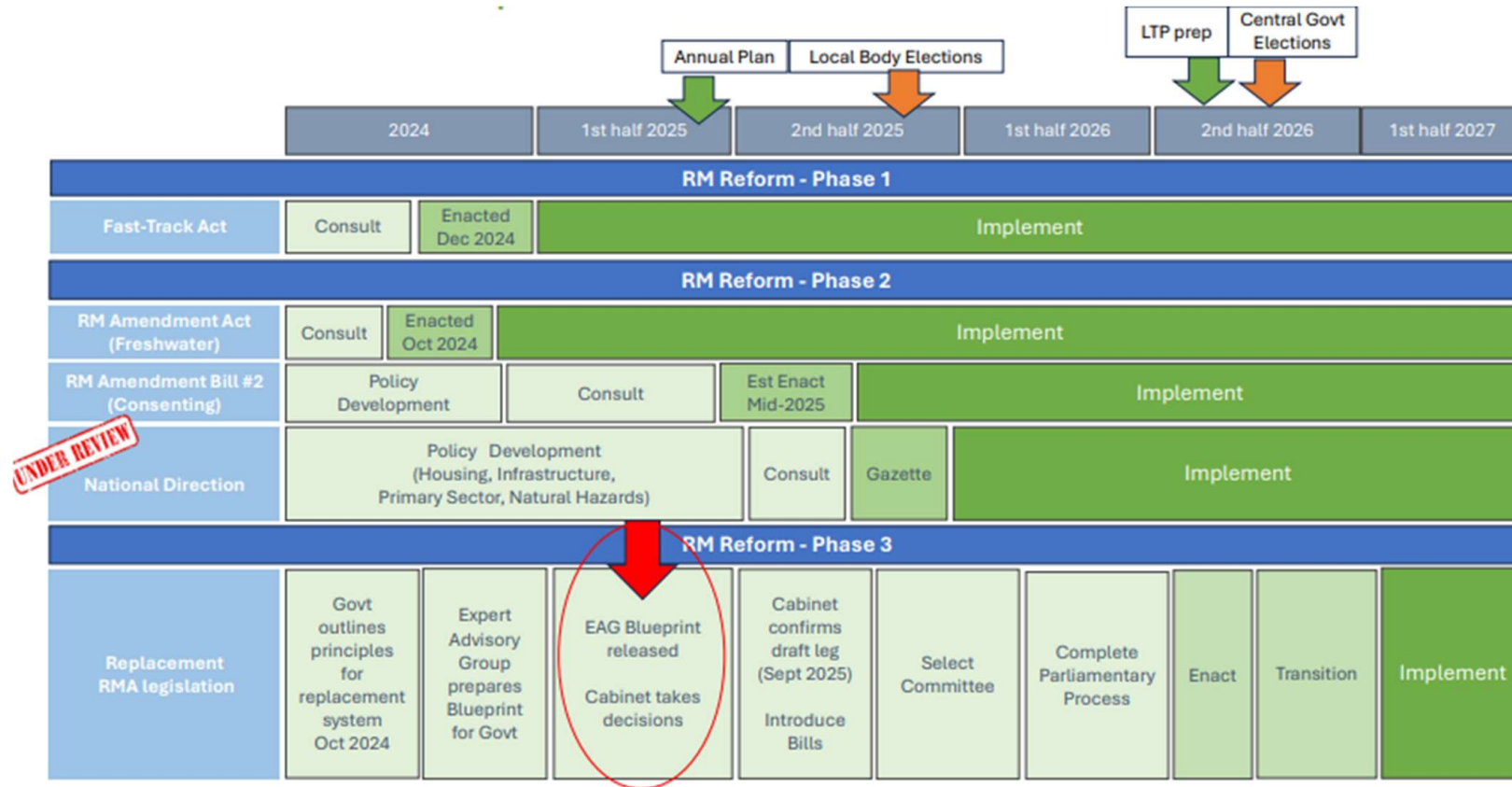
Planning Tribunal

- Disputes on consent applications
- Disputes on existing consent conditions

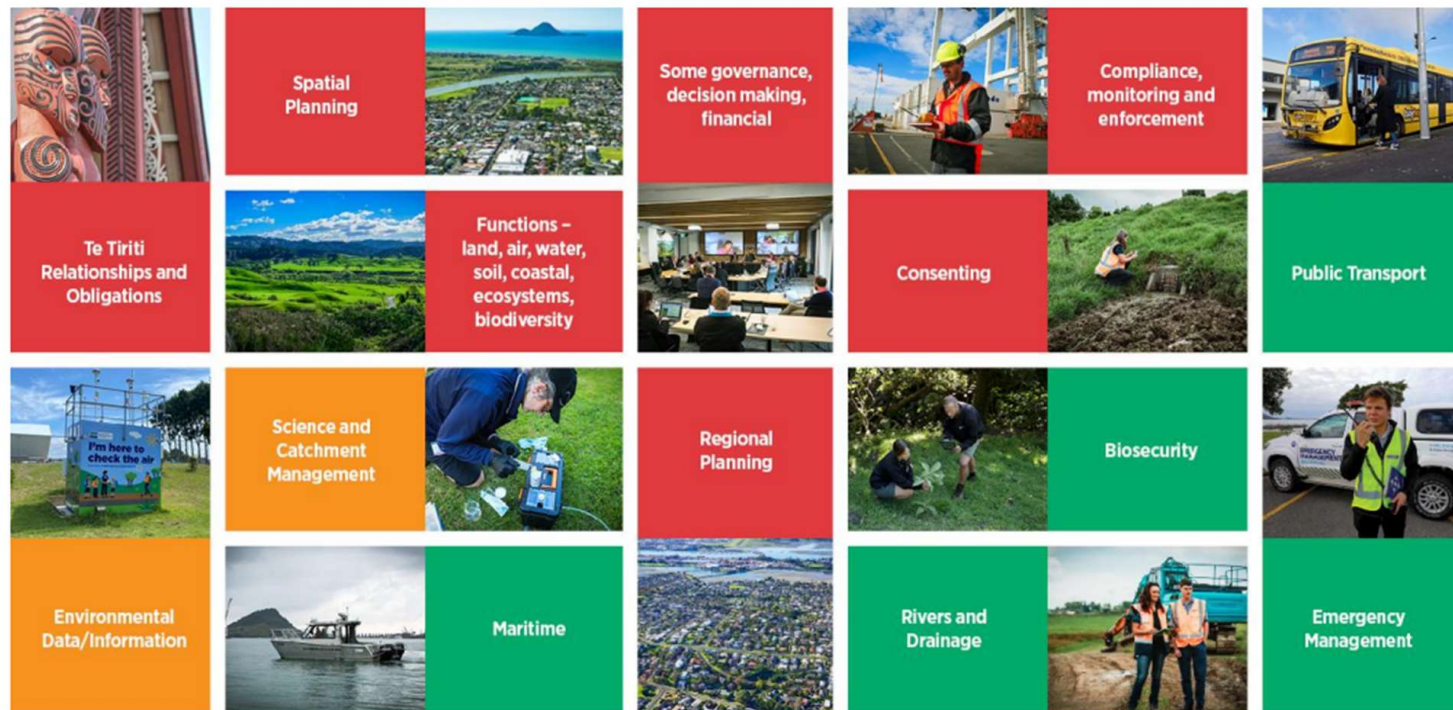
Environment Court

- Appeals on spatial plans and regulatory plans
- Appeals on decisions to refuse consent
- Enforcement action

Timeline



Impact on Council functions



Red: RM Reform changes affects these areas of Council most
Green: Largely not affected by this reform

Key shifts

- Stronger national direction
- Spatial planning as a core element
- Greater acknowledgement of private property rights
- New responsibilities for regional councils
- No 'generic' Treaty clause
- Centralisation of enforcement, compliance and maybe environmental monitoring
- Rapid implementation



Kia uruuru mai

Karakia to close meetings

Kia uruuru mai
Ā hauora
Ā haukaha
Ā haumaia
Ki runga, Ki raro
Ki roto, Ki waho
Rire rire hau
Paimārie

Fill me with
Vitality
Strength
Bravery
Above, below
Within, outwards
Let the wind blow and bind
Peace upon you

Nau mai e ngā hua

Karakia for kai

Nau mai e ngā hua
o te wao
o te ngakina
o te wai tai
o te wai Māori
Nā Tāne
Nā Rongo
Nā Tangaroa
Nā Maru
Ko Ranginui e tū iho nei
Ko Papatūānuku e takoto ake nei
Tūturu o whiti whakamaua kia
tina
Tina! Hui e! Taiki e!

Welcome the gifts of food
from the sacred forests
from the cultivated gardens
from the sea
from the fresh waters
The food of Tāne
of Rongo
of Tangaroa
of Maru
I acknowledge Ranginui above and Papatūānuku
below
Let there be certainty
Secure it!
Draw together! Affirm!

AGENDA AUTHORISATION

Agenda for the Policy and Planning Committee meeting held on Tuesday 29 April 2025.

Confirmed:



16 Apr, 2025 3:44:09 PM GMT+12

A D McLay

Director Resource Management

Approved:



17 Apr, 2025 6:33:28 AM GMT+12

M J Nield

Director – Corporate Services