Environmental Science and Policy Committee

Meeting will be held in the Council Chamber, Level 2, Philip Laing House, 144 Rattray Street, Dunedin

This meeting will be livestreamed to the ORC Official YouTube Channel

Members:
Cr Lloyd McCall (Co-Chair)
Mr Edward Ellison (Co-Chair)
Ms Karen Coutts
Cr Alexa Forbes
Cr Gary Kelliher
Cr Michael Laws
Cr Kevin Malcolm
Cr Tim Mepham
Cr Andrew Noone
Cr Gretchen Robertson
Cr Bryan Scott
Cr Alan Somerville
Cr Elliot Weir
Cr Kate Wilson

Senior Officer: Richard Saunders, Chief Executive

Meeting Support: Kylie Darragh, Governance Support Officer

27 June 2024 11:15 AM

Agenda Topic Page

1. WELCOME

2. APOLOGIES

No apologies received at time of publication.

3. PUBLIC FORUM

At the time of publishing no requests to speak had been received.

4. CONFIRMATION OF AGENDA

Note: Any additions must be approved by resolution with an explanation as to why they cannot be delayed until a future meeting.

5. DECLARATION OF INTERESTS

Members are reminded of the need to stand aside from decision-making when a conflict arises between their role as an elected representative and any private or other external interest they might have. The Register of Councillors Pecuniary Interests are published on the ORC website.

6. PRESENTATIONS

At the time of printing no requests to present had been received.

7. CONFIRMATION OF MINUTES 4

That the minutes of the Environmental Science and Policy Meeting of 20 March 2024 be received and confirmed as a true and accurate record.

8. OPEN ACTIONS FROM THE RESOLUTIONS OF THE COMMITTEE

There are currently no open actions for this committee.

9. MATTERS FOR CONSIDERATION 8

The purpose of this report is to share the State of the Environment (SOE) report: Air quality trends 2005 – 2023 and to briefly summarise the SOE reports' key findings.

The purpose of this report is to present the Water Quality and Biomonitoring report 2018-2023 (attached as Attachment 1) to the Committee. The report presents the most recent results of State of the Environment (SoE) monitoring undertaken to inform attribute tables in Appendix 2A and Appendix 2B of the National Policy Statement for Freshwater Management (NPSFM, 2020). This report also provides some additional regional analysis of the results.

This paper sets out work currently underway in the biodiversity area at ORC to document indigenous biodiversity. It overviews the development of regional threat classifications and includes details of regional conservation statuses for the species groups of indigenous vascular plants and amphibians in Otago.

The purpose of this report is to present the Water Quality and Biomonitoring report 2018-2023 (attached as Attachment 1) to the Committee. The report presents the most recent results of State of the Environment (SoE) monitoring undertaken to inform attribute tables in Appendix 2A and Appendix 2B of the National Policy Statement for Freshwater Management (NPSFM, 2020). This report also provides some additional regional analysis of the results.

Otago Regional Council

Environmental Science and Policy Committee
MINUTES

Minutes of an ordinary meeting of the Environmental Policy and Science Committee held in the Council Chamber, Level 2 Philip Laing House, 144 Rattray Street, Dunedin on Wednesday 20 March 2024, commencing at 9:00 AM.

PRESENT

Mr Edward Ellison *(Chairperson)*
Cr Lloyd McCall
Ms Karen Coutts
Cr Alexa Forbes
Cr Gary Kelliher
Cr Michael Laws
Cr Kevin Malcolm
Cr Tim Mepham
Cr Andrew Noone
Cr Gretchen Robertson
Cr Bryan Scott
Cr Alan Somerville
Cr Elliot Weir
Cr Kate Wilson

1. WELCOME

Chairperson Edward Ellison welcomed Councillors, Iwi Representative members of the public and staff to the meeting at 9.00AM and opened with a karakia. Staff present included Richard Saunders (Chief Executive), Anita Dawe (GM Policy and Science), Gavin Palmer (GM Operations), Joanna Gilroy (Acting GM Regulatory), Amanda Vercoe (GM Governance, Culture and Customer), Trudi McLaren (Governance Support), Fleur Matthews (Manager Policy and Planning) Tom Dyer (Manager Science) James Adams (Senior Policy Analyst).

2. APOLOGIES *[YouTube 7:40]*

The apology from Cr Laws for lateness was noted.

3. PUBLIC FORUM *[YouTube 7:45]*

Aaron Hawkins Chair of the Cosy Homes Charitable Trust spoke and after an opportunity for questions, Chair Ellison thanked them for attending.

Cr Scott sat back for this item as he is a Trustee of the Cosy Homes Charitable Trust and left the meeting at 9:02AM.

Bevan Wilson of the Strath Taieri Irrigation Group spoke and after an opportunity for questions Chair Ellison thanked them for attending.

Cr Wilson sat back for this item.

Cr Scott returned to the meeting at 9:28 am.

4. CONFIRMATION OF AGENDA *[YouTube 31:40]*

Resolution: Chair Ellison Moved/Cr Weir Seconded
That the agenda be confirmed as published.
MOTION CARRIED

5. DECLARATIONS OF INTERESTS *[YouTube 31:45]*

No changes to Councillor Declarations of Interests were noted. Councillors were reminded to signal to the Chair any conflicts of interest arising during the meeting.

Cr Scott sat back during the Public Forum presentation from Cosy Homes Charitable Trust
Cr Wilson sat back during the Public Forum presentation from Strath Taieri Irrigation Group

6. PRESENTATIONS

No requests to present were received.

7. CONFIRMATION OF MINUTES *[YouTube 32:16]*

Resolution: Cr Weir Moved, Cr Noone Seconded

That the minutes of the Environmental Science and Policy Meeting held on 13 December 2023 be received and confirmed as a true and accurate record.

MOTION CARRIED

8. OPEN ACTIONS FROM RESOLUTIONS OF THE COMMITTEE

There are currently no open actions for this committee.

9. MATTERS FOR CONSIDERATION

9.1. Air quality activities 2023 update *[YouTube 32:56]*

The purpose of this report was to present the results of two air quality projects undertaken during 2023: black carbon monitoring in Arrowtown and spatial PM_{10} monitoring in Alexandra.

Anita Dawe (GM Policy and Science), Tom Dyer (Manager Science) and Sarah Harrison (Scientist Air Quality) were present to speak to the report and respond to questions.

Resolution ESP24-101: Edward Ellison Moved, Cr Wilson Seconded

That the Council:

1) ***Notes** the two studies undertaken as part of the Air Quality programme.*

MOTION CARRIED

9.2. Port Otago air quality screening study *[YouTube 1:05:43]*

This report presented the results of an air quality pilot study for sulphur dioxide (SO_2) undertaken at Port Otago during 2022-2023.

Anita Dawe (GM Policy and Science), Tom Dyer (Manager Science) and Sarah Harrison (Scientist Air Quality) were present to speak to the report and respond to questions.

Resolution ESP24-102: Cr Malcolm Moved, Cr Somerville Seconded

That the Committee:

1) ***Notes** this report.*
2) ***Notes** staff recommendation that further monitoring of SO_2 is not required at this time.*

MOTION CARRIED

9.3. Annual Air Quality Report 2023 *[YouTube 1:11:41]*

This annual report discussed the results of the State of the Environment (SOE) monitoring for air quality for the year 2023.

Anita Dawe (GM Policy and Science), Tom Dyer (Manager Science) and Sarah Harrison (Scientist Air Quality) were present to speak to the report and respond to questions.

Cr Scott returned to the meeting at 10:11 am.

Resolution ESP24-103: Cr Weir Moved, Cr Forbes Seconded

That the Council:

1) ***Notes** this report.*

MOTION CARRIED

10. CLOSURE

There was no further business and Chairperson Ellison declared the meeting closed at 10:13 AM and gave a karakia.

_____ _____

Chairperson Date

9.1. SOE Air Quality Trends

Prepared for: Environmental Science and Policy Committee

Report No. SPS2407

Activity: Environmental: Air

Author: Sarah Harrison, Scientist – Air Quality

Endorsed by: Anita Dawe, General Manager Policy and Science

Date: 27 June 2024

PURPOSE

[1] The purpose of this report is to share the State of the Environment (SOE) report: Air quality trends 2005 – 2023 and to briefly summarise the SOE reports' key findings.

EXECUTIVE SUMMARY

[2] Particulate matter less than 10 micrometres in diameter (PM_{10}) data have been analysed for the years 2005 – 2023. In Otago, the National Environmental Standard for Air Quality (NESAQ) are regularly exceeded in three towns – Alexandra, Arrowtown and Mosgiel[1]. PM is extremely seasonal in most Otago towns, with highest emissions occurring in winter.

[3] Trend analysis shows that PM_{10} concentrations deriving from home heating emissions have for the most part, improved over time. The Arrowtown airshed has improved at the greatest rate, at 6.1% per year. The Alexandra airshed has degraded in recent years, with concentrations increasing over time at a rate of 3.2% per year, but with evidence that this is not driven by increases to home heating emissions. All other airsheds have improved between 1.8% and 3.3% per year.

RECOMMENDATION

That the Committee:

1) ***Notes** this report.*

BACKGROUND

[4] ORC operates a State of the Environment air quality monitoring network. The primary parameter monitored is PM_{10}, which has been monitored continuously since 2005. Anthropogenic PM_{10} is produced by combustion sources such as industrial activity, vehicle exhaust and solid fuel burning for home heating and by processes or vehicle movements that create dust. The NESAQ limit for PM_{10} is 50 µg/m³ for a 24-hour average, however, there is no known safety threshold for human health.

[5] Particulate matter is highly seasonal in Otago in most areas. High PM_{10} concentrations are observed in most towns during winter months, which is caused by home heating emissions combined with calm weather and temperature inversions. Many of Otago's airsheds regularly exceed the National Environmental Standard for Air Quality (NESAQ) for PM_{10}.

[1] Three of Otago's monitoring sites, Clyde, Cromwell, and Milton cannot be compared to the NESAQ

[6] The aim of this state and trends report for air quality is to assess the long-term trends of the PM_{10} monitoring data, and to describe the rate of increase (degrading trend, or air quality getting worse) or decrease (improving trend, or air quality getting better) of concentrations. The previous SOE report analysed state and trends of PM_{10} data up until the year 2019. This report provides the most up to date trends and will be used for the Air Plan review process.

DISCUSSION

[7] Between 2005 and 2023 the number of NESAQ exceedances have decreased at every key indicator site[2] (Table 1). The number of exceedances doesn't always explain the direction of the long-term trend because exceedances are extreme outliers in the data. The monthly averages are a more suitable parameter for trend analysis because it more appropriately reflects the typical air quality standard. The long-term trends were analysed at each site using statistical trend analysis based on the monthly averages (Table 2).

[2] Monitoring method accepted under NESAQ

Table 1 Number of NESAQ exceedances for the key indicator sites

Year	Alexandra - 65 Ventry Street	Alexandra - 5 Ventry St	Arrowtown - School	Arrowtown - Alexander Street	Central Dunedin	Mosgiel
2005	42					11
2006	45		17		6	8
2007	33		39		1	4
2008	74		38		9	9
2009	40		31		6	7
2010	51		39		11	8
2011	40		27		14	8
2012	40		24		1	N/A*
2013	46		15		1	5
2014	51			48	0	5
2015	22			30	0	7
2016	38			32	0	9
2017		3		45	0	9
2018		2		29	1	4
2019		6		19	0	4
2020		6		25	0	5
2021		3		23	1	4
2022		4		12	0	1
2023		3		10	0	4

*Not monitored during winter

Table 2 Summary of trend analysis

Site	Time range	Trend	Annual change	Total change
Alexandra - 65 Ventry Street	2006-2016	No trend [b]	N/A	N/A
Alexandra - 5 Ventry Street	2018-2023	Degrading	3.2	19.2
Arrowtown - Alexander Street	2015-2023	Improving	-6.2	-55.8
Balclutha [a]	2010-2018	Degrading	1.3	11.7
Central Dunedin	2008-2023	Improving	-3.1	-49.6
Clyde	2008-2020		-3.3	-42.9
Cromwell	2008-2021		-1.8	-25.2
Milton	2008-2021		-2.9	-40.6
Mosgiel	2013-2023		-1.8	-18

[a] Balclutha was analysed in the previous SOE report. There has been no new data and therefore it was not analysed again in 2024. The results are included here for completeness.
[b] Analysis indicated neither improving nor degrading trends.

[8] The trend results show that most sites are improving over time to various degrees, except for the Alexandra site which shows air quality has degraded. The Arrowtown site has shown the highest annual decrease of concentrations, of -6.2%. Clyde and Central Dunedin have shown the next highest annual decreases, with -3.3 and -3.1% respectively. Out of the improving airsheds, Mosgiel has shown the lowest rate of improvement with –1.8% change per year. The Alexandra 5 Ventry Street site has a degrading trend for the last six years of monitoring. Further analysis showed that this was not due to home heating emissions as these concentration increases did not happen in winter. Further information needs to be gathered to understand the cause of this. The trend is also only based on six years of data which is quite a short time frame so further data is required to confirm this.

[9] A previous report shows that the Balclutha site was also degrading between 2010-2018. Monitoring was discontinued here when monitoring equipment failed in 2018 and it is unknown why it was not replaced at that time. Further monitoring will be considered in the next review of the monitoring network.

[10] In summary, there have been some improvements to ambient air quality between 2005 and 2023, however the NESAQ is still being exceeded at every site apart from Central Dunedin, and further improvements are required to meet the current NESAQ for PM_{10} and future limits for $PM_{2.5}$. Further data or analysis is required to understand the Alexandra trend.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[11] ORC's air quality monitoring programme is aligned with ORC's strategic directions, and supports:

a. Providing the best available information on Otago's air quality.
b. Designing interventions to achieve good air quality.

[12] This SOE report is an important source for informing the Air Plan review.

Financial Considerations

[13] N/A

Significance and Engagement

[14] N/A

Legislative and Risk Considerations

[15] The NESAQ has been under review by the Ministry for the Environment for a number of years. One of the outcomes of the review has been to include 24-hour and annual limits for $PM_{2.5}$, while retaining the existing PM_{10} limits. The proposed $PM_{2.5}$ 24-hour hour limit is 25 µg/m³, however, the recently updated WHO guideline limit for PM2.5 is 15 µg/m³; either of these are likely to produce more frequent and higher magnitude exceedances in Otago towns that already record high numbers of exceedances for PM_{10}, as well as possible exceedances for towns that do not record PM_{10} exceedances.

Climate Change Considerations

[16] Air quality and climate change are interlinked and impact each other. Many air pollutants affect the amount of sunlight absorbed in the atmosphere and this impacts heating and cooling.

[17] Changes in climate impacts air quality as more frequent temperature extremes and stable highs may promote the formation and accumulation of some pollutants and may cause higher levels of both dust and pollens. Long term monitoring of both PM_{10} and $PM_{2.5}$ will provide for tracking trends of these natural sources compared to combustion sources. Changes to temperatures in Otago may also impact the way Otago residents heat and cool their homes.

Communications Considerations

[18] A media release will be prepared for this report and the report uploaded onto ORC's website.

[19] SOE air quality data is made available to the public via upload to the Land Air Water Aotearoa (LAWA) website on an hourly basis.

NEXT STEPS

[20] ORC will continue investigating Otago airsheds for possible future monitoring sites and investigating the spatial differences within airsheds during 2024.

[21] Annual air quality reports are presented each year. The next SOE report for air quality will be written in 2029.

ATTACHMENTS

1. SOE Air Quality Trends 2005-2023 [**9.1.1** - 38 pages]

State of the Environment report: Air quality trends 2005 – 2023

June 2024

Otago Regional Council

Otago Regional Council
Private Bag 1954, Dunedin 9054
70 Stafford Street, Dunedin 9016
Phone 03 474 0827
Fax 03 479 0015
Freephone 0800 474 082
www.orc.govt.nz

Front cover image by Simon Darby.

Report writer: Sarah Harrison, Scientist – Air Quality, Otago Regional Council

Reviewed by: Tamsin Mitchell, Senior Environmental Scientist – Air Quality, Greater Wellington Te Pane Matua Taiao

Ben Mackey, Science Team Leader – Land, Otago Regional Council

Published 27 June 2024

The author would like to thank the ORC Environmental Monitoring team for the air quality data collection, verification and network oversight, and Tamsin Mitchell for her technical input into the data analysis.

Otago Regional Council

Executive summary

Otago Regional Council (ORC) operates a State of the Environment (SOE) air quality monitoring network. The aims of the programme include reporting data in accordance with the National Environmental Standards for Air Quality (NESAQ) and the Resource Management Act (RMA), and to develop understanding of the influences of emissions and meteorology on pollutant concentrations. Over the past 20 years this monitoring has focused on PM_{10}, small particles with a diameter of less than 10 micrometres.

This report evaluates the air quality monitoring results for the period of 2005 – 2023, with particular emphasis on the long-term trends to provide up to date analyses for the review of the Regional Plan: Air.

Particulate matter is highly seasonal in Otago in most areas. High PM_{10} concentrations are observed in many towns during winter months, which is caused by home heating emissions combined with calm weather and temperature inversions. Airsheds such as Alexandra, Arrowtown and Mosgiel regularly exceed the National Environmental Standard for Air Quality (NESAQ) for PM_{10}. This extreme seasonality means that non-winter concentrations are low, and all sites are currently meeting the annual Ambient Air Quality Guideline (AAQG).

Long-term trend analysis indicates that PM_{10} concentrations have improved in Arrowtown, Central Dunedin, Clyde, Cromwell, Milton, and to a lesser degree, Mosgiel. In Alexandra, PM_{10} analysis indicates concentrations show an increasing trend, however further data is required to confirm this.

The results of this report will be used to inform future work on air quality strategy and policy in Otago.

Otago Regional Council

Contents

Otago Regional Council

List of figures

List of tables

Otago Regional Council

Glossary

AAQG	Ambient Air Quality Guidelines (2002)
Airshed	Area designated by a regional council for air quality management
BAM	Beta Attenuation Monitor
Exceedance	Where a contaminant exceeds its threshold concentration
MfE	Ministry for the Environment
NESAQ	National Environmental Standard for Air Quality (2004)
PM	Particulate Matter
$PM_{2.5}$	Particulate matter less than 2.5 µm in diameter
PM_{10}	Particulate matter less than 10 µm in diameter
µm	Micrometre, one millionth of a metre
µg/m³	Microgram per cubic metre, unit of concentration
WHO	World Health Organization

1. Introduction

Clean ambient air is a fundamental resource for human health and the natural environment. Ambient air quality is affected by the amounts and types of pollutants that are emitted into air, and the meteorological conditions that impact their dispersion. Otago has a varied and complex topography, producing varying climate zones from alpine to coastal environments.

Of the ambient air pollutants commonly monitored in New Zealand, particulate matter (PM) is the biggest concern in Otago, with some airsheds regularly failing to meet national standards. The main emission source of PM in Otago is solid fuel burning for home heating, with lesser additional influence from vehicle emissions, industry, outdoor burning, and natural sources (Wilton, 2019).

This report evaluates the long-term trends of the SOE monitoring results for 2005 – 2023.

1.1. Purpose of this report

This report aims to:

- Report and evaluate the long-term trends for PM_{10}, providing the most recent analysis for the review of Otago's Regional Plan: Air.
- Inform future policy and strategy work for Otago.

1.2. Scope and outline

This report presents and analyses data collected by the monitoring network for the since 2005.

The following sections are included in this report:

- Section 2 describes the current air quality assessment framework.
- Section 3 describes Otago's monitoring network.
- Section 4 provides analyses of the temporal trends in air quality.
- Section 5 discusses the results of the analyses.

2. Air quality assessment framework

2.1. National air quality indicators

The National Ambient Air Quality Guidelines (AAQG) were first established in 1994 by the Ministry for the Environment (MfE), based on international public health information (MfE, 2002). The AAQG was revised in 2002, which recommended limits on concentrations for certain ambient air pollutants.

In 2004 the National Environmental Standards for Air Quality (NESAQ) were adopted (revised in 2011) and established mandatory minimum requirements for five pollutants – PM_{10}, nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO) and ozone (O_3). The objectives of these standards are to provide an acceptable level of protection to human health and the environment. These standards are currently being revised to include $PM_{2.5}$ (particulate matter with a diameter of less than 2.5 micrometres). Table 1 provides the current ambient air quality standards and guidelines for PM_{10}.

Pollutant	Limit type	Threshold concentration (µg/m³)	Averaging period	Number of allowable exceedances
PM_{10}	Standard	50	24-hour	1 per year
	Guideline	20	Annual	n/a

Table 1 New Zealand standards and guidelines for particulate matter

2.2. Ambient pollutants

2.2.1. Particulate matter

Particulate matter (PM) refers to particles, or aerosols, suspended in the atmosphere. PM can be natural or anthropogenic in origin and can either be directly emitted or formed in the atmosphere as a result of chemical reactions between other pollutants. PM therefore occurs in a range of sizes and chemical compositions. PM can be classified by size – fine and coarse. Fine particulate matter consists of particle sizes up to 2.5 µm in diameter ($PM_{2.5}$). Coarse particulate matter is the group of particles with diameter sizes between 2.5-10 µm. PM_{10} is the fine and the coarse fractions combined.

Fine particulate matter, or $PM_{2.5}$, is mainly a result of incomplete combustion such as vehicle emissions, and the combustion of wood and coal for industry or heating. It is comprised of organic and inorganic compounds, metals and black carbon (soot). These particles can remain suspended in the air for many days and can be transported hundreds of kilometres.

Coarse particulate matter ($PM_{2.5\text{-}10}$) is a product of mechanical forces such as wind erosion, crushing and abrasion. Natural sources include pollen, soils and sea salt. Anthropogenic sources include dust suspended from roads and industrial activity. Coarse PM tends to fall out of suspension within minutes or hours and can travel up to 50 kilometres from the source.

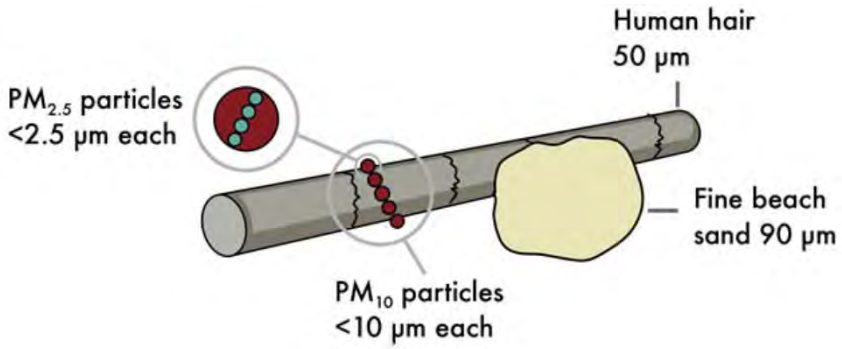


Figure 1 Comparison of particle sizes. Source: Ministry for the Environment

While ORC has largely focused on monitoring PM_{10} in the past, it is worth noting that during wood burning seasons, the majority of the PM_{10} particles are made up of the smaller fractions, $PM_{2.5}$ and smaller.

2.2.2. Particulate matter health impacts

Both short and long-term exposure to particulate matter can cause and exacerbate serious health issues, specifically to the respiratory and circulatory systems. The most vulnerable to PM are the young, the elderly and anyone with pre-existing conditions. Fine and ultra-fine (PM_1 and smaller) are the most dangerous as smaller particles can penetrate the respiratory system further and enter the blood stream (WHO, 2013). Currently there is no established safety threshold for particulate matter.

In 2022 the Health and Air Pollution New Zealand study (HAPINZ), which models the impact of air pollution exposure on health and subsequent social costs, was updated for the year 2016. It was found that the overall social cost to New Zealand, including premature deaths, decreased quality of life and lost productivity was $15.6 billion in 2016. The main sources of harmful air pollution were traffic emissions (nitrogen dioxide, NO_2[1]) and home heating emissions ($PM_{2.5}$). The below graph (Figure 2) shows the number of hospitalisations and premature deaths attributed to air pollution in Otago for 2016. In addition to these health impacts, the number of asthma cases attributed to NO_2 was 410 and the number of reduced activity days due to $PM_{2.5}$ was 217, 332.

[1] In Otago nitrogen dioxide was monitored between 1997 and 2004, and again in 2021 and was found to be compliant with the NESAQ. The results of the HAPINZ report and the updated WHO guideline (40 µg/m³ annual limit) indicate the importance of further monitoring NO_2, as health impacts are occurring at lower pollutant concentrations than previously realised.

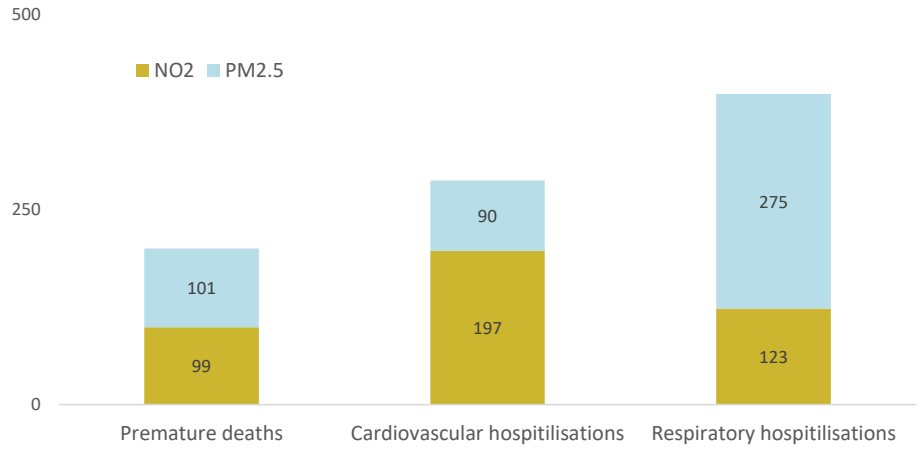


Figure 2 **Health impacts of $PM_{2.5}$ and nitrogen dioxide in Otago for 2016, data source: HAPINZ 3.0, (Kuschel, *et. al.*, 2022).**

2.3. Pressures and influences on air quality

Ambient air quality at any location is the result of a complex relationship between emissions and meteorology. Anthropogenic emission sources include home heating, vehicle exhaust, industrial and commercial discharges and outdoor burning. Local meteorology and long-term climate help determine how pollution accumulates or disperses and can have a greater influence on ambient air quality than emission quantities do. Temperature inversions in the atmosphere are common in many Otago towns during winter, which vastly limits the dispersion of PM and causes degraded air quality.

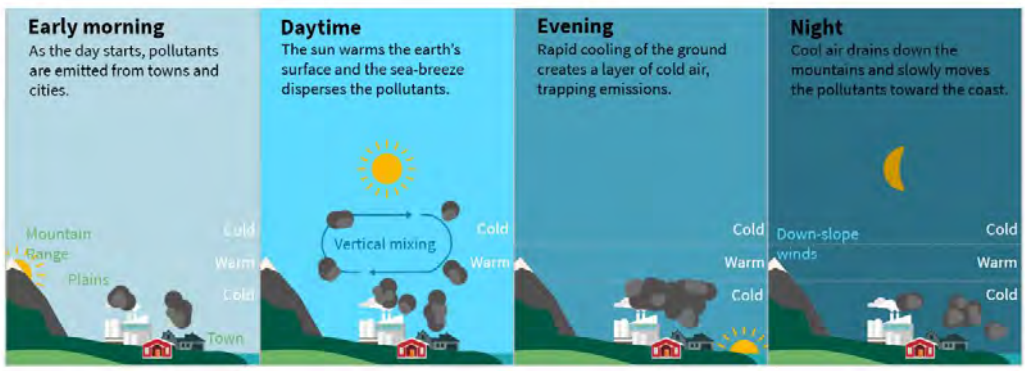


Figure 3 **Temperature inversion. Source: LAWA**

Emissions inventories estimate the total emissions for a town using information such as fuel types, burner types and age, fuel usage, and census data for domestic emissions, and consents and traffic data for industrial and vehicle emissions. The emissions inventories that have been undertaken in Otago show that solid fuel burning for domestic heating is the source of most of the PM, up to 90% in some towns (Wilton, 2019).

The 2018 census data showed that the use of wood burners was reported in 51% of households in Otago, which is much higher than the national average of 31% (Stats NZ, 2020), and a general trend in many Otago towns is that the number of wood burners has increased due to urban development (Harrison, 2021).

The emissions inventories carried out in Otago have provided the following trend estimates of total PM_{10} emissions for Otago towns (Table 2). These reductions were attributed to the reduction in the use of coal for domestic heating and the replacement of older burners to those compliant with the NESAQ. In Mosgiel approximately a third of emissions reductions were due to industry closure or transitioning to cleaner fuels (Wilton, 2016).

Town	2005 total emissions (kg/day)	2016 total emissions (kg/day)	% decrease
Alexandra	367	171	51%
Arrowtown	183	94	48%
Milton	250	119	50%
Mosgiel	533	271	49%

Table 2 Emissions (kg/day) in Otago airsheds

Between 2008 and 2020 ORC undertook an incentive (Clean Heat Clean Air subsidy to replace older solid-fuel burners with cleaner heating options) to help Otago residents replace older burners in Alexandra, Arrowtown, Clyde, Cromwell and Milton. Analysis of these results indicated that there were positive influences on air quality, in terms of number of exceedances and annual and winter averages, but these improvements were strongest during the most active phases of the programme, in the years prior to 2013 (Mills, 2018).

Emissions sources and quantities and meteorology are discussed in further detail in previous SOE reports (Harrison, 2021 and Mills, 2016).

2.4. International air quality indicators

New Zealand standards and guidelines have in the past been consistent with the World Health Organization (WHO) recommendations (WHO, 2006) for PM. However, in 2021 WHO released updated guidelines based on more recent research that confirms pollutants are more harmful at lower concentrations than previously thought. Table 3 lists the WHO guidelines for PM.

Pollutant	Threshold concentration (µg/m3)	Averaging period
$PM_{2.5}$	15	24-hour
	5	annual
PM_{10}	45	24-hour
	15	annual

Table 3 World Health Organization guideline values for PM_{10} and $PM_{2.5}$

2.5. Otago airshed management

2.5.1. Airsheds

Otago Regional Council gazetted 22 airsheds in 2005 in accordance with NESAQ requirements. The airsheds are ranked from Airshed 1 (most degraded air quality) to Airshed 4 (not expected to be degraded). Twenty-two towns and cities have been allocated one of these four airsheds (Figure 4). Rural areas outside of town boundaries are considered to be a fifth airshed, where air quality is expected to be acceptable.

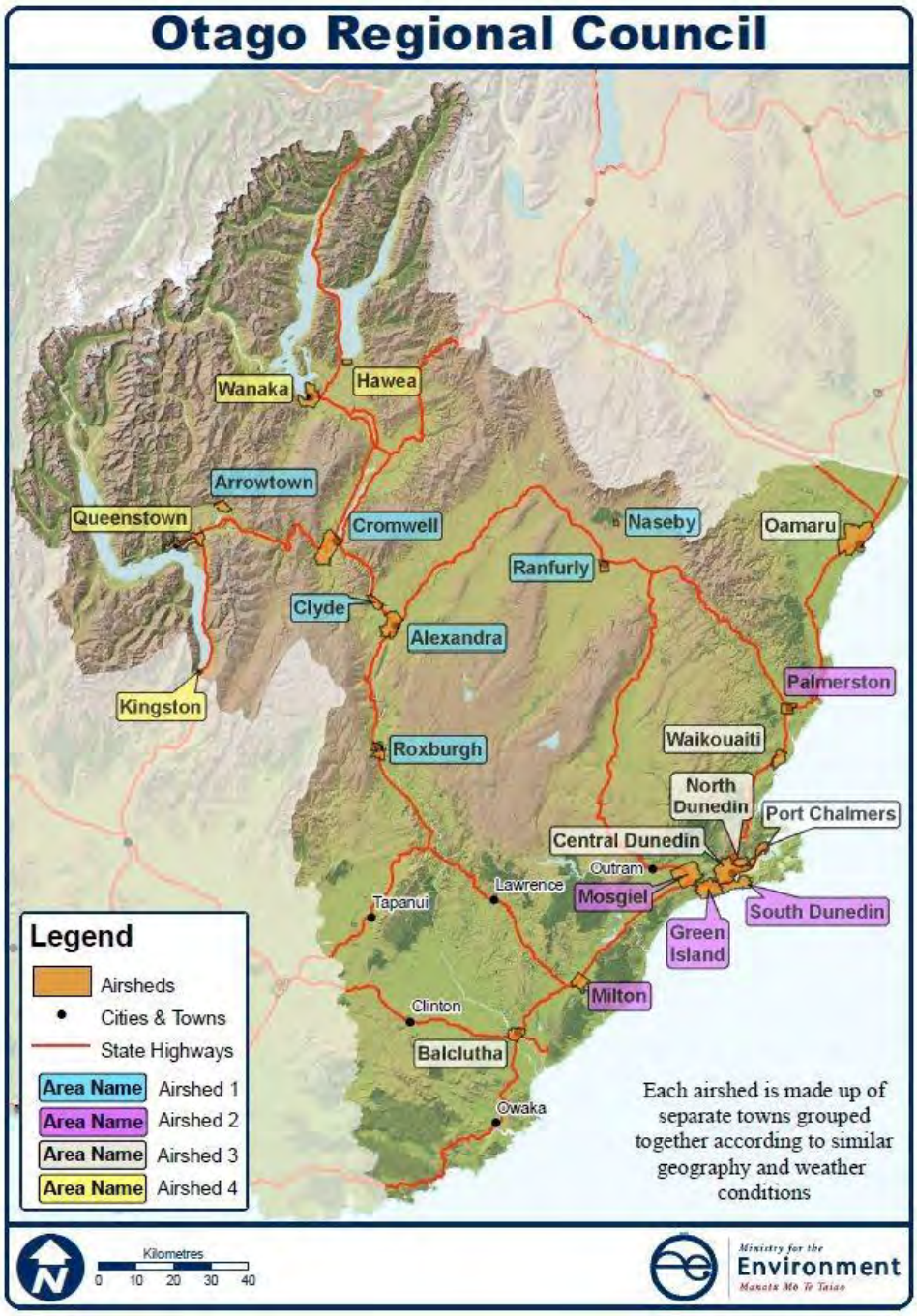


Figure 4 **Otago Regional Council gazetted airsheds**

3. Air quality monitoring network

3.1. Background

ORC operates a long-term air quality monitoring network in the region. Monitoring began in 1997, and since that time ambient pollutants PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO have been monitored in various locations throughout Otago at various times. Most of the monitoring performed over the last 15 years has been in response to the requirements of the NESAQ, with a focus on particulate matter.

Otago's large area and wide distribution of population centres set amongst varying terrain and climate make it challenging to provide a true and complete representation of ambient air quality. Where possible, monitoring sites are situated in accordance with the NESAQ; in places where the standard is breached by the greatest margin or frequency.

3.2. Monitoring objectives

The objective of Otago's air quality monitoring programme is to provide scientifically robust data for the following purposes:

- To manage the region's air resource
- To measure the effects of ORC's air quality management initiatives
- To fulfil the statutory requirements of the Resource Management Act 1991 (RMA)
- To measure and report on compliance with the NESAQ

A range of monitoring activities and investigations are needed to fulfil these objectives. In addition to continuous site monitoring, other activities include emissions inventories, source apportionment studies, spatial investigations, and screening studies of other pollutants such as nitrogen dioxide, sulphur dioxide and carbon monoxide.

3.3. Monitoring programme

There are two types monitoring site used in the air quality monitoring network:

[1] Regulatory monitoring at long-term sites that run continuously in Alexandra, Arrowtown, Central Dunedin and Mosgiel, referred to as key indicator sites. Results from these sites are used to report compliance with NESAQ.

[2] Survey monitoring was performed at sites that ran during winter months only, Clyde, Cromwell and Milton (there was also a site at Balclutha until 2018, and results for this site are analysed in the previous SOE reports). Results are used to quantify air quality during winter and assist in tracking trends. Table 3 lists the monitoring history for 2005 – 2023.

Airshed	Site	Purpose	Length of record
1	Alexandra	Regulatory	2005 - 2016 2017 - 2023
	Arrowtown		2007 - 2014 2014 - 2023
	Clyde	Winter survey	2008 – 2020*
	Cromwell		2008 – 2021*
2	Milton		2008 – 2021*
	Mosgiel	Regulatory	2008 - 2023
3	Central Dunedin		2006 - 2023

*All winter survey EBAMs were replaced in 2020/2021 with MetOne ES642 sensors to measure $PM_{2.5}$ instead of PM_{10}.

Table 4 Air monitoring sites and their purpose in the network

3.4. Monitoring methods

3.4.1. Particulate matter monitoring and measurement

PM_{10} was monitored using two types of beta attenuation monitor (BAM), manufactured by Teledyne in the USA. BAMs measure the particle mass density by comparing the sample deposited on the filter tape with the blank tape; as the particle mass increases, the beta count decreases. Standard sampling methods are required for reporting for compliance with the NESAQ. The BAM1020 is accepted by the US Environmental Protection Agency (USEPA) as an equivalent reference method for measuring PM_{10}. BAM1020 were used at the Alexandra, Arrowtown, Central Dunedin and Mosgiel sites.

The survey sites were monitored using an Environmental Beta Attenuation Monitor (EBAM). The EBAM is not considered an equivalent reference method, and as such, cannot be compared against the NESAQ, but it is designed to provide accurate PM_{10} averages and can be used for trend analysis. All stations are sited and operated where possible, using ASNZS 3580.1.1:2016 Methods for sampling and analysis of ambient air – Guide to siting monitoring equipment.

3.4.2. Meteorological monitoring and measurement

Air temperature, wind speed and wind direction all influence the accumulation and dispersion of pollutants. These parameters were recorded continuously at the PM_{10} monitoring sites in order to describe localised meteorological effects on PM_{10}.

Figure 5 **ORC air quality monitoring station at Arrowtown, with particulate matter instrument inlets circled in red, and the meterological sensors circled in yellow.**

4. Particulate matter trends

Air quality varies greatly temporally over short and long-term time periods. Day to day variability is often due to weather effects such as temperature and wind speed. Seasonal variability is driven by changes in sources, such as the increase of home heating emissions in winter.

Long term trends in air quality are affected by regulatory requirements, changes to fuel choices and burner technology over time, the addition or removal of point sources of emissions, and natural variability of long-term climate patterns (e.g., El Niño Southern Oscillation).

4.1. Compliance with standards and guidelines

4.1.1. 24-hour PM_{10} standard

The following table shows the number of NESAQ exceedances, defined as the number of days the daily average PM_{10} exceeded 50 µg/m³.

Year	Alexandra - 65 Ventry Street	Alexandra - 5 Ventry St	Arrowtown - School	Arrowtown - Alexander Street	Central Dunedin	Mosgiel
2005	42					11
2006	45		17		6	8
2007	33		39		1	4
2008	74		38		9	9
2009	40		31		6	7
2010	51		39		11	8
2011	40		27		14	8
2012	40		24		1	N/A*
2013	46		15		1	5
2014	51			48	0	5
2015	22			30	0	7
2016	38			32	0	9
2017		3		45	0	9
2018		2		29	1	4
2019		6		19	0	4
2020		6		25	0	5
2021		3		23	1	4
2022		4		12	0	1
2023		3		10	0	4

*Data was not recorded during winter months

Table 5 Number of NESAQ exceedances for key indicator sites

The Alexandra at 65 Ventry Street site has the highest number of exceedances, with 74 during 2008. The fewest exceedances occurred in 2015, with 22. Since the site was relocated in 2017, the number of exceedances has been much lower, with between 2 and 6 exceedances occurring each year. The differences between sites are due to spatial differences in concentrations (Longley, 2023) and increased wind dispersion at the current site (ORC, 2021). The difference in concentrations between the two sites is approximately 23% (Longley, 2023).

For Arrowtown, the highest number of exceedances occurred in 2014, the first year the site was relocated to its current location, with 48 exceedances. Since then, the number of exceedances has trended downwards.

The number of NESAQ exceedances occurring in Central Dunedin has decreased over time. Since 2012, the site has recorded at most, one exceedance every few years, which complies with the NESAQ.

The Mosgiel site's number of exceedances has stayed within the same range of between four and 11 since 2005, excepting 2022 where there was only one. The highest frequency of exceedances (11) occurred in 2005.

An overall trend for all sites is that the years 2018-2023 have fewer exceedances than previous years.

4.1.2. Annual PM_{10} guideline

The graph below shows the annual averages of the regulatory sites relative to the AAQG and WHO 2021 guidelines of 20 and 15 µg/m³, respectively.

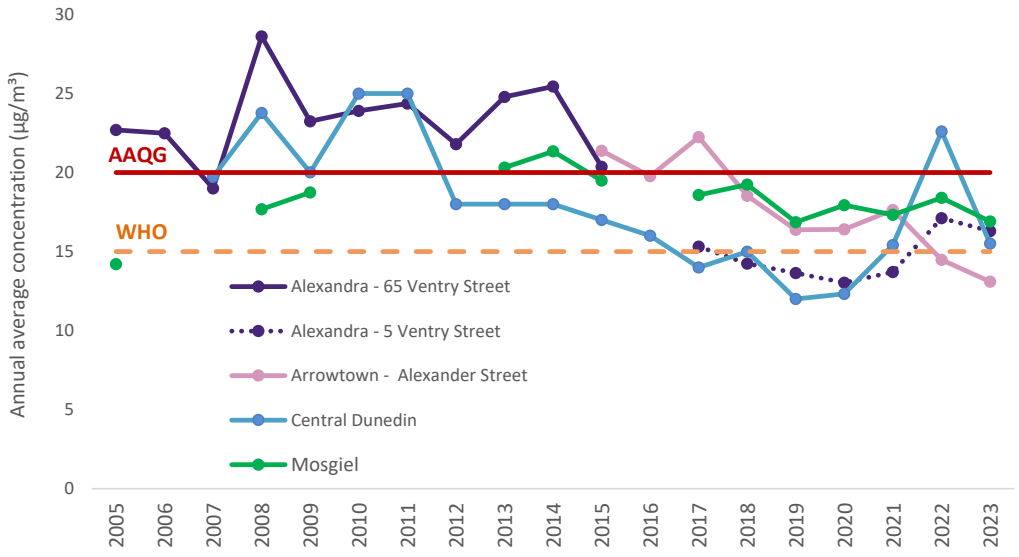


Figure 6 Annual average PM_{10} concentrations (µg/m³) for key indicator sites

The annual data for the 65 Ventry Street site in Alexandra frequently exceeded the guidelines with peak concentration recorded in 2008. Since the site was moved to 5 Ventry Street, the data met both guidelines for the years 2018 to 2021 but exceeded the WHO guideline for 2022 and 2023.

Arrowtown annual averages have trended downwards and since 2018 has complied with the AAQG and met the WHO guideline in 2022 and 2023.

Since 2012 Central Dunedin has met the AAQG, and between 2017 and 2020, also met the WHO 2021 guideline. The annual average for 2022 increased to exceed both guidelines, and it is thought that the data was impacted by significant construction occurring at the site.

The Mosgiel site has been compliant with the AAQG from 2015 onwards, however has not met the WHO guideline during this time.

4.2. Short-term temporal trends

Short-term spatial trends can show the different emission sources and characteristics in the airsheds. The patterns in PM concentrations can be seen at various timescales, i.e., hourly, daily, weekly and seasonal. Figure 7 shows the four key indicator sites for the years 2017 – 2023. All four sites have different patterns over the different timescales. The Central Dunedin site shows daily and weekday patterns most consistent with traffic and industrial emissions, with an increase in PM_{10} concentrations between 6:00 and 8:00 in the morning and slow decline in the evening; consistent through the week but much lower on weekends. This site doesn't have a seasonal pattern, unlike the other three sites.

Alexandra and Arrowtown have strong seasonal patterns, with the highest concentrations occurring over winter months, and very strong home heating signatures (morning and evening peaks) in the daily plot. Mosgiel has a combination of the two of these patterns, it exhibits slightly weaker seasonal and daily patterns because it has a combination of PM_{10} sources, including home heating emissions, traffic and industrial (Figure 7).

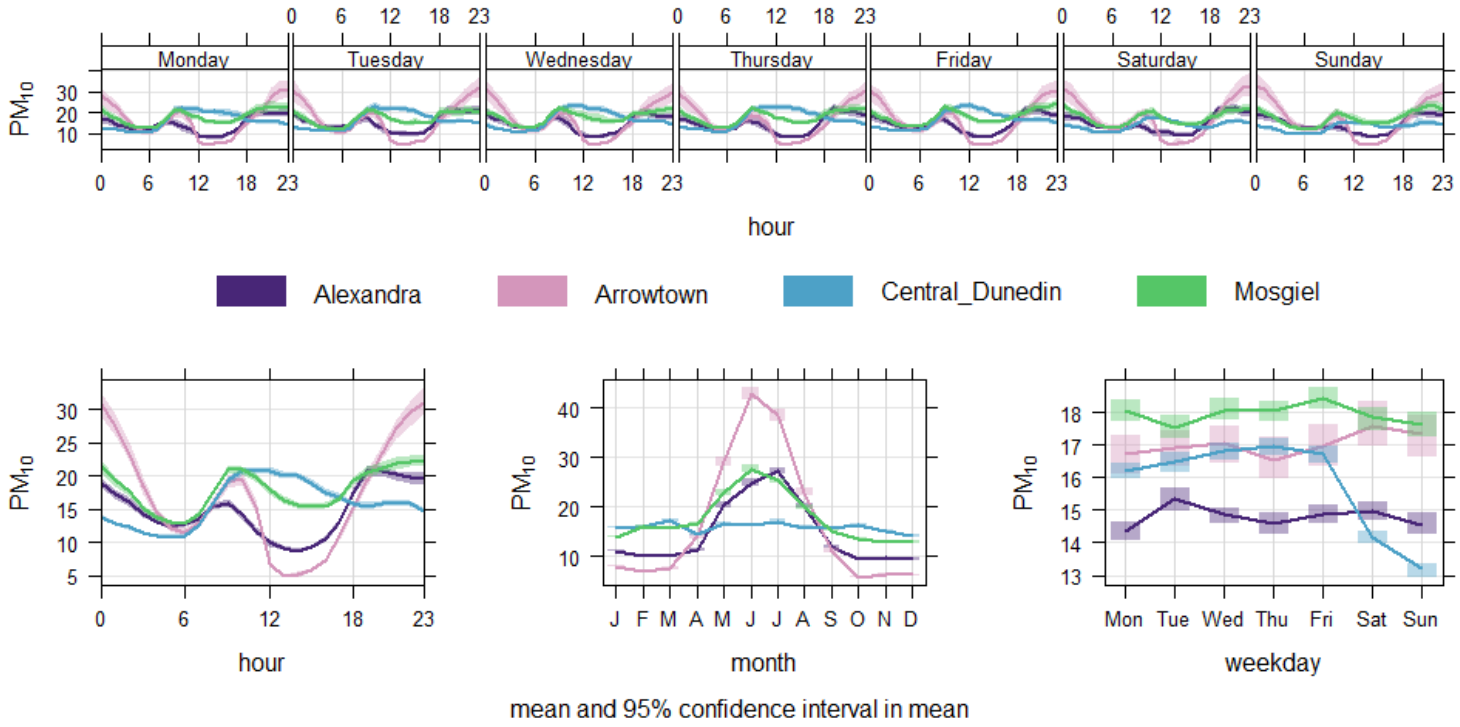


Figure 7 **Daily, monthly and week day patterns for the key indicator site**

4.3. Long-term temporal trends

4.3.1. Trend visualisation

Long-term data can be visualised in a trend level graph, which plots the concentrations by time of day, month and year. In these trend level graphs the PM_{10} concentrations are represented by colours ranging from blue (low concentrations) to red (high concentrations). Figures 8 to 11 show the trend level plots for Alexandra, Arrowtown, Central Dunedin and Mosgiel.

For Alexandra, the highest concentrations occur during morning and night in winter however there is a background concentration of between 10 and 20 µg/m³ during morning and evening hours and non-winter months (Figure 8).

At Arrowtown the winter months are clearly highlighted with high concentrations for the morning and evening hours. These peak concentrations are lower in 2021 and 2022 (Figure 9).

For Central Dunedin there are no clear seasonal patterns, however on a daily basis, the highest concentrations occur from 8am onwards. This graph also shows that concentrations were frequently above 50 µg/m³ prior to and including 2011 (Figure 10). The 2022 year also stands out as having higher concentrations than preceding years and this is discussed in section 4.3.2.

The trend level plot for Mosgiel shows the complexity of this airshed (Figure 11). Across the years for every month there is a slight increase in concentrations at around 8 am in the morning, which indicates a traffic influence. This plot also shows the seasonal home heating concentrations occurring in winter at morning and evenings.

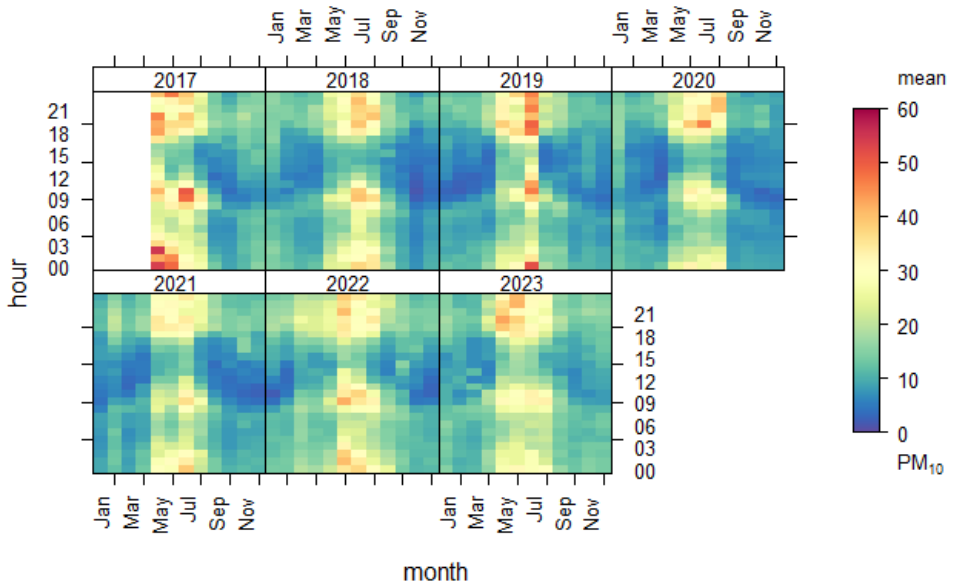


Figure 8 **Trend level plot for Alexandra PM_{10}**

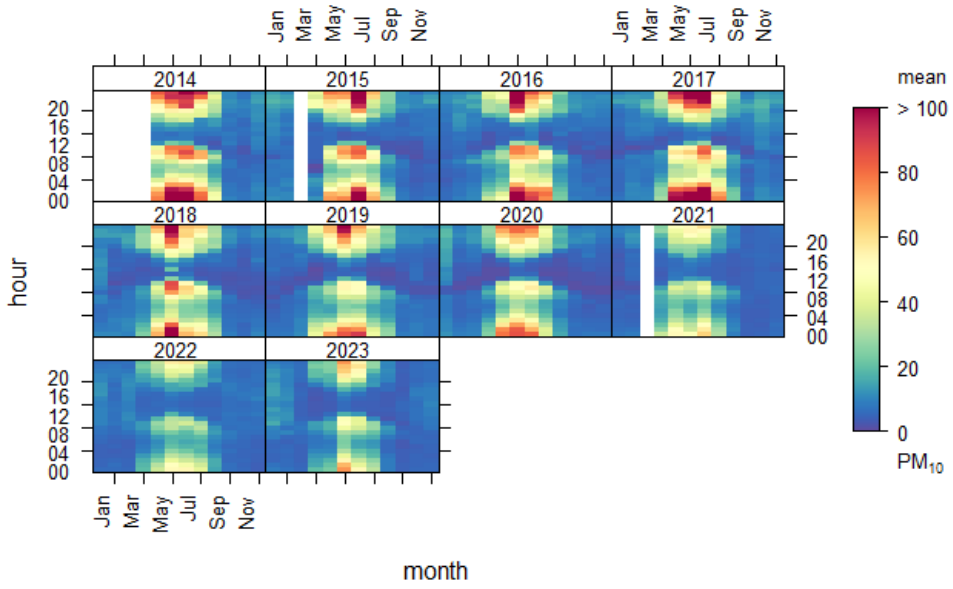


Figure 9 **Trend level plot for Arrowtown PM_{10}**

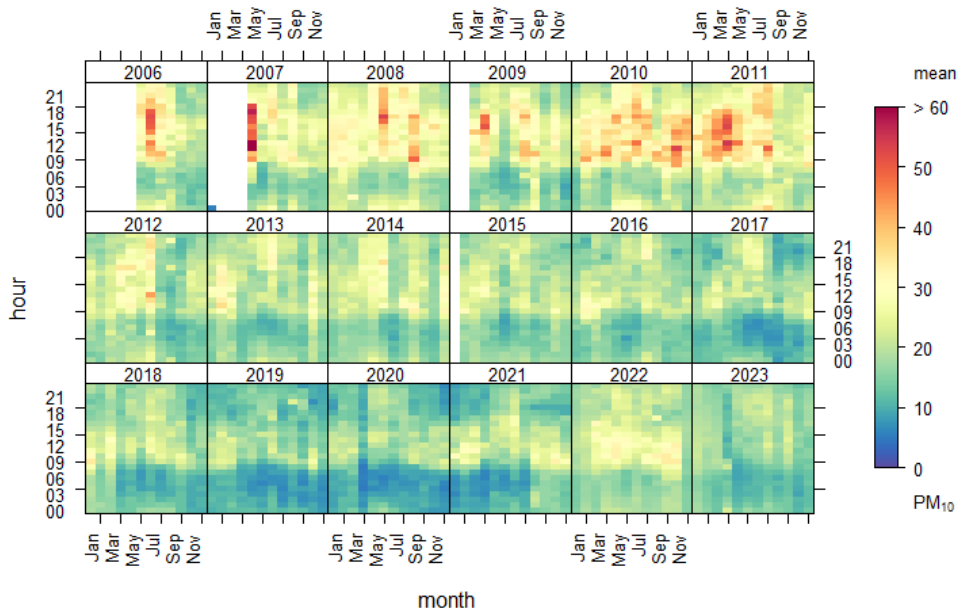


Figure 10 **Trend level plot for Central Dunedin PM_{10}**

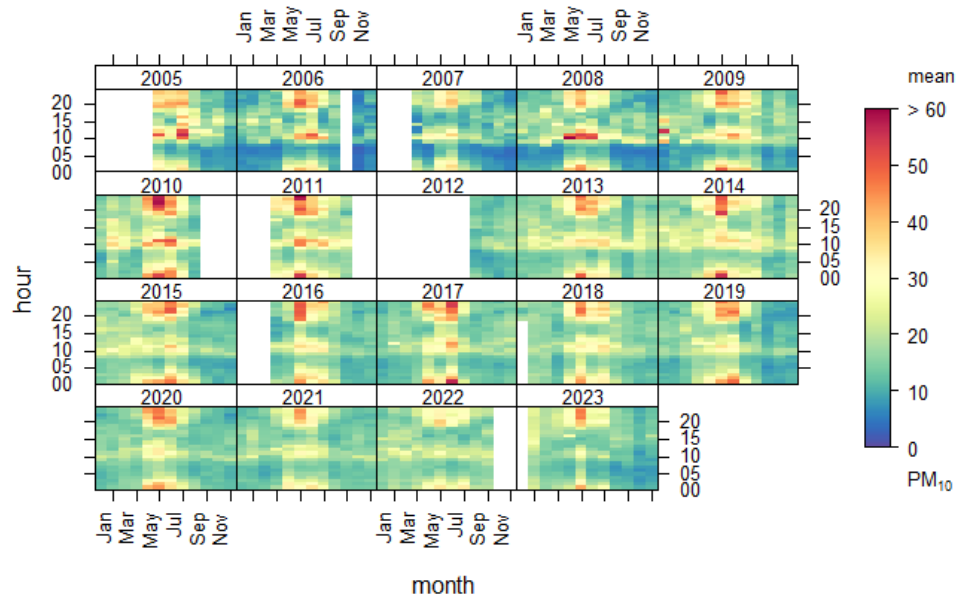


Figure 11 **Trend level plot for Mosgiel PM_{10}**

Figures 11 to 13 show the trend levels for Clyde, Cromwell and Milton. Like Arrowtown, the Clyde trend level plot shows high winter concentrations, as well as the slow progression from higher to lower concentrations through the years (Figure 12).

The Cromwell trend level plot is also very similar however it does have higher concentrations than Clyde, especially during the evening hours. The years 2018-2020 are significantly lower in terms of evening concentrations than the preceding years (Figure 13).

The trend level for Milton is also similar to the other winter-only sites. In contrast to Clyde and Cromwell, the PM_{10} concentrations remain very high in the early hours of the morning, particularly for the years prior to 2018 (Figure 14).

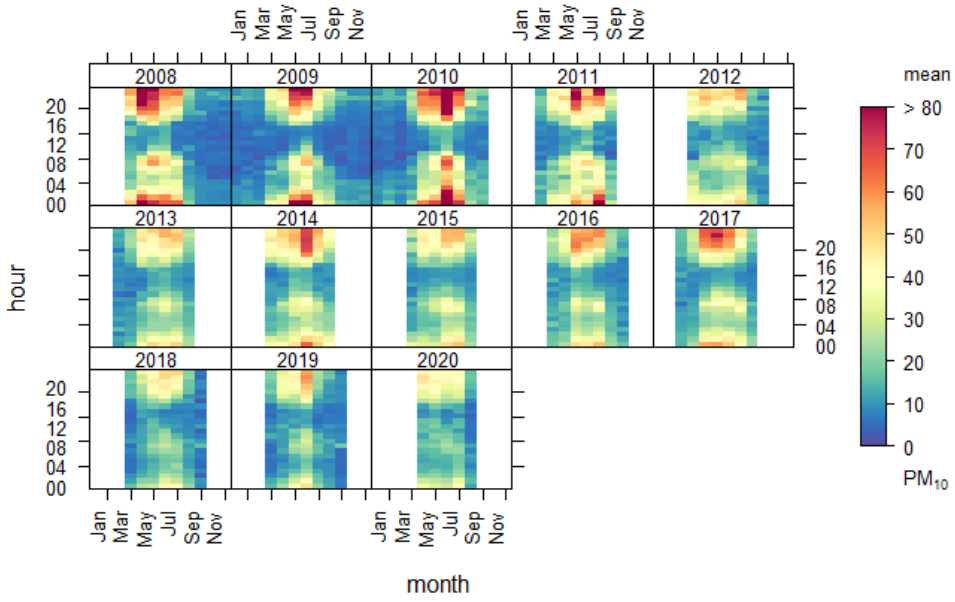


Figure 12 Trend level plot for Clyde PM_{10}

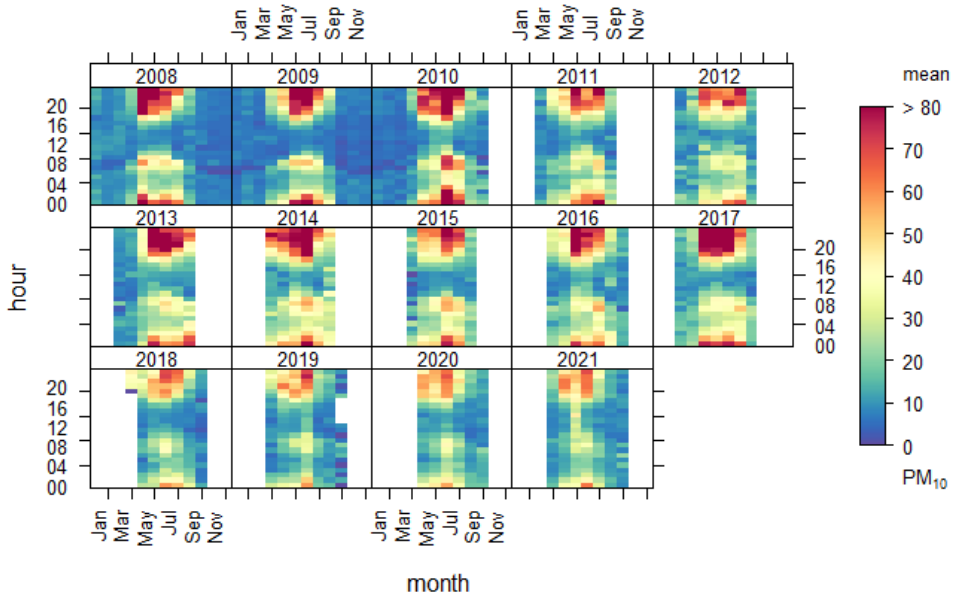


Figure 13 **Trend level plot for Cromwell PM_{10}**

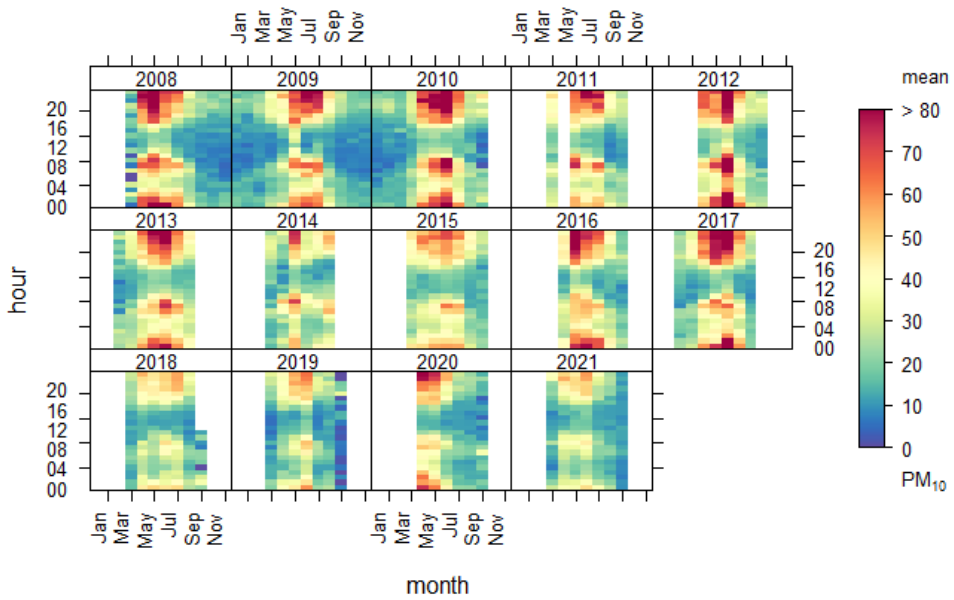


Figure 14 **Trend level plot for Milton PM_{10}**

4.3.2. Dunedin data

As discussed in the previous sections the construction of a building (including the demolition of the previous building) was occurring adjacent the Dunedin site from September 2021 to November 2022 and this resulted in higher-than-normal PM_{10} concentrations, likely due to suspension of dust and emissions from construction vehicles. The below graph shows the difference between the data prior to (2017-2021) and during the construction/demolition process. The daily and week-day patterns have the same shape, but with a difference of approximately 5 µg/m³ (Figure 15).

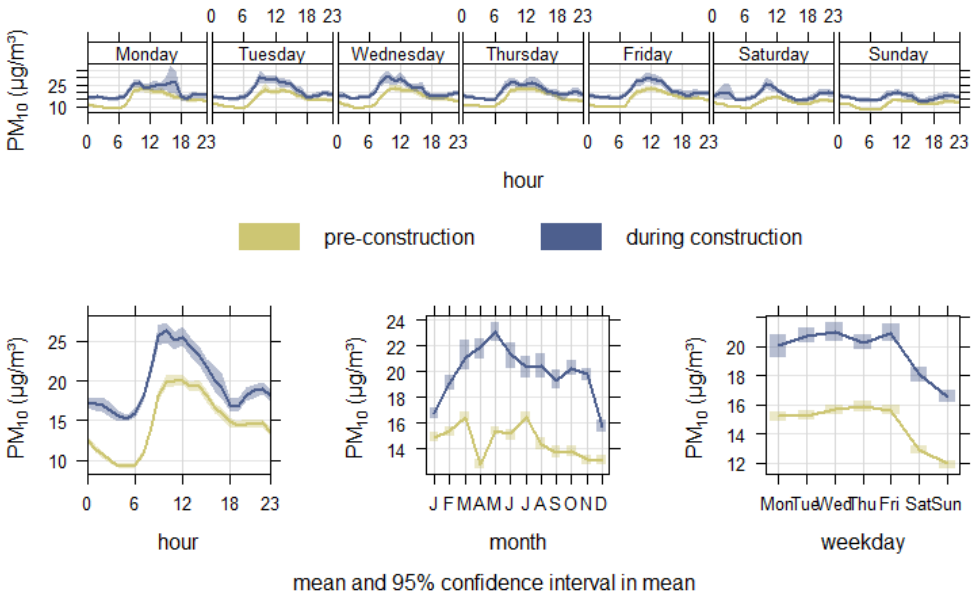


Figure 15 **Time variation of the Dunedin site showing impact of local construction on PM_{10} concentrations.**

4.3.3. Trend analyses

Statistical testing can be used to determine overall increasing or decreasing trends of long-term air quality data. It provides a p-value, that represents the probability that random chance could explain a change in ambient air quality. A p-value of 0.1 suggests that we are 90% confident that the changes observed in PM_{10} are not due to chance. For this report trend analyses were performed at all sites for all available data. However, some sites have been re-located to an area with different typical concentrations within this timeframe, such as at Alexandra and Arrowtown. Trend analysis can only be performed on some of the years due to these differences.

Trends were evaluated using two types of techniques – the Theil-Sen and the smooth-trend. The Theil-Sen is a non-parametric regression analysis customised for air quality data (Carslaw and Ropkins 2012). Theil-Sen analyses work best when applied to monotonic trends i.e., data that is either only increasing or only decreasing, and is best performed on continuous data with data gaps of less than five months duration, and complete start and end years (NAQWG, 2024).

The smooth-trend analysis fits a smooth line to the dataset using monthly mean concentrations. The line is fit to show important features and variation within the data without including excessive noise from the dataset (Carslaw *et al.,* 2014). Both analyses can be applied to deseasonalised data, which means to remove the seasonal variation, so underlying trends can be assessed. The Alexandra, Arrowtown and Mosgiel sites were deseasonalised for the following analyses.

4.3.4. Trend results

Theil-Sen analyses were done for the key indicator sites Alexandra, Arrowtown, Central Dunedin and Mosgiel. Table 6 shows the results of these analyses.

Site		Trend period	Average % change per year [confidence intervals]	Significance
Alexandra 5 Ventry Street	Year-round	2018-2023	3.2, [1.2, 5.6]	p <0.001
	Winter	2017-2023	-0.4 [-4.7, 4.3]	no trend
Arrowtown	Year round	2015-2023	-6.2 [-6.4, -5.9]	p <0.001
	Winter	2015-2023	-6.1 [-6.5, -5.7]	p <0.001
Central Dunedin	Year round	2008-2023	-3.1 [-3.6, -2.6]	p <0.001
Mosgiel	Year round	2013-2023	-1.8 [-2.2, -1.5]	p <0.001
	Winter	2013-2023	-2.4 [-3.4, -0.7]	p <0.01

Table 6 Theil-Sen analysis results of PM_{10} monthly means at the key indicator sites

The Alexandra data shows a degrading trend for year-round data, with an increase of 3.2% per year. There is no trend when the winter data is analysed by itself (Table 6). Unlike the other

three regulatory sites, the smooth trend analysis shows no change in the 95th percentiles between 2017 and 2023. It shows a slight increase of the mean (Figure 16). It is important to note that while the minimum recommendation for Theil-Sen analysis is at least six complete years and this data meets that requirement; more data from future years will produce a more accurate trend. The Alexandra data is further analysed in the next section.

There has been a decrease of PM_{10} concentrations of 6.2% per year in Arrowtown, which equates to a cumulative 56% decrease over the nine years of analysis (Table 6). This trend is similar to the previous analysis on the Arrowtown School site data for 2006-2013, where a 4% annual decrease was reported for winter months (Mills, 2016). This confirms that Arrowtown PM_{10} concentrations have been decreasing consistently over time, as this trend is shown in both site locations. The smooth trend analysis shows that the 95th and 50th percentiles of the de-seasonalised monthly concentrations have been decreasing over the years (Figure 16).

Central Dunedin shows a significant decrease in PM_{10} of 3.1% per year totalling 49% improvement over 16 years (Table 6). A large part of improvement seen in Dunedin was due to the resource consent renewals during the early 2010's, which switched many industrial discharges to using better emission controls and/or cleaner fuels, and resulted in lowered emissions for PM_{10} (Mills, 2016). This decrease can be seen in the 95th percentiles for the smooth-trend for years 2010-2013 (Figure 16).

The Mosgiel Theil-Sen analysis indicates an improving trend of 1.8% per year, which is the lowest rate of improvement of all the Otago sites, excluding Alexandra. The 95th percentile shows this steady decrease in Figure 16. Mosgiel winter trend analysis indicates a 2.4% improvement per year.

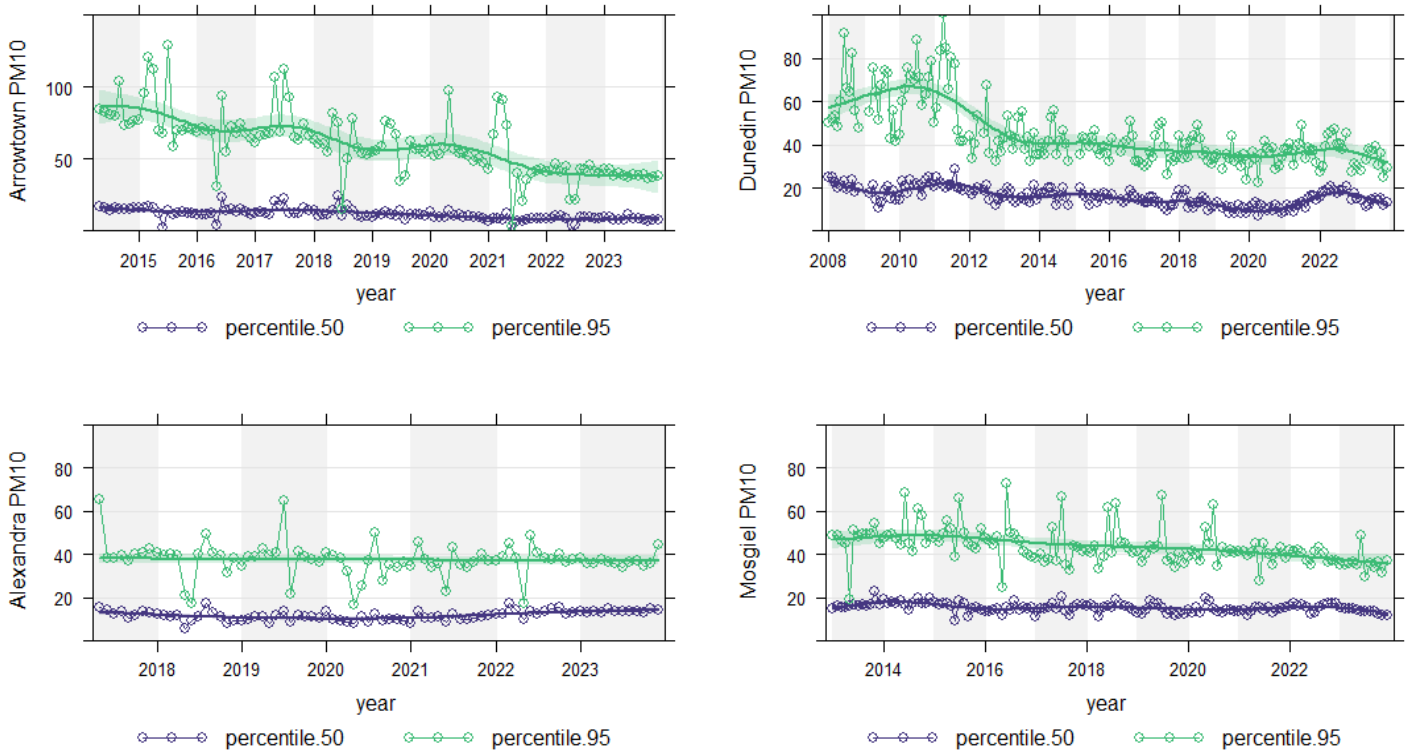


Figure 16 **Smooth-trend analysis for Arrowtown, Alexandra, Central Dunedin and Mosgiel – 95th percentile and median**

4.3.5. Alexandra trend results

Table 7 provides the results of further analysis on Alexandra data.

Site		Trend period	Average % change per year	Significance
5 Ventry Street	Summer	2017-2023	4.5 [-0.2, 11.4]	*p* <0.1
	Winter	2017-2023	-0.4 [-4.7, 4.3]	no trend
65 Ventry Street	Year round	2006-2016	-0.5 [-1.1, 0.3]	no trend
	Winter	2005-2016	-1.5 [-2.8, 0.2]	*p* <0.1

Table 7 Theil-Sen results of Alexandra data

The Alexandra winter data shows no trend, which indicates that home heating emissions have not been the driver for the degrading trend seen on the year-round data. Further analysis of the winter months versus the summer months show that the years 2022 and 2023 in particular have quite high concentrations during summer, and are frequently above 10 µg/m³ on a monthly average. These high summer concentrations seem to be the driver for an increasing trend for years analysed, although this has a significance of p<0.1 which is not a strong result.

Analysis on the Alexandra data for 2006 to 2016 shows no trends on either year-round data and only a weak improving trend (p<0.1) on the winter data (Table 7). This indicates that in general, the Alexandra airshed has neither improved nor degraded significantly in terms of average PM_{10} concentrations since ORC began monitoring it in 2005.

4.3.6. Trend results for survey sites

The survey sites were monitored during winter months only. Theil-Sen analysis was undertaken to infer trends on the winter season data. Table 8 displays the Theil-Sen results for the survey sites.

Site		Trend period	Average % change per year	Significance
Clyde	Winter only	2008-2020	-3.3 [-4.2, -1.8]	*p* <0.001
Cromwell	Winter only	2008-2021	-1.8 [-2.9, 0.1]	*p <0.1*
Milton	Winter only	2008-2021	-2.9 [-3.9, -2.0]	*p* <0.001

Table 8 Theil-Sen analysis results of PM_{10} monthly means at the survey sites

Clyde and Milton experienced statistically significant decreases in PM_{10} concentrations over the monitoring period. Clyde showed a 3.3% improvement per year, over the 13 years, which adds up to a total of 44.2%. This downward trend can be seen clearly in the smooth-trend 50th and 95th percentile (Figure 17).

Cromwell shows the least improvement, with 28% over the 14 years. It can be seen in the smooth-trend analysis that there has been a downward shift from 2018 onwards in the 95th percentile, prior to this there was no obvious downward trend.

Milton has improved by 41.2% in total over the 14 years, and this downward trend appears to be consistent, as seen in the 50th and 95th percentiles (Figure 17).

During this analysis it was noted that the data for these three sites for the years 2018 onwards was lower than previous years, and this may be impacting these trends.

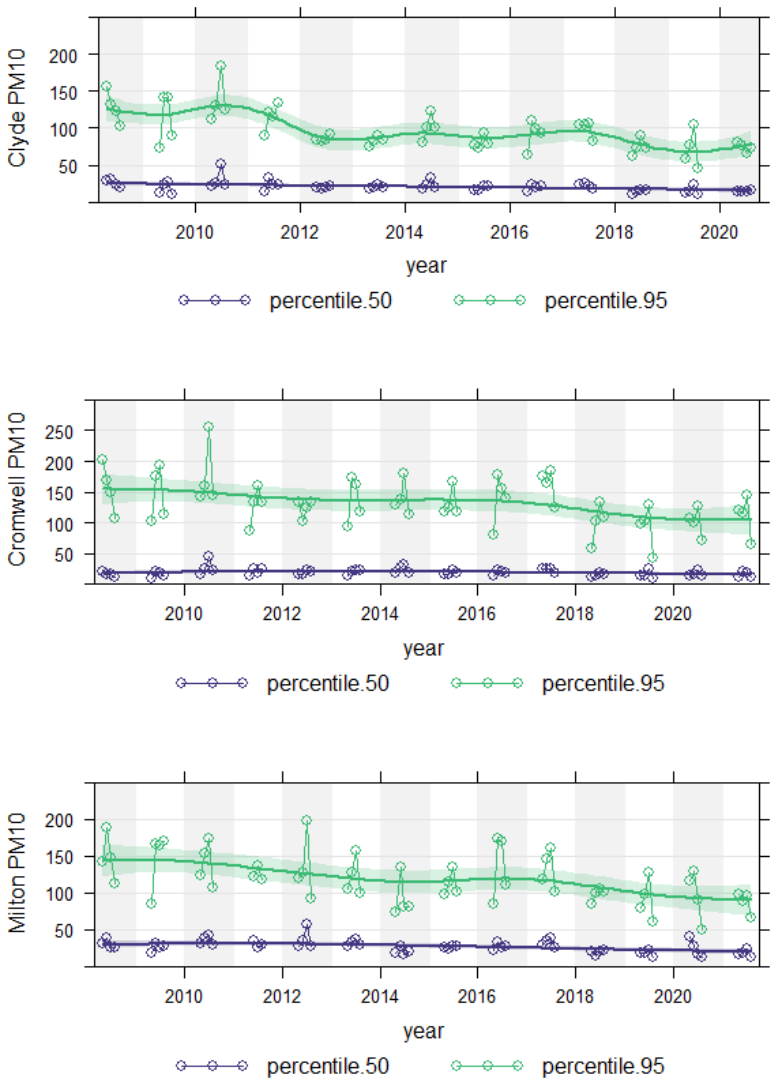


Figure 17 Smooth-trend analysis for the survey sites – 95th percentile and median

5. Discussion

Air quality monitoring results indicate a wide range of ambient air quality throughout the region. Many towns are characterised by highly seasonal patterns in PM_{10} due to solid fuel burning in winter. There is evidence that replacing older burners with more efficient ones has had a positive impact on reducing emissions, and consequently the concentrations. However, this has not been enough to meet the NESAQ limit for PM_{10} in many Otago towns and further actions would be required to achieve this.

The long-term air quality trends in Otago indicate that air quality has been improving across all the monitored airsheds except for the Alexandra airshed. The trend analyses show that Arrowtown followed by Clyde have had the highest degree of improvement, with 6.2% and 3.3% change in concentrations per year, respectively. Both of these sites, along with Milton have shown the most consistently decreasing PM concentrations across their respective monitoring periods. The Arrowtown site's number of NESAQ exceedances have also halved over the last ten years. The Cromwell site has improved by 1.8% per year which is the lowest rate of improvement for the Air Zone 1 areas (airsheds which received incentives to replace older solid-fuel burners with cleaner heating options), excluding Alexandra. Neither of the Alexandra sites have shown improvement since monitoring began in 2005, and the current site at 5 Ventry Street is showing degradation, although six years is a short time-period for trend analysis and to properly assess trends more data is required.

The Central Dunedin site's improvements are attributed to resource consent limits becoming stricter around the year 2011 (Mills, 2016). Neither Mosgiel nor Dunedin homes were eligible for financial incentives to improve home heating methods, however it is expected that these emissions will have improved over time as wood burner technology improves. Further investigation into the sources of emissions in Mosgiel and Central Dunedin would be beneficial for the future management of air quality in these airsheds.

Previous reports (Harrison, 2021 and Mills, 2016) have discussed the possibility of urban growth having a negative impact on the air quality trends, where new burners are being added to the fleet at the same rate as old burners are being replaced. In the case of Cromwell, it has experienced the highest percentage of increased number of dwellings than the other monitored airsheds, with 33% between the years 2006 and 2018 (Stats NZ, 2020), so it is possible that the reason for the low rate of improvement of PM concentrations is due to this. For Alexandra the increase of number of dwellings is only 12% which is lower than both Arrowtown and Clyde (24% and 22% respectively, Stats NZ, 2020). Further research into the emission sources for Alexandra is recommended.

The influence of seasonal variability on air quality data can be removed for trend analysis, however there are larger climactic cycles that also occur and can have an impact on air quality, such as the El Niño Southern Oscillation. In New Zealand El Niño commonly causes southerly winds during winter, resulting in colder than usual temperatures, while La Niña causes warmer than average land and sea temperatures. The years 2021 and 2022 were both La Niña years, with 2022 being the strongest La Niña since 1950 (Stats NZ, 2023). These results remain comparable to previous trend analyses, but future analysis with additional years of data is recommended.

6. References

Carslaw, D.C., Ropkins, K. (2012). Openair — *an R package for air quality data analysis*. Environmental Modelling & Software, Volume 27-28, 52-61 pp.

Carslaw, D.C. (2019). *The openair manual — open-source tools for analysing air pollution data*. Manual for version 2.6-6, University of York.

Carslaw, D.C., Beevers, S.D., Tate J.E. (2007). *Modelling and assessing trends in traffic-related emissions using a generalised additive modelling approach*. Atmospheric Environment 41 (26), 5289-5299 pp.

Kuschel et. al., (2022). *Health and air pollution in New Zealand 2016 (HAPINZ 3.0): Volume 1 – Finding and implications*. Report prepared by G Kuschel, J Metcalfe, S Sridhar, P Davy, K Hastings, K Mason, T Denne, J Berentson-Shaw, S Bell, S Hales, J Atkinson and A Woodward for Ministry for the Environment, Ministry of Health, Te Manatū Waka Ministry of Transport and Waka Kotahi NZ Transport Agency, March 2022. https://environment.govt.nz/assets/publications/HAPINZ/HAPINZ-3.0-Findings-and-implications.pdf

Longley, I. (2023). *Mapping of winter air quality in Alexandra*. National Institute of Water and Atmospheric Research Ltd

Ministry for the Environment (2002). *Ambient air quality guidelines – 2002 update*. Air Quality Report No. 32. Wellington: Ministry for the Environment.

National Air Quality Working Group, (2024). *Guidance for calculating LAWA air quality trends.*

Otago Regional Council (2009). *Regional Plan: Air for Otago*. Otago Regional Council, Dunedin.

Mills, D. (2016). *SOE Report: Air Quality 2005 – 2014*. Otago Regional Council, Dunedin.

Mills, D. (2018). *An assessment of the Clean Heat Clean Air Program's effectiveness*. Otago Regional Council Committee report.

Harrison, S. (2021). *State and Trends of Air Quality in the Otago Region 2010 – 2019*. Otago Regional Council, Dunedin.

Standards New Zealand (2016). AS/NZS 3580.1.1. *Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment.*

Standards New Zealand (2016). *AS/NZS 3580.9.11. Methods for sampling and analysis of ambient air, Method 9.11: Determination of suspended particulate matter – PM_{10} beta attenuation monitors.*

Stats NZ (2020). *Statistical area 1 dataset for 2018 Census – updated March 2020*. Stats NZ Tatauranga Aotearoa.

Stats NZ (2023). *El Nino Southern Oscillation,* updated 27 September 2023. Accessed on 8 February 2024. https://www.stats.govt.nz/indicators/el-nino-southern-oscillation/#about

Wilton, E. (2019). *Wanaka, Cromwell and Clyde Air Emission Inventory – 2019*. Environet Limited.

World Health Organization (2006). *WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide – global update 2005*. Regional office for Europe.

Otago Regional Council

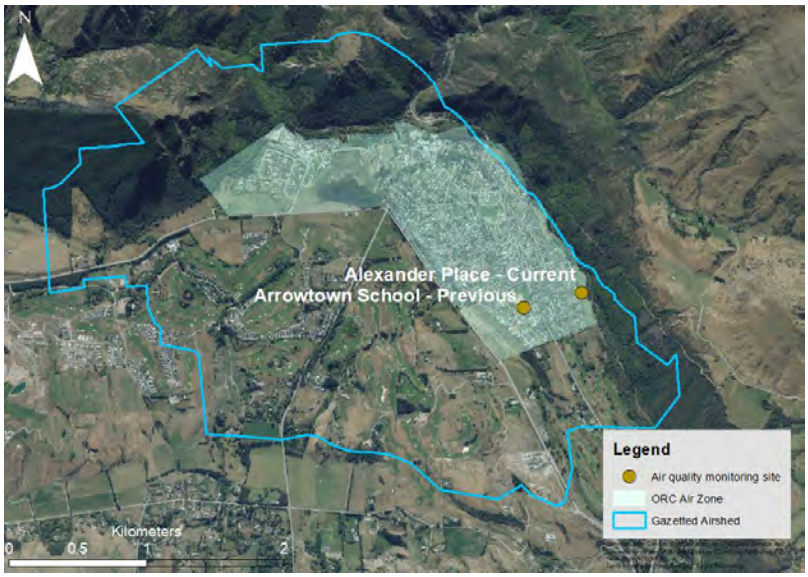
World Health Organization (2013). *Review of evidence of health aspects of air pollution – REVIHAAP Project Technical Report*. Regional office for Europe.

World Health Organization (2021). *WHO global air quality guidelines. Particulate matter ($PM_{2.5}$ and PM_{10}), ozone, nitrogen dioxide, sulfur dioxide and carbon monoxide.* Geneva: World Health Organization; 2021.

Appendix: Airshed and Air Zone boundary maps

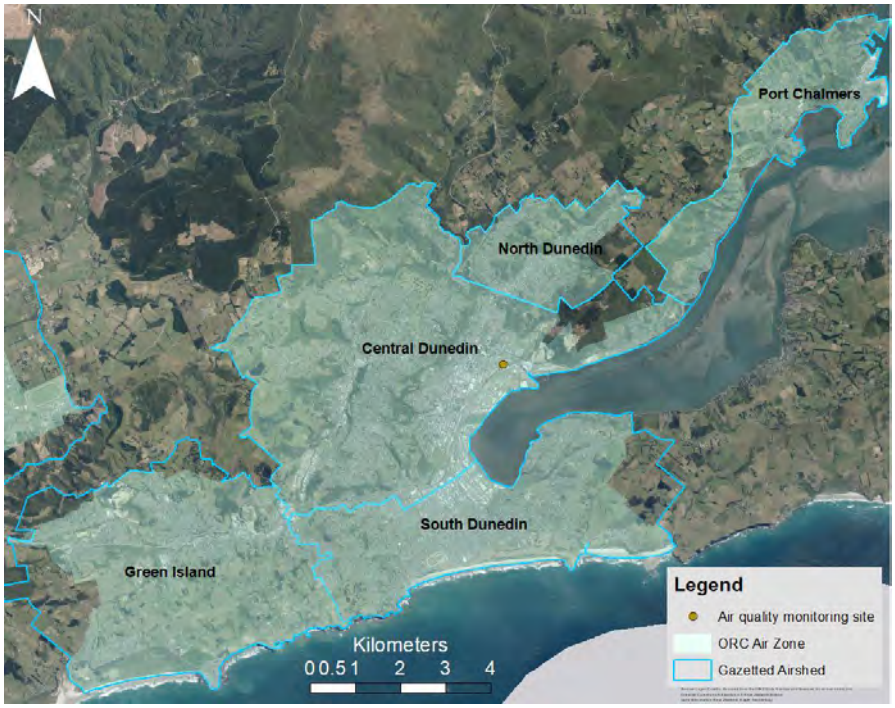
Note: ORC Air Zones were established under the Air Plan to better align land use with air quality management.

Arrowtown



Alexandra

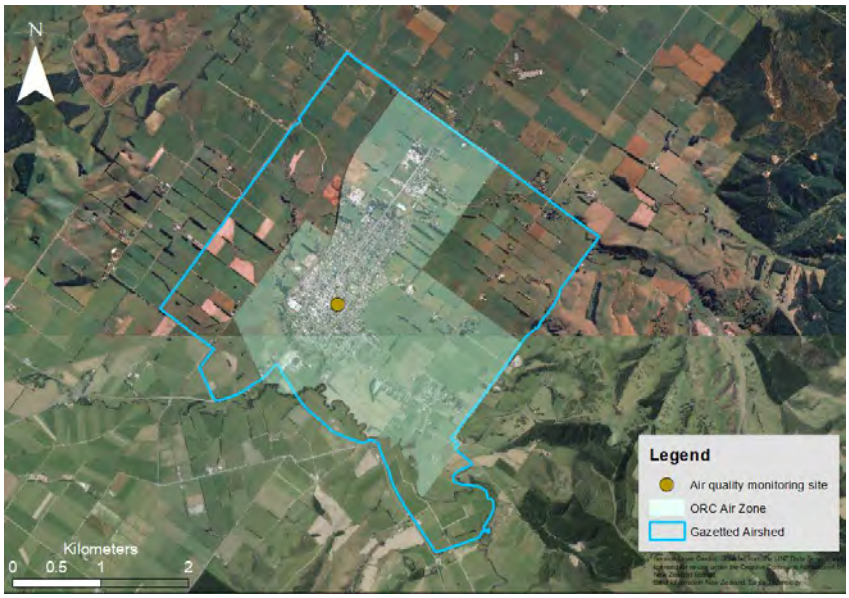
Otago Regional Council



Central Dunedin

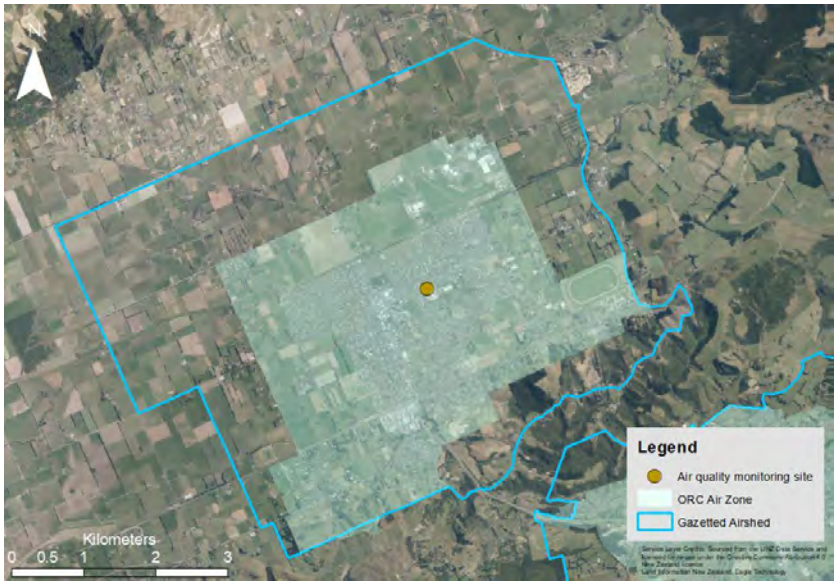
Clyde

Cromwell



Milton

Otago Regional Council


Legend
Air quality monitoring site
ORC Air Zone
Gazetted Airshed
Kilometers
0 0.5 1 2 3

Mosgiel

9.2. Annual Water Quality Report 2023

Prepared for:	Environmental Science and Policy Committee
Report No.	SPS2330
Activity:	Environmental: Water
Author:	Markus Dengg, Water Quality Scientist
Endorsed by:	Anita Dawe, General Manager Policy and Science
Date:	17th April 2024

PURPOSE

[1] The purpose of this report is to present the Water Quality and Biomonitoring report 2018-2023 (attached as Attachment 1) to the Committee. The report presents the most recent results of State of the Environment (SoE) monitoring undertaken to inform attribute tables in Appendix 2A and Appendix 2B of the National Policy Statement for Freshwater Management (NPSFM, 2020). This report also provides some additional regional analysis of the results.

EXECUTIVE SUMMARY

[2] The Otago Regional Council (ORC) monitors the water quality of a selection of Otago rivers and lakes through long-term State of the Environment (SoE) monitoring programmes.

[3] Monitoring is now focused on the attributes requiring limits on resource use (Appendix 2A, NPSFM, 2020) in the NPSFM. These attributes include phytoplankton (lakes), dissolved oxygen (DO, rivers and lakes), cyanobacteria (lakes), periphyton (rivers), total nitrogen (TN, lakes), total phosphorus (TP, lakes), ammonia (NH_4-N, rivers, and lakes) and nitrate toxicity (NNN, rivers and lakes), suspended fine sediment (SFS, rivers) and *E. coli* (rivers and lakes).

[4] The ORC also monitors the attributes requiring action plans (Appendix 2B, NPSFM, 2020). These attributes include submerged plants (native and invasive, lakes), fish (rivers), macroinvertebrates (rivers), deposited fine sediment (rivers), dissolved reactive phosphorus (DRP, rivers) and ecosystem metabolism (rivers).

[5] The water quality report results show that the state of river and lake water quality is spatially variable across Otago and is best at lakes, river and stream reaches located at high elevations under predominantly native cover or conservation land. These sites tend to be in the upper catchments of the large lakes (e.g. Hāwea, Wakatipu and Wānaka) and some tributaries of the Clutha Mata-Au (e.g., Lindis River, Nevis River, Dart River). Other areas, such as urban streams in Dunedin, intensified catchments in the North Otago FMU, and the Catlins FMU and some tributaries in the Lower Clutha Rohe have poorer water quality.

RECOMMENDATION

That the Committee:

1) ***Notes** this report.*

BACKGROUND

[6] ORC has been monitoring rivers and lakes as part of its long term SoE monitoring programme for surface water quality since the early 1990s. With the introduction of the NPS-FM additional parameters have been added.

[7] The NPS-FM defines the ranges for numeric attribute bands, which are designated band A (good water quality) to D/E (poor water quality). The attribute bands represent a graduated range of conditions supporting environmental values from high (A band) to low (D/E band). For most attributes, the D band represents an unacceptable condition (with the threshold between the C and the D band being referred to as the 'bottom line') while an A band represents good water quality.

[8] The attributes monitored include those in Appendix 2A and 2B of the NPSFM (attached as Appendix 2) which have been graded according to the relevant attribute table and calculation guidance provided.

DISCUSSION

[9] The water quality report results show that the state of river and lake water quality is spatially variable across Otago and is best at lakes, river and stream reaches located at high elevations under predominantly native cover or conservation land. These sites tend to be in the upper catchments of the large lakes (e.g. Hāwea, Wakatipu and Wānaka) and some tributaries of the Clutha Mata-Au (e.g., Lindis River, Nevis River, Dart River). Other areas, such as urban streams in Dunedin, intensified catchments in the North Otago FMU, and the Catlins FMU and some tributaries in the Lower Clutha Rohe have poorer water quality.

[10] Set out below is more detailed discussion on river and lake water quality, including by Freshwater Management Unit, along with river ecosystem health.

River Water Quality

[11] The report demonstrates that ·Ammonia and Nitrate concentrations are in the A or B band for 104 of 106 river sites and all lakes monitored in Otago.

[12] Dissolved reactive phosphorus (DRP) was variable, but in the A, B, and C band for 91 of 106 river monitoring sites, with the highest concentrations of DRP found in the Lower Clutha Rohe, North Otago FMU and the Manuherekia Rohe.

[13] Sites at the bottom of catchments tended to have higher concentrations of E. coli than upper catchment sites. This is evidenced for example in the Upper Lakes Rohe, where *E.coli* generally achieved an A band as compared to the Lower Clutha Rohe where the lower catchments generally achieved the D and E Bands.

[14] Natural processes such as tannin staining and glacial flour influenced the suspended fine sediment results, with many sites in the Clutha Mata-Au, Catlins and Taieri FMUs

achieving a C band. There are sites below the national bottom line in the Catlins FMU and Lower Clutha Rohe.

[15] Of the 10 sites monitored for dissolved oxygen (DO), two sites in the Dunstan Rohe achieved the A band. The rest of the sites in Otago achieved the B or C Band.

Lake Water Quality

[16] For lakes, the attributes monitored are Total Nitrogen (TN) and Total Phosphorus (TP), Chlorophyll-*a* Chl-*a*, cyanobacteria biovolume ammonia, *E.coli*, dissolved oxygen, and submerged plants (Lake SPI).

[17] The Upper Lakes Rohe achieved the A attribute band for most attributes measured for its lakes. For lakes in the Taieri FMU, Lower Clutha Rohe and Roxburgh Rohe, variable results across the attributes were achieved.

[18] For TN and TP, deep and relatively large lakes generally achieved the A band while shallower lakes, where more nutrients can be resuspended from the sediment and less water is available to buffer terrestrial nutrient input, achieved the C band. Lake Tuakitoto achieved a D band for nutrients, which was not unexpected given the lake is a shallow wetland.

[19] All lakes monitored achieved the A band for cyanobacteria biovolume. Lakes that achieved the B, C or D band for nutrients, such as Lake Hayes, Lake Tuakitoto and Lake Waihola, also achieved the B, C, or D band for Chl-*a*.

[20] Lake Hayes, which is nutrient rich, suffers from algal blooms and stratifies during the warmer months with bottom waters becoming anoxic, falls below the national bottom line for annual median phytoplankton and DO.

[21] All monitored lakes achieved the A or B band for ammonia and at least the C band for submerged plant growth.

River Ecosystem Health

[22] Ecosystem health parameters for deposited sediment and Chl-*a* (periphyton) were monitored monthly and all other parameters (macroinvertebrates, fish, and ecosystem metabolism) were monitored annually in rivers.

[23] Periphyton in Otago saw a spatial gradation from lower concentrations in the Upper Lakes Rohe, to higher concentrations in the Dunedin & Coast and North Otago FMUs. Of the monitoring sites, 25 of 34 sites, mainly in the Upper Lakes Rohe, Dunstan Rohe and Dunedin & Coast FMU achieved an A or B attribute band for periphyton.

[24] Deposited sediment is monitored at 34 sites, and all sites other than the Matukituki River obtained an A attribute band, reflecting a minimal impact of deposited fine sediment on instream biota.

[25] The fish index of biotic integrity (IBI) measures the condition of fish communities at a particular site. No national bottom line exists for Fish IBI, and continued monitoring will inform future bottom-line establishment. Fish IBI is generally better closer to the coast where more species are observed due to the presence of diadromous migratory fishes.

[26] A total of28 of 35 sites are above the D band which is the national bottom line for macroinvertebrate health.

OPTIONS

[27] This is a noting paper, so no options are outlined.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[28] This report contributes to the ORC strategic objective of *Healthy water, soil and coast* and *Healthy and diverse ecosystems*, informing on the state of our freshwater resources to create an environment that supports healthy people and ecosystems.

[29] Land use and freshwater management will be addressed, as far as practicable, through the new LWRP and non-regulatory action plans.

Financial Considerations

[30] This SoE monitoring is covered within existing budget and work programmes.

Significance and Engagement

[31] Not applicable

Legislative and Risk Considerations

[32] Monitoring networks must comply with national legislation and effectively evaluate objectives in regional plans. However, as policies can change rapidly, there is generally a lag for implementing network changes and then further delay until sufficient data is collected to enable analysis.

Climate Change Considerations

[33] There are no directly relevant climate change considerations however the SoE monitoring for surface water quality will be one source of information that can be used over time to understand the effects of climate change on our rivers and lakes.

Communications Considerations

[34] The current report features a new design, aimed to make it more accessible and visually appealing to the public. The Science Team will collaborate with the Communications Team and Environmental Implementation Team to make this report available for catchment groups and interested parties via social media, e-mail, and more traditional ways of communication. The report will also made available on the ORC website.

NEXT STEPS

[35] The next annual report will cover the period July 2019 to June 2024.

[36] A network monitoring review is planned for the2024-25 financial year. The outcomes of that review will assist to identify gaps in the network and ensure continued compliance with obligations to monitor in higher order documents.

ATTACHMENTS

1. Details of Attributes in Appendix 2A and 2B of the NP [**9.2.1** - 2 pages]
2. Report 2018-2023 NPSFM (1) [**9.2.2** - 31 pages]


Otago
Regional
Council
Water Quality & Ecosystem Health
Otago 2018-2023


Tititea Mt Apiring
3,033 m
6,700 km² of
conservation area
136 lakes
480 km of
coastline
Queenstown-
Lakes
Central Otago
Waitaki
Dunedin
Clutha
318
Catchments
6,500 km²
Marine area
Biggest river in
Aotearoa by flow
Our Region
Area
31,000 km²
Population
225,186
Iwi
Ngāi Tahu
5 City or District
Councils
2

Upper Lowburn, Dunstan Rohe

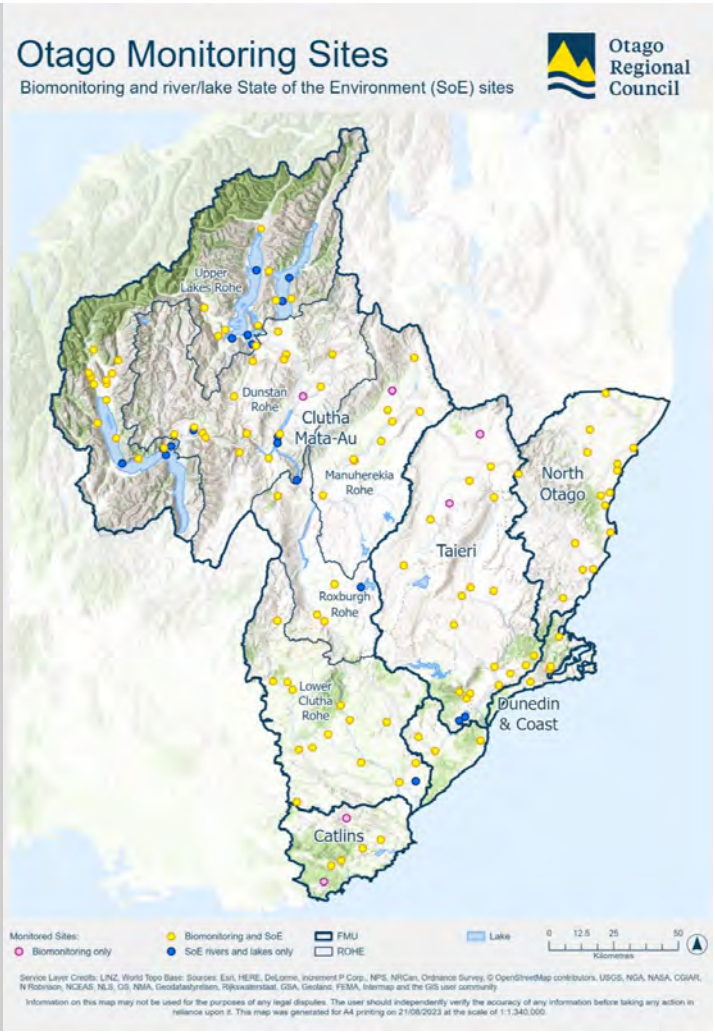
Our regional monitoring network

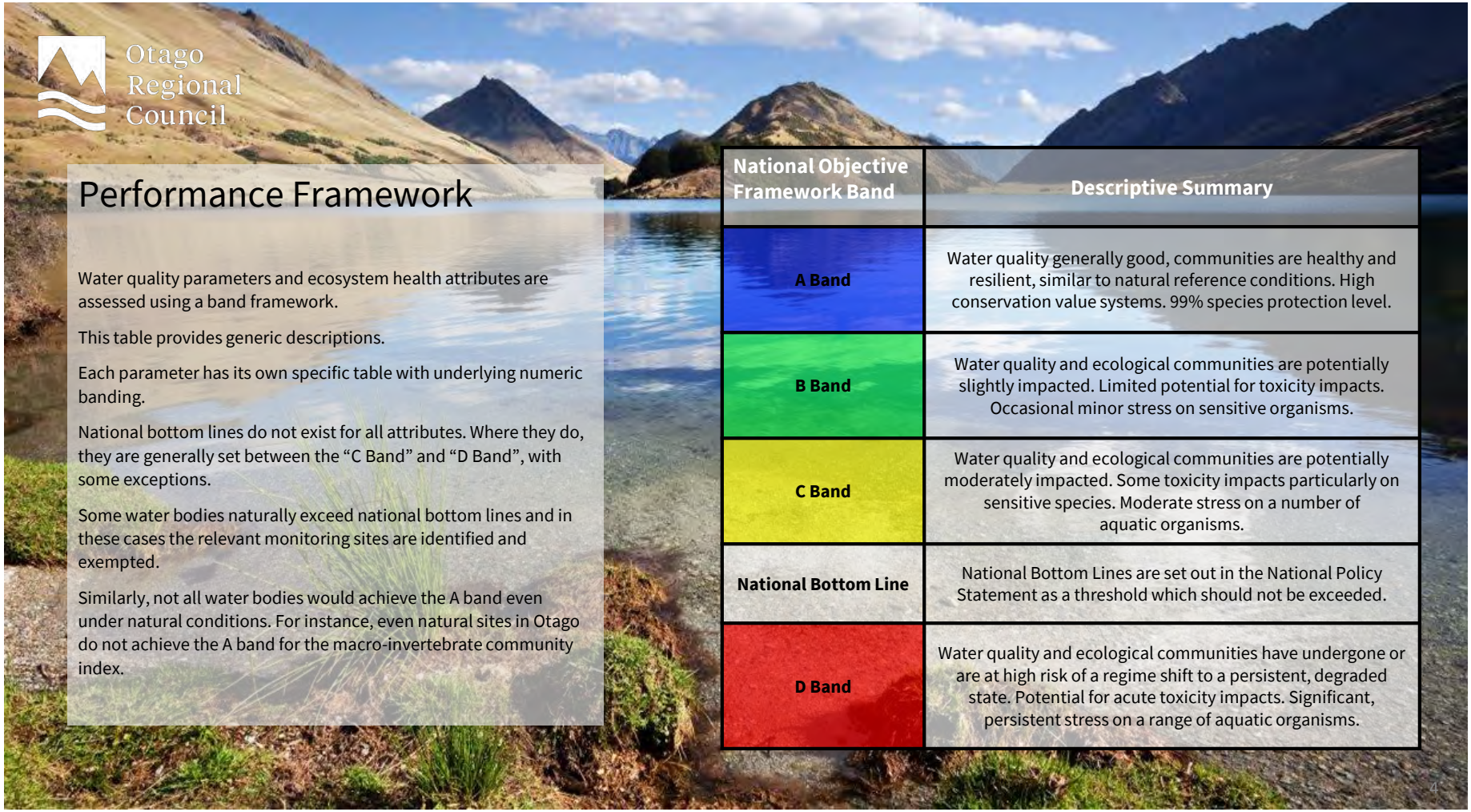
Water quality and ecosystem health are an integral component of environmental health and influence many uses and values of our waterways.

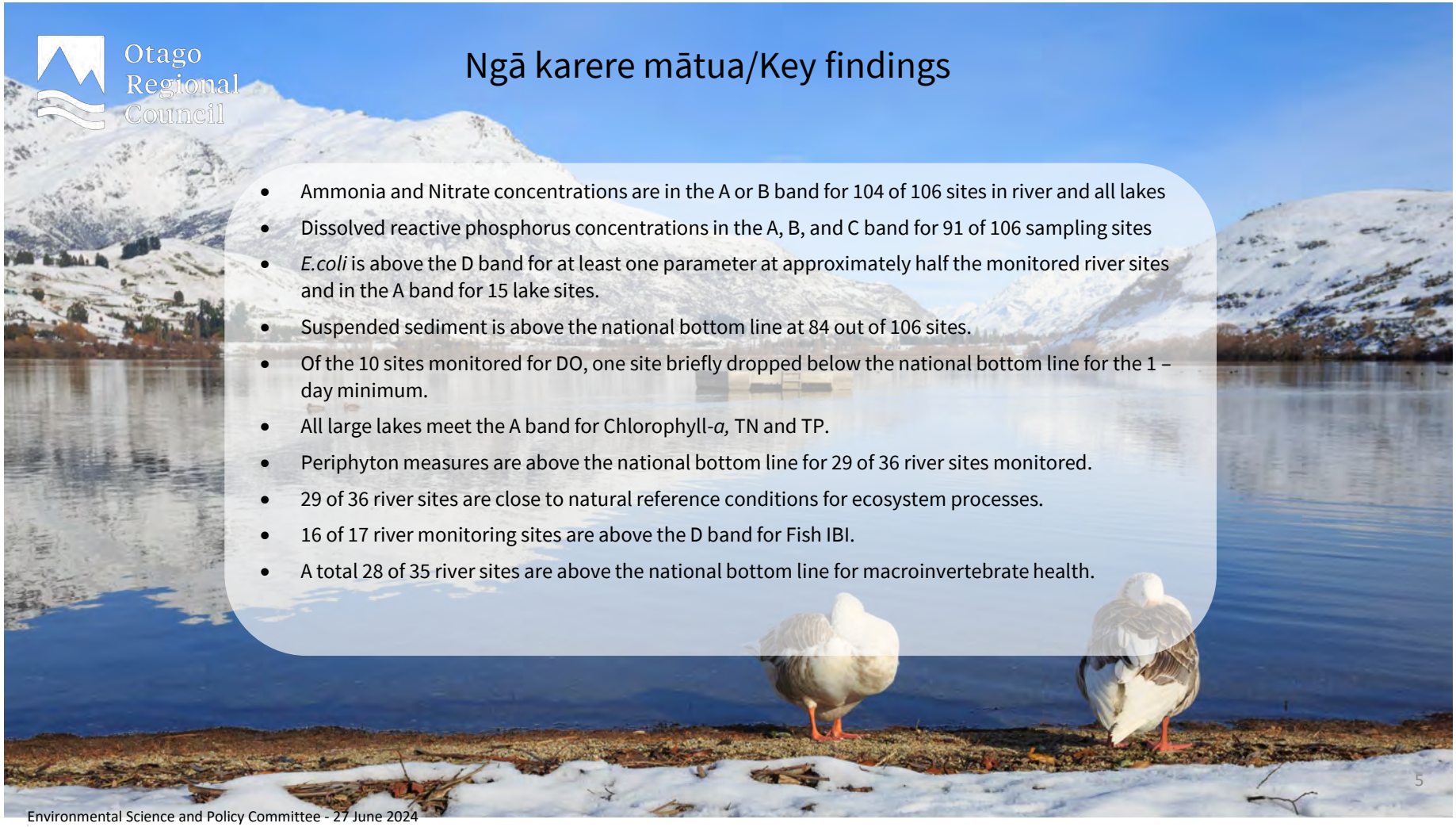
Otago Regional Council (ORC) operates a State of Environment (SoE) water quality monitoring network in lakes and rivers throughout the region. The information gathered through this programme is used to report on the state and trends of water quality and ecosystem health over time to inform environmental management and policy effectiveness.

The ORC currently monitors 105 river sites and 8 lakes. The sites are chosen to represent river types in the Otago region, based on the River Environment Classification (REC). See pages 12 and 23 for site names and numbers used in the following graphics.

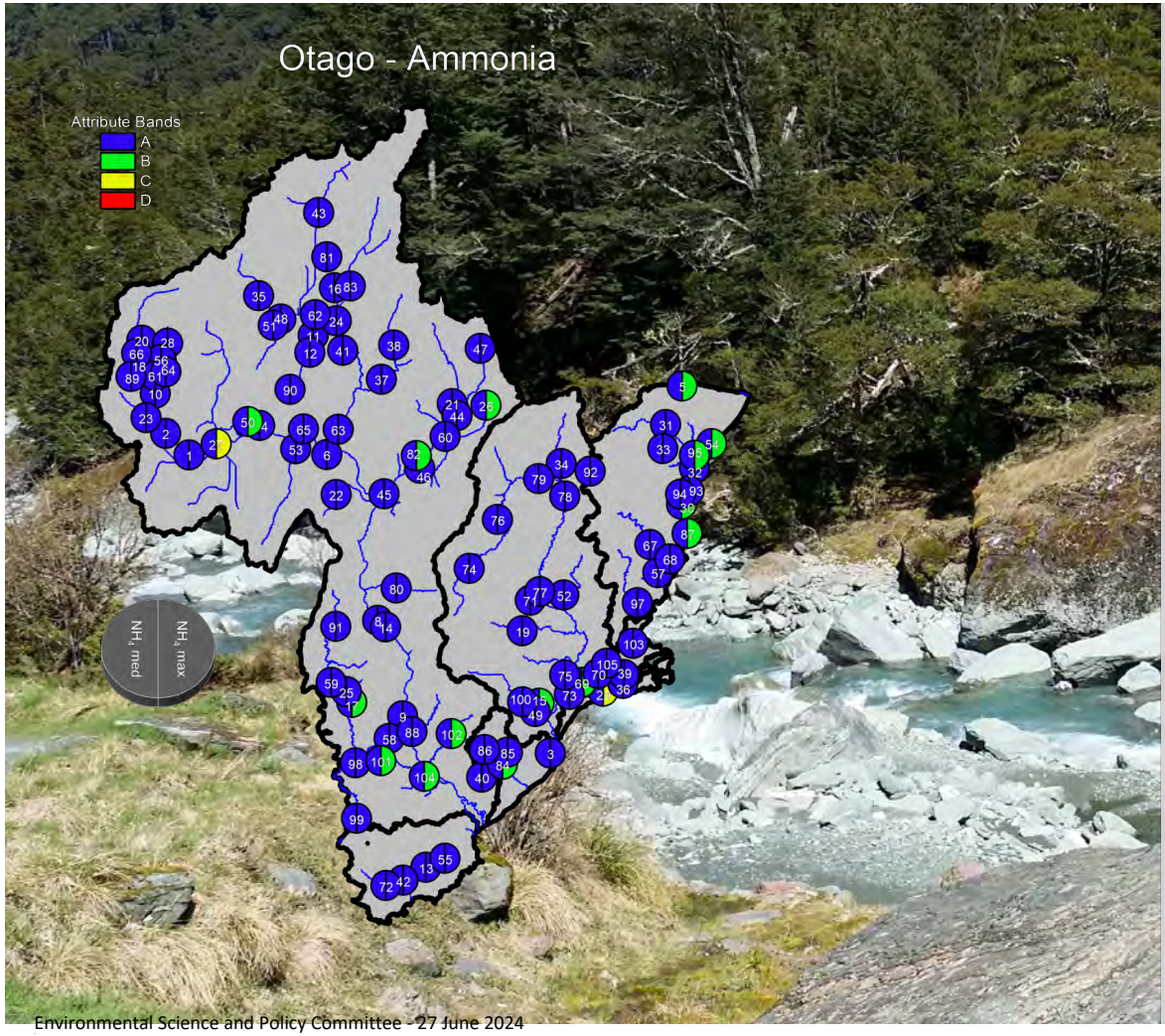
This report gives an overview of state results for the monitoring period 1st July 2018- 30th June 2023 against water quality parameters or ecosystem health attributes defined by the National Objectives Framework (NOF) as described in the National Policy Statement – Freshwater Management 2020. Full technical reports, including trend analysis, can be found on our homepage, and data can be accessed via our environmental data portal.




Otago Regional Council
Performance Framework
Water quality parameters and ecosystem health attributes are assessed using a band framework.
This table provides generic descriptions.
Each parameter has its own specific table with underlying numeric banding.
National bottom lines do not exist for all attributes. Where they do, they are generally set between the "C Band" and "D Band", with some exceptions.
Some water bodies naturally exceed national bottom lines and in these cases the relevant monitoring sites are identified and exempted.
Similarly, not all water bodies would achieve the A band even under natural conditions. For instance, even natural sites in Otago do not achieve the A band for the macro-invertebrate community index.
National Objective Framework Band
Descriptive Summary
A Band
Water quality generally good, communities are healthy and resilient, similar to natural reference conditions. High conservation value systems. 99% species protection level.
B Band
Water quality and ecological communities are potentially slightly impacted. Limited potential for toxicity impacts. Occasional minor stress on sensitive organisms.
C Band
Water quality and ecological communities are potentially moderately impacted. Some toxicity impacts particularly on sensitive species. Moderate stress on a number of aquatic organisms.
National Bottom Line
National Bottom Lines are set out in the National Policy Statement as a threshold which should not be exceeded.
D Band
Water quality and ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state. Potential for acute toxicity impacts. Significant, persistent stress on a range of aquatic organisms.
4


Otago Regional Council
Ngā karere mātua/Key findings
Ammonia and Nitrate concentrations are in the A or B band for 104 of 106 sites in river and all lakes
Dissolved reactive phosphorus concentrations in the A, B, and C band for 91 of 106 sampling sites
E.coli is above the D band for at least one parameter at approximately half the monitored river sites and in the A band for 15 lake sites.
Suspended sediment is above the national bottom line at 84 out of 106 sites.
Of the 10 sites monitored for DO, one site briefly dropped below the national bottom line for the 1 – day minimum.
All large lakes meet the A band for Chlorophyll-a, TN and TP.
Periphyton measures are above the national bottom line for 29 of 36 river sites monitored.
29 of 36 river sites are close to natural reference conditions for ecosystem processes.
16 of 17 river monitoring sites are above the D band for Fish IBI.
A total 28 of 35 river sites are above the national bottom line for macroinvertebrate health.
5
Environmental Science and Policy Committee - 27 June 2024


Otago
Regional
Council
Water Quality - Rivers



Nitrate toxicity - Ammonia (Rivers)

High levels of ammoniacal nitrogen (NH4-N) in water can create conditions that make it difficult for aquatic insects or fish to survive. In Otago rivers, ammonia concentrations are generally low, achieving an A or B band. At these concentrations, ammonia is not expected to be harmful to most freshwater species and does not pose a risk for humans.

River sites that are experiencing higher anthropogenic pressures via activities such as agricultural runoff, fertilizer application or effluent discharge generally have higher concentrations of NH_4-N.

The main sources of NNN and NH_4-N are fertilizers, wastewater, and animal waste. NNN and NH_4-N can come from diffuse sources, such as land runoff or point sources, like wastewater pipes.

	Ammonia (toxicity) mg/l		
	Description	numeric attribute state	
		Annual median	Annual maximum
A	99% species protection level: No observed effect on any species tested.	≤0.03	≤0.05
B	95% species protection level: Starts impacting occasionally on the 5% most sensitive species.	>0.03 and ≤0.24	>0.05 and ≤0.40
	National bottom line	0.24	0.4
C	80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).	>0.24 and ≤1.3	>0.4 and ≤2.2
D	Starts approaching acute impact level (that is, risk of death) for sensitive species.	>1.3	>2.2

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.

7

Nitrate toxicity – Nitrite-Nitrate-Nitrogen (Rivers)

High levels of nitrate-nitrite-nitrogen (NNN) in water can create conditions that make it difficult for aquatic insects or fish to survive. In Otago rivers, concentrations are generally very good (< 0.03 mg/l for NNN), complying with the A band. At these concentrations, NNN is not expected to be harmful to most freshwater species and does not pose a risk for humans.

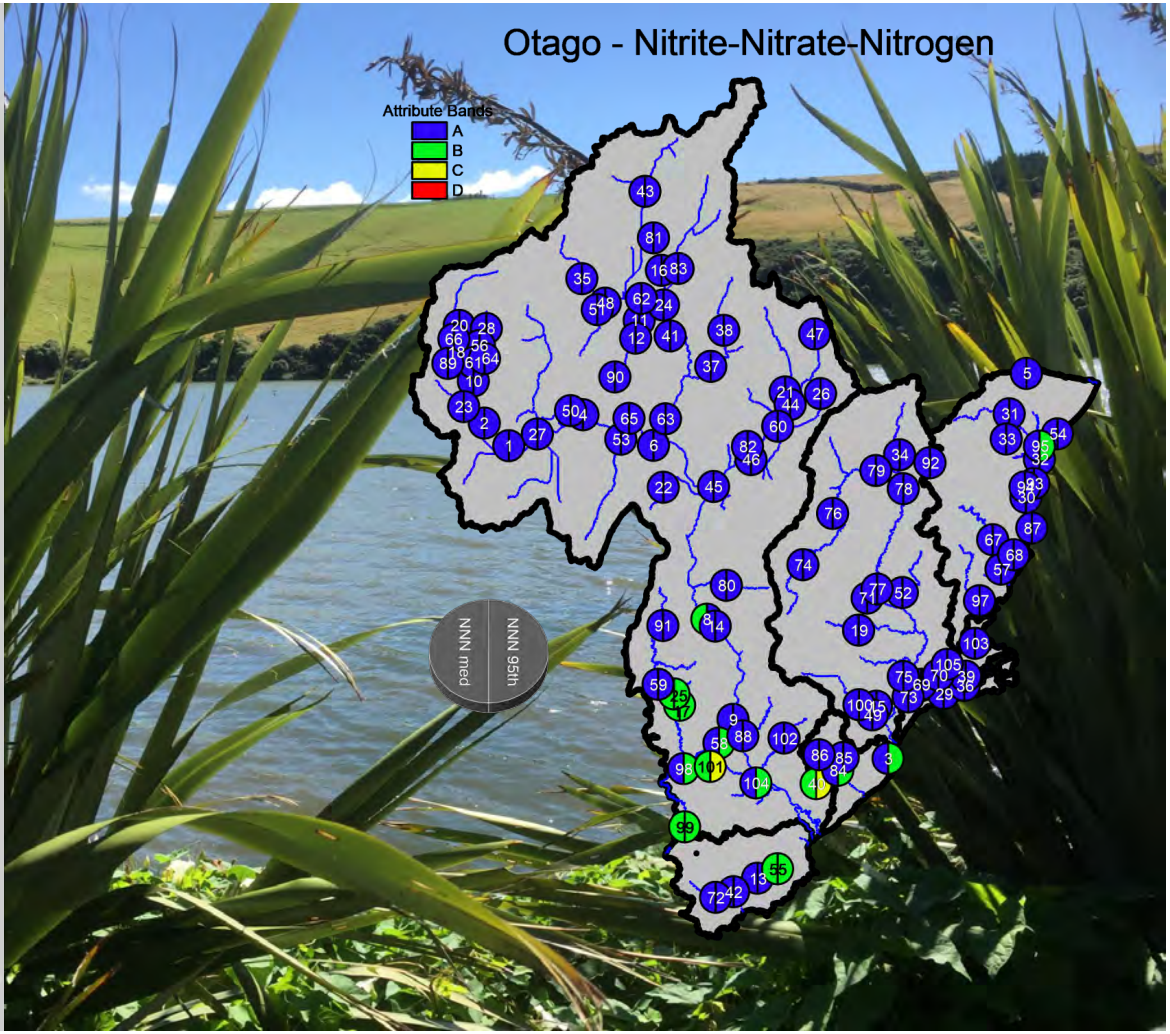
River sites that are experiencing higher anthropogenic pressures such as intensive farming or urban development generally have higher concentrations of NNN.

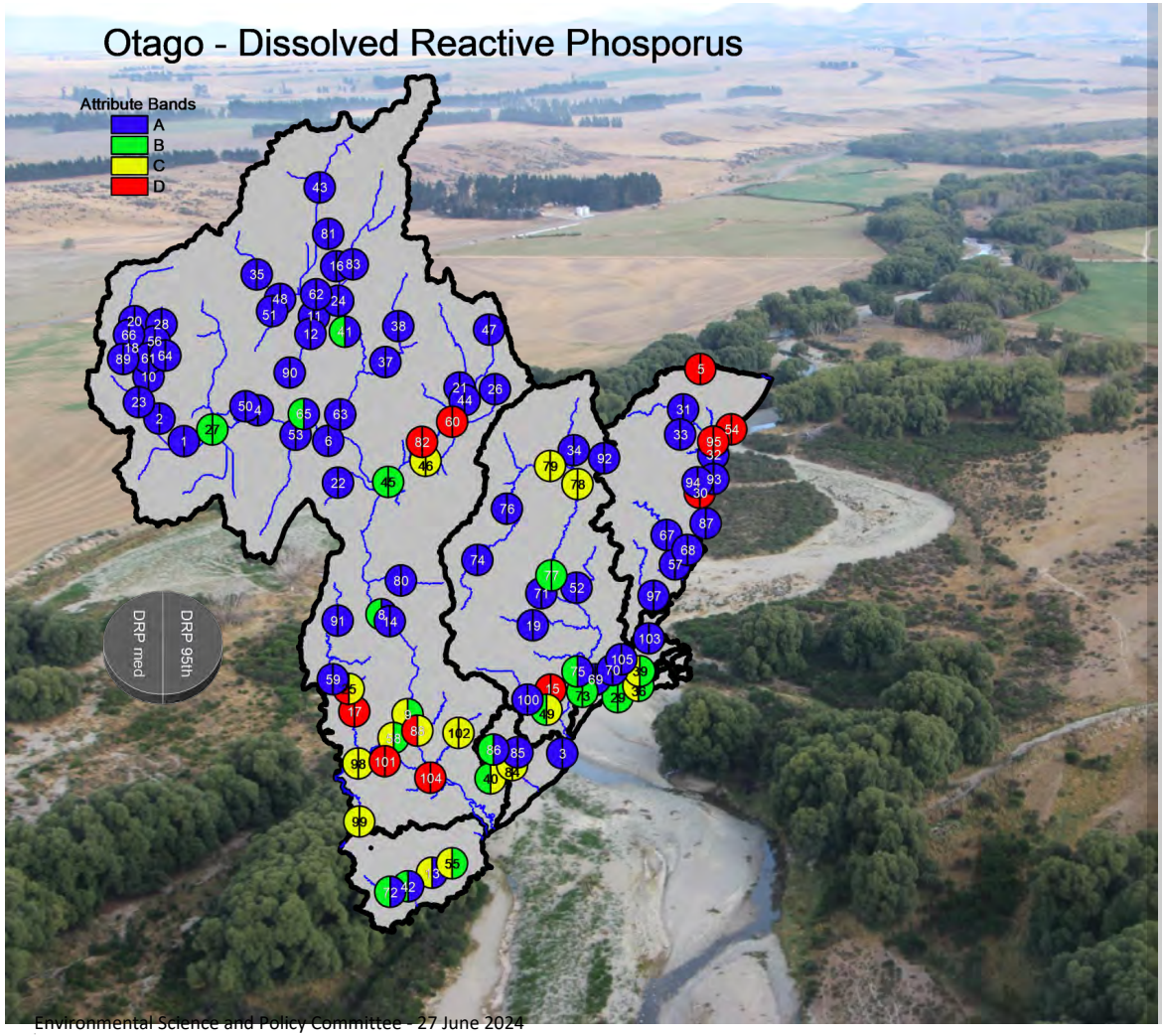
The main sources of NNN and NH4-N are fertilizers, wastewater, and animal waste. NNN and NH4-N can come from diffuse sources, such as land runoff or point sources, for example wastewater pipes.

Sites below the national bottomline for the 95th percentile for NNN are Lovells Creek (#40) and Wairuna Stream (#101; both Lower Clutha Rohe).

	Nitrate (toxicity) mg/l		
	Description	numeric attribute state	
		Annual median	Annual 95th percentile
A	High conservation value system. Unlikely to be effects even on sensitive species.	≤1.0	≤1.5
B	Some growth effect on up to 5% of species.	>1.0 and ≤2.4	>1.5 and ≤3.5
	National bottom line	2.4	3.5
C	Growth effects on up to 20% of species (mainly sensitive species such as fish). No acute effects.	>2.4 and ≤6.9	>3.5 and ≤9.8
D	Impacts on growth of multiple species, and starts approaching acute impact level (that is, risk of death) for sensitive species at higher concentrations (>20 mg/L).	>6.9	>9.8

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.





DRP(Rivers)

Dissolved reactive phosphorus is a form of phosphorus that is readily available for uptake by algal cells, allowing for fast algal growth if supply is sufficient. In the NPS-FM, the DRP attributes includes the impact of DRP on algal growth, invertebrates , fish and ecosystem processes. Therefore, bands are indicative of the health of several water quality components.

A total of 12 sites show DRP concentrations which fall in the D band. These sites are located in the Manuherekia Rohe and the Lower Clutha, Dunedin & Coast and North Otago FMU's. This measure has no national bottom line. However, the D-band indicates substantial DRP elevation above natural reference conditions.

	Dissolved reactive phosphorous (mg/L)		
	Description	numeric attribute state	
		median	95th percentile
A	Ecological communities and ecosystem processes are similar to those of natural reference conditions. No adverse effects attributable to dissolved reactive phosphorus (DRP) enrichment are expected.	≤ 0.006	≤ 0.021
B	Ecological communities are slightly impacted by minor DRP elevation above natural reference conditions. If other conditions also favour eutrophication, sensitive ecosystems may experience additional algal and plant growth, loss of sensitive macroinvertebrate taxa, and higher respiration and decay rates.	> 0.006 and ≤0.010	> 0.021 and ≤0.030
C	Ecological communities are impacted by moderate DRP elevation above natural reference conditions. If other conditions also favour eutrophication, DRP enrichment may cause increased algal and plant growth, loss of sensitive macro-invertebrate and fish taxa, and high rates of respiration and decay.	> 0.010 and ≤ 0.018	> 0.030 and ≤ 0.054
D	Ecological communities impacted by substantial DRP elevation above natural reference conditions. In combination with other conditions favouring eutrophication, DRP enrichment drives excessive primary production and significant changes in macroinvertebrate and fish communities, as taxa sensitive to hypoxia are lost.	>0.018	>0.054

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.

9

E. coli (Rivers)

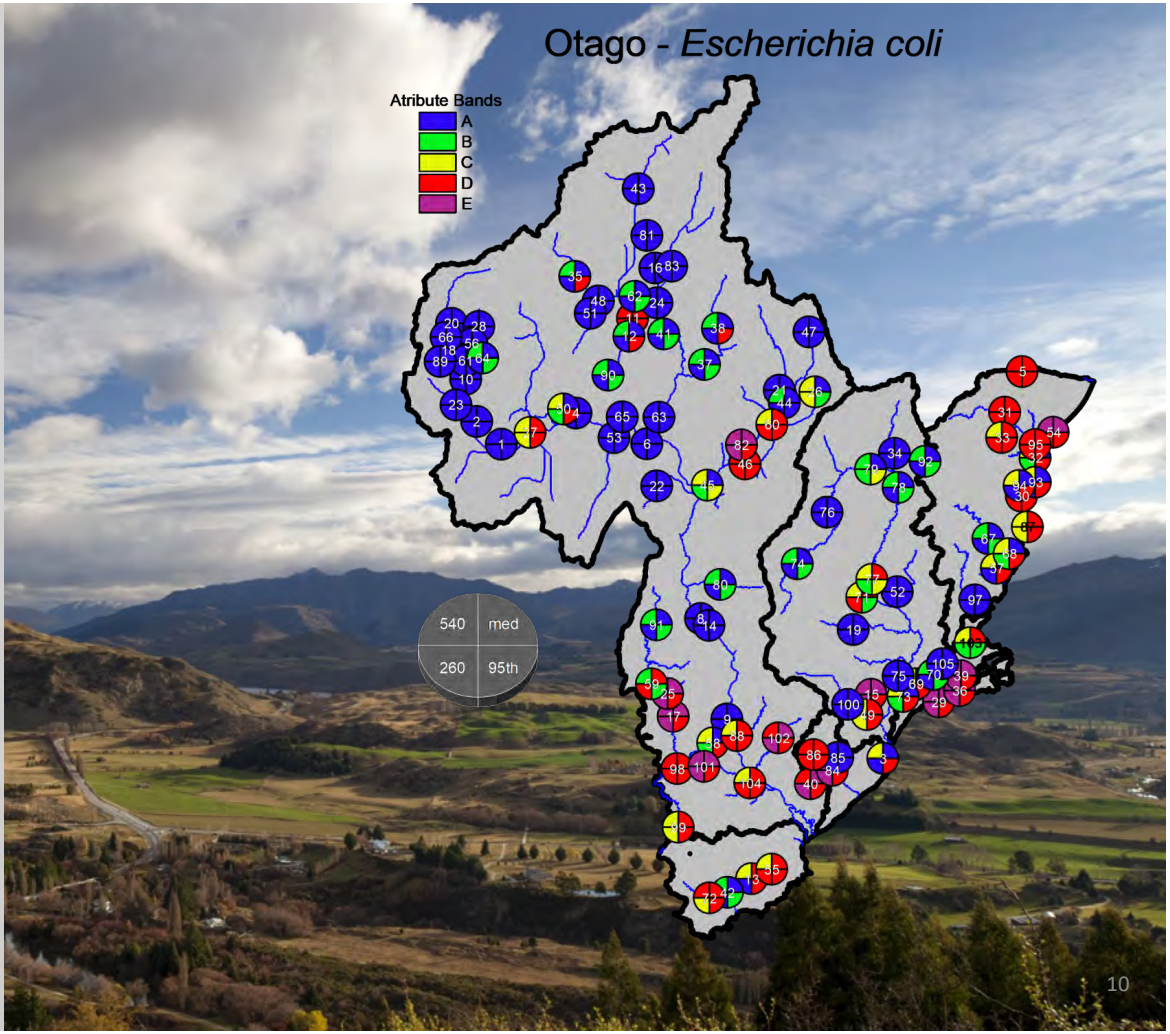
The bacterium *Escherichia coli* (*E. coli*) is naturally present in animal faeces and in freshwater and can reach high concentrations by the addition of wastewater or runoff from agricultural pastures to streams. High densities of *E. coli* indicate that the water has been contaminated with faecal matter and may therefore contain pathogens (such as cryptosporidium) that can cause illness.

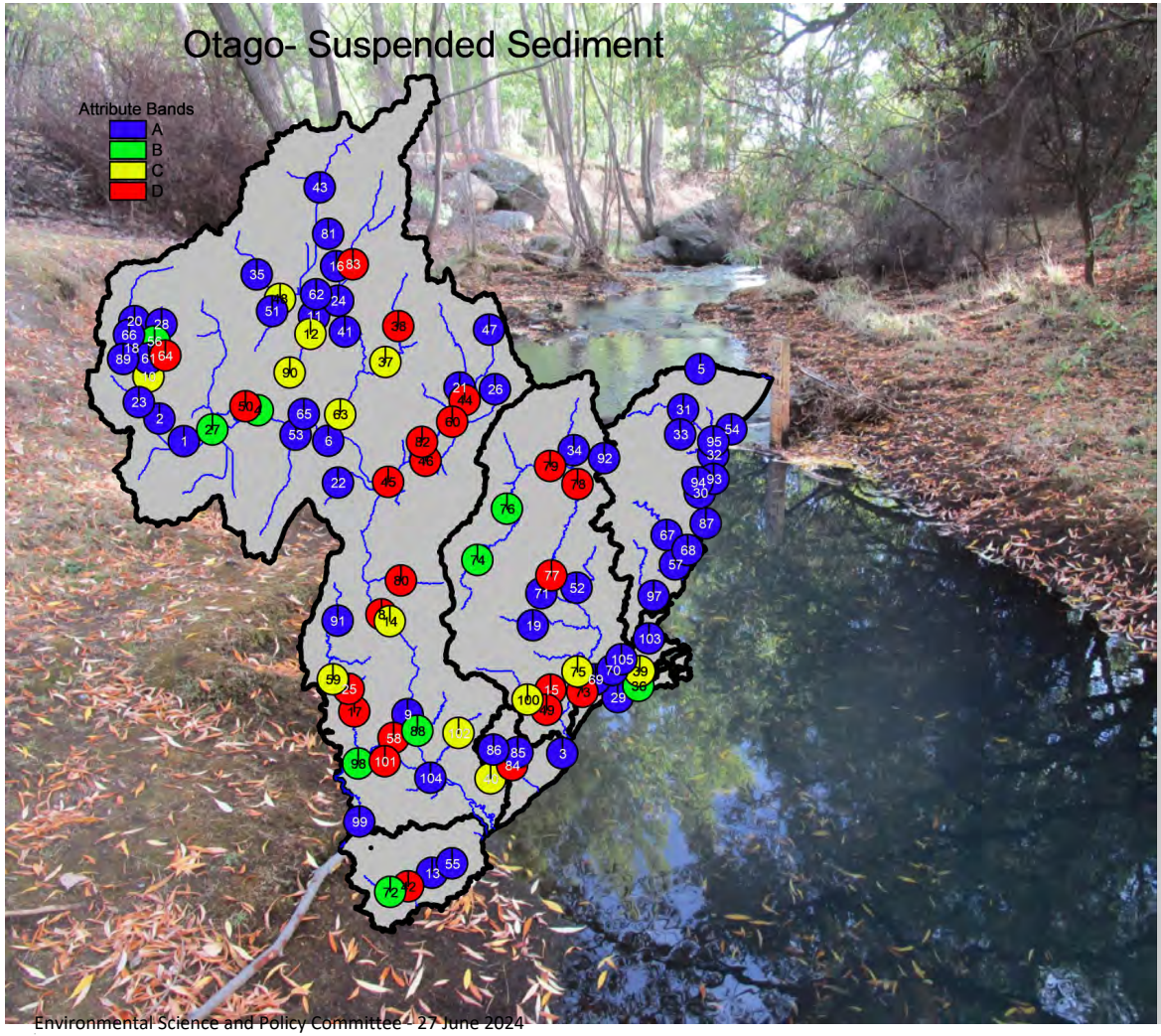
The NPS-FM uses four different metrics to inform the current state of *E. coli* in rivers and lakes: median, 95th percentile, 260 MPN (Most Probable Number)/100mL exceedance, and 540 MPN/100mL exceedance.

Sites that are below the D band for at least one *E. coli* measure are located in Dunedin & Coast and North Otago FMU's and the Lower Clutha Rohe.

	Escherichia Coli	E.Coli/100ml			
	Description	Numeric attribute state			
	Description of risk of Campylobacter infection (based on E. coli indicator)	% exceedances over 540/100 mL	% exceedances over 260/100 mL	Median concentration /100 mL	95th percentile of E. coli/100 mL
A	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 1%.	<5%	<20%	≤130	≤540
B	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 2%.	5-10%	20-30%	≤130	≤1000
C	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is >3%.	10-20%	20-34%	≤130	≤1200
D	20-30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >3%.	20-30%	>34%	≤130	>1200
E	For more than 30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >7%.	>30%	>50%	>260	>1200

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.





Suspended Sediment (Rivers)

Elevated concentrations of suspended fine sediment negatively influence benthic environments, fish community composition. Suspended fine sediment is naturally present in all rivers due to the presence of organic substances and the weathering of rocks. Rather than monitoring visual clarity, ORC is monitoring turbidity which is independent of ambient light conditions and can be robustly converted to visual clarity.

The two major rivers in Otago, the Clutha and Taieri, are influenced by natural sources of suspended fine sediment. High loads of glacial flour are present in the Clutha, creating its unique turquoise colour, while natural tannin staining is responsible for the brown colour of the Taieri and some rivers in the Catlins FMU.

Four sites, the Owaka River, Catlins River, Tahakopa River and Waipahi River fail the national bottom line for suspended sediments. These sites are located in the Catlins FMU and Lower Clutha Rohe.

	Suspended fine sediment	visual clarity (m)			
	Description	Numeric attribute state by suspended sediment class			
		1	2	3	4
A	Minimal impact of suspended sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.	≥1.78	≥0.93	≥2.95	≥1.38
B	Low to moderate impact of suspended sediment on instream biota. Abundance of sensitive fish species may be reduced.	<1.78 and ≥1.55	<0.93 and ≥0.76	<2.95 and ≥2.57	<1.38 and ≥1.17
C	Moderate to high impact of suspended sediment on instream biota. Sensitive fish species may be lost.	<1.55 and ≥1.34	<0.76 and ≥0.61	<2.57 and ≥2.22	<1.17 and ≥0.98
	National bottom line	1.34	0.61	2.22	0.98
D	High impact of suspended sediment on instream biota. Ecological communities are significantly altered and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.	<1.34	<0.61	<2.22	<0.98

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.

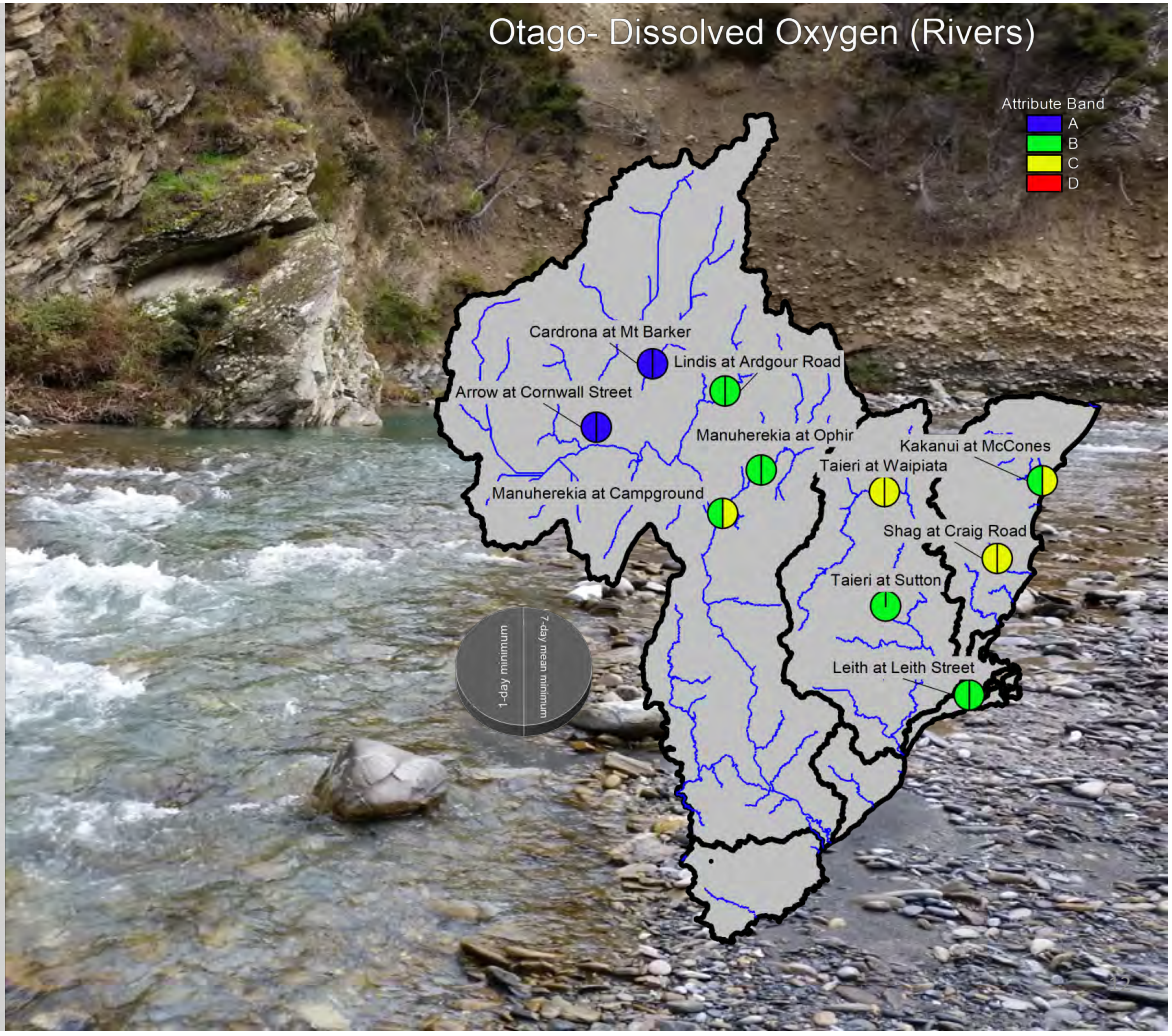
Dissolved Oxygen (Rivers)

Dissolved Oxygen (DO) is a measure of the amount of oxygen that is contained in water. Many organisms, including fish and macroinvertebrates breath oxygen (via their gills) and bacteria consume oxygen when decomposing organic matter. Fast flowing streams or alpine streams tend to hold high concentrations of DO while slow flowing or stagnant waters tend to be low in DO because biomass decomposition processes consume oxygen. If oxygen concentrations in water fall below 5 mg/L organisms become stressed and DO concentrations <2 mg/L can lead to the death of organisms.

All sites monitored achieve attribute bands above the national bottom line. Readers interest in the technical information behind calculations of bands can find more information following to the link on the last page of this report.

	Dissolved Oxygen (ecosystem health) Rivers		
	Description	mg/L (milligrams per litre)	
		numeric attribute state	
		7-day mean minimum (summer period: 1 November to 30th April)	1-day minimum (summer period: 1 November to 30th April)
A	No stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near-pristine) sites.	≥8.0	≥7.5
B	Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.	≥7.0 and <8.0	≥5.0 and <7.5
C	Moderate stress on a number of aquatic organisms caused by dissolved oxygen levels exceeding preference levels for periods of several hours each day. Risk of sensitive fish and macroinvertebrate species being lost.	≥5.0 and <7.0	≥4.0 and <5.0
	National bottom line	5	4
D	Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.	<5.0	<4.0

The Environmental data portal shows an additional five sites to those presented here, these sites were not analysed due to insufficnet data for reporting.



Otago Regional Council

Sampling site numbers and names seen in figures pages 6 to 14

#	Site	#	Site	#	Site	#	Site
1	12 Mile Creek at Glenorchy Queenstown Road	28	Invincible Creek at Rees Valley Road	54	Oamaru Creek at SH1	80	Teviot at Bridge Huts Road
2	25 Mile Creek at Glenorchy Queenstown Road	29	Kaikorai Stream at Brighton Road	55	Owaka at Katea Road	81	The Neck Creek at Meads Road
3	Akatore Creek at Akatore Creek Road	30	Kakaho Creek at SH1	56	Ox Burn at Rees Valley Road	82	Thomsons Creek at SH85
4	Arrow at Morven Ferry Road	31	Kakanui at Clifton Falls Bridge	57	Pleasant at Patterson Road Ford	83	Timaru at Peter Muir Bridge
5	Awamoko at SH83	32	Kakanui at McCones	58	Pomahaka at Burkes Ford	84	Tokomairiro at Blackbridge
6	Bannockburn at Lake Dunstan	33	Kauru at Ewings	59	Pomahaka at Glenken	85	Tokomairiro at Lisnatunny
8	Benger burn at SH8	34	Kye Burn at SH85 Bridge	60	Poolburn at Cob Cottage	86	Tokomairiro at West Branch Bridge
9	Blackcleugh Burn at Rongahere Road	35	Leaping Burn at Wanaka Mt Aspiring Road	61	Precipice Creek at Glenorchy Paradise Road	87	Trotters Creek at Mathesons
10	Buckler Burn at Glenorchy Queenstown Road	36	Leith at Dundas Street Bridge	62	Quartz Creek at Maungawera Valley Road	88	Tuapeka River
11	Bullock Creek at Dunmore Street Footbridge	37	Lindis at Ardgour Road	63	Quartz Reef Creek at SH8	89	Turner Creek at Kinloch Road
12	Cardrona at Mt Barker	38	Lindis at Lindis Peak	64	Rees at Glenorchy Paradise Road Bridge	90	Upper Cardrona at Tuohys Gully Road
13	Catlins at Houipapa	39	Lindsays Creek at North Road Bridge	65	Roaring Meg at SH6	91	Upper Pomahaka at Aitchison Runs Road
14	Clutha at Millers Flat	40	Lovells Creek at Station Road	66	Scott Creek at Routeburn Road	92	Upper Shag at SH85 Culvert
15	Contour Channel	41	Luggate Creek at SH6 Bridge	67	Shag at Craig Road	93	Waianakarua at Browns
16	Craig Burn at SH6	42	Maclennan at Kahuiku School Road	68	Shag at Goodwood Pump	94	Waianakarua at South Branch SH1
17	Crookston Burn at Kelso Road	43	Makarora at Makarora	69	Silverstream at Taieri Depot	95	Waiareka Creek at Taipo Road
18	Dart at The Hillocks	44	Manuherikia at Blackstone	70	Silverstream at Three Mile Hill Road	97	Waikouaiti at Confluence
19	Deep Stream at SH87	45	Manuherikia at Galloway	71	Sutton Stream at SH87	98	Waipahi at Cairns Peak
20	Dundas Creek at Mill Flat	46	Manuherikia at Ophir	72	Tahakopa at Tahakopa	99	Waipahi at Waipahi
21	Dunstan Creek at Beattie Road	47	Manuherikia downstream of Fork	73	Taieri at Allanton Bridge	100	Waipori at Waipori Falls Reserve
22	Fraser at Old Man Range	48	Matukituki at West Wanaka	74	Taieri at Linnburn Runs Road	101	Wairuna at Millar Road
23	Greenstone at Greenstone Station Road	49	Meggat Burn at Berwick Road	75	Taieri at Outram	102	Waitahuna at Tweeds Bridge
24	Hawea at Camphill Bridge	50	Mill Creek at Fish Trap	76	Taieri at Stonehenge	103	Waitati at Mt Cargill Road
25	Heriot Burn at Park Hill Road	51	Motatapu at Wanaka Mt Aspiring Road	77	Taieri at Sutton	104	Waiwera at Maws Farm
26	Hills Creek at SH85	52	Nenthorn at Mt Stoker	78	Taieri at Tiroiti	105	Whare Creek at Whare Flat Road
27	Horn Creek at Queenstown Bay	53	Nevis at Wentworth Station	79	Taieri at Waipiata		

13


Otago
Regional
Council
Water Quality - Lakes
14

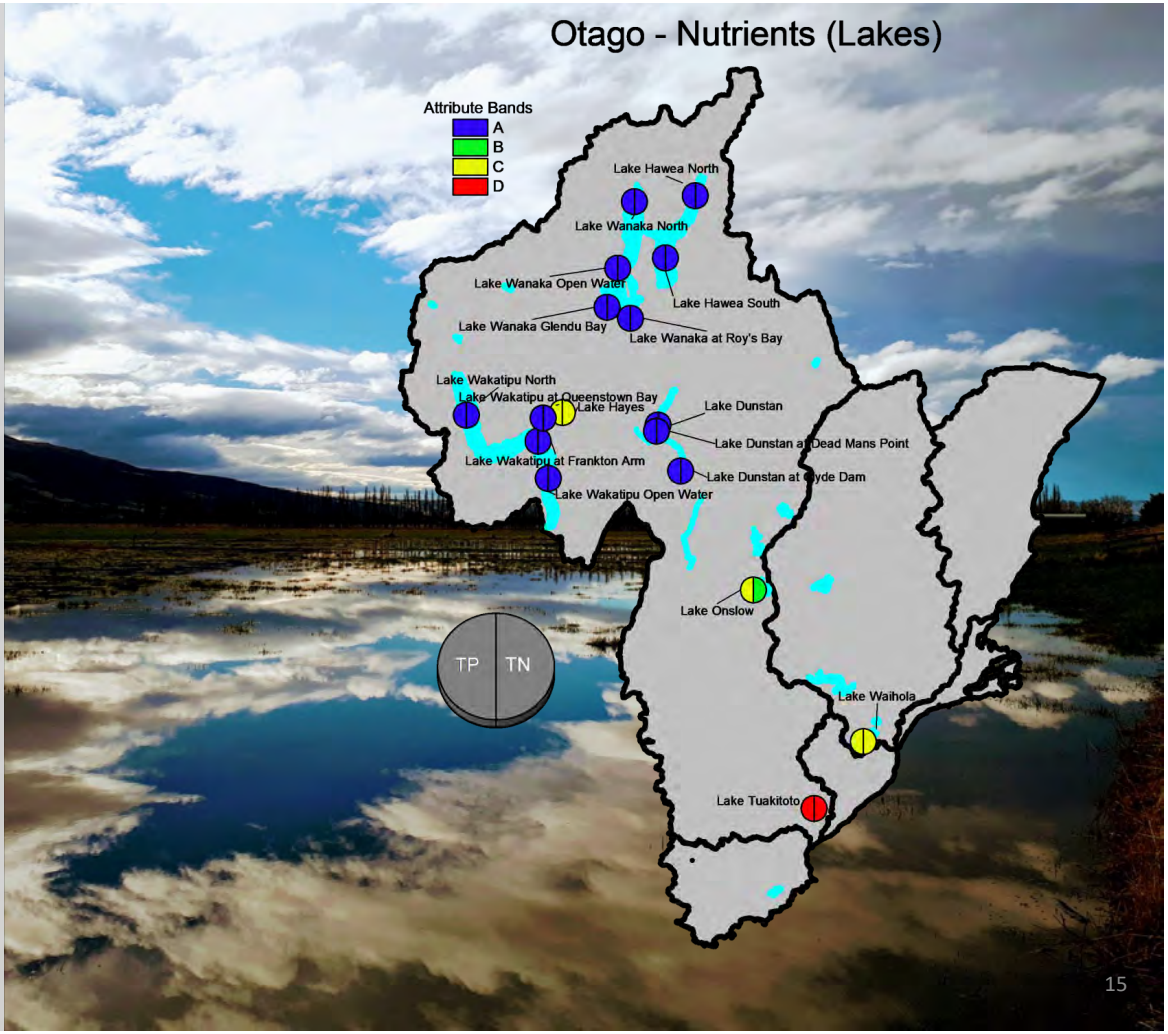
Nutrients - Total Nitrogen & Total Phosphorus (Lakes)

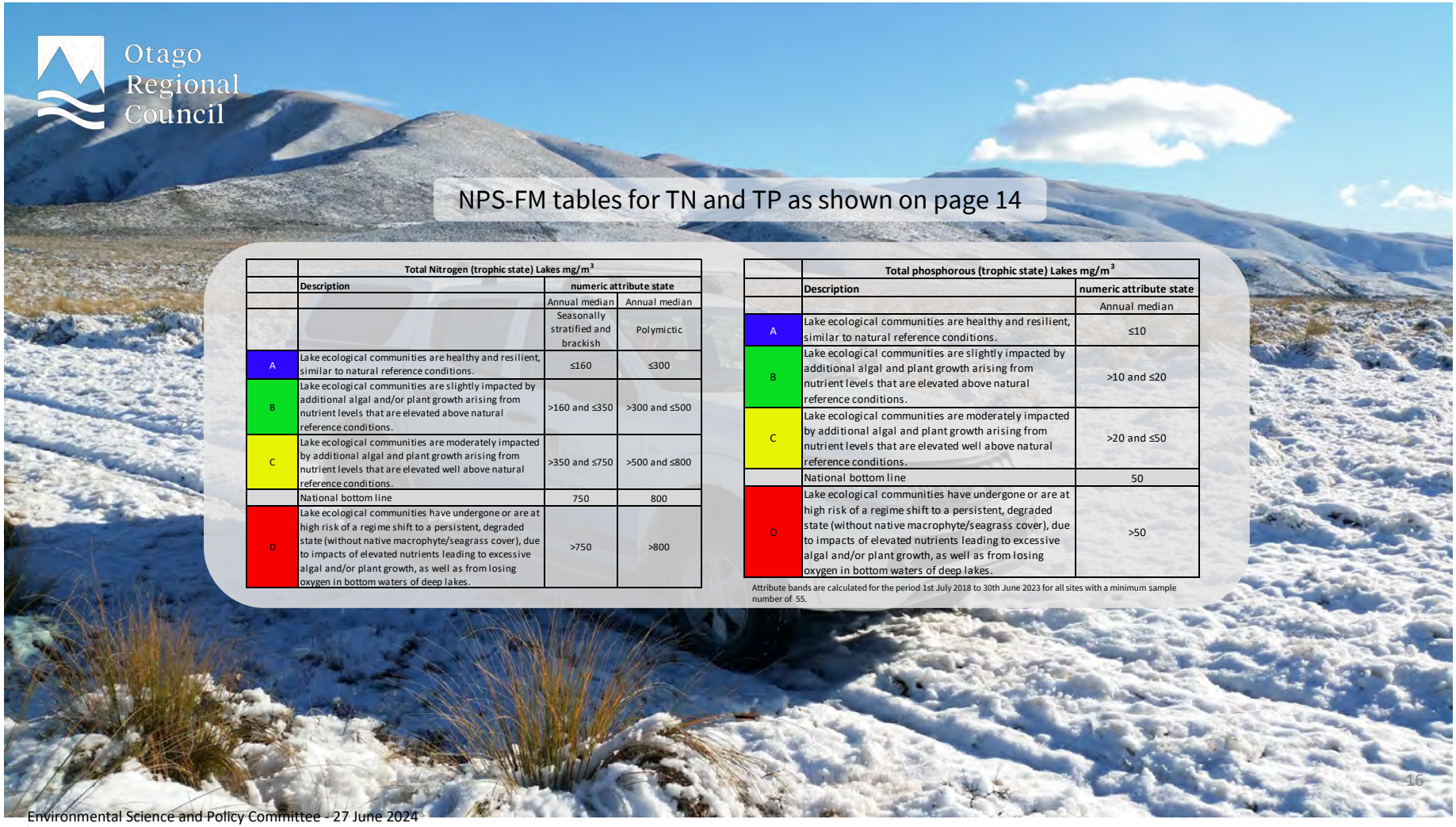
The growth of algae, forming the basis of food-webs in lakes, is controlled by the amount and availability of nutrients. The major nutrients algae need for growth are nitrogen (N) and phosphorous (P). The concentrations of these nutrients in freshwater often give an indication of the possible magnitude of algal growth.

Lakes in the Upper Lakes Rohe (Lake Wakatipu, Lake Wānaka, and Lake Hāwea) and Lake Dunstan (Dunstan Rohe) achieve the A band for TN and TP, however rapid urban development is a threat to lake water quality. Lakes in other parts of Otago show a poorer current state, i.e., Lake Hayes achieves the C band for TN and TP.

Lake Waihola and Lake Tuakitoto are both shallow wetlands with mainly agricultural activity in their catchments. Shallow lakes commonly have high sediment re-suspension due to wind activity which enriches lake nutrient concentrations.

NPSFM tables for TN and TP are given on the next page.

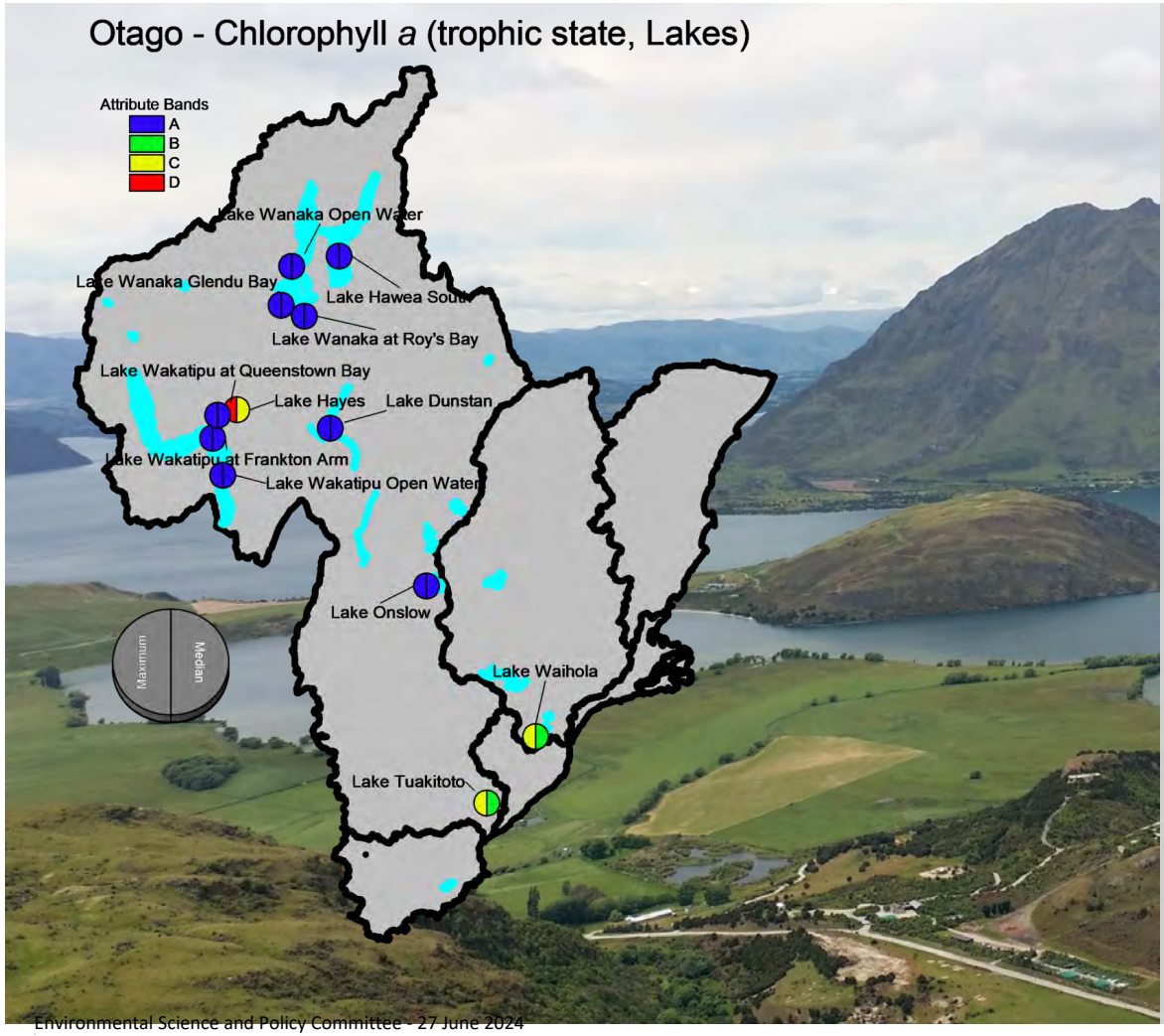




	Total Nitrogen (trophic state) Lakes mg/m^3		
	Description	numeric attribute state	
		Annual median	Annual median
		Seasonally stratified and brackish	Polymictic
A	Lake ecological communities are healthy and resilient, similar to natural reference conditions.	≤160	≤300
B	Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.	>160 and ≤350	>300 and ≤500
C	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions.	>350 and ≤750	>500 and ≤800
	National bottom line	750	800
D	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte/seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.	>750	>800

	Total phosphorous (trophic state) Lakes mg/m^3	
	Description	numeric attribute state
		Annual median
A	Lake ecological communities are healthy and resilient, similar to natural reference conditions.	≤10
B	Lake ecological communities are slightly impacted by additional algal and plant growth arising from nutrient levels that are elevated above natural reference conditions.	>10 and ≤20
C	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions.	>20 and ≤50
	National bottom line	50
D	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte/seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.	>50

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.



Phytoplankton (Lakes)

Phytoplankton or algal growth depends on the availability of nutrients and other physicochemical factors such as temperature, wave action, light intensity, and pH. The best proxy for phytoplankton growth is the measurement of chlorophyll *a* (Chl-*a*), which is indicative of photosynthetically active cells. Therefore, higher Chl-*a* concentrations are equivalent to increased phytoplankton growth. The NPS-FM uses Chl-*a* as an indicator of phytoplankton in lakes.

Most monitored lakes achieve the A band for Chl-*a*. Lake Waihola and Lake Tuakitoto achieve the B band for annual median Chl-a and the C band for annual maximum Chl-*a*. Lake Hayes falls below the national bottom line for annual median Chl-a and shows the C band for annual maximum Chl-a.

	Phytoplankton (trophic state) Lakes		
	Description	**Chlorophyll-*a* mg/m^3**	
		Annual median	Annual maximum
A	Lake ecological communities are healthy and resilient, similar to natural reference conditions.	≤2	≤10
B	Lake ecological communities are slightly impacted by additional algal and/or plant growth arising from nutrient levels that are elevated above natural reference conditions.	>2 and ≤5	>10 and ≤25
C	Lake ecological communities are moderately impacted by additional algal and plant growth arising from nutrient levels that are elevated well above natural reference conditions. Reduced water clarity is likely to affect habitat available for native macrophytes.	>5 and ≤12	>25 and ≤60
	National bottom line	12	60
D	Lake ecological communities have undergone or are at high risk of a regime shift to a persistent, degraded state (without native macrophyte/seagrass cover), due to impacts of elevated nutrients leading to excessive algal and/or plant growth, as well as from losing oxygen in bottom waters of deep lakes.	>12	>60

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.

17

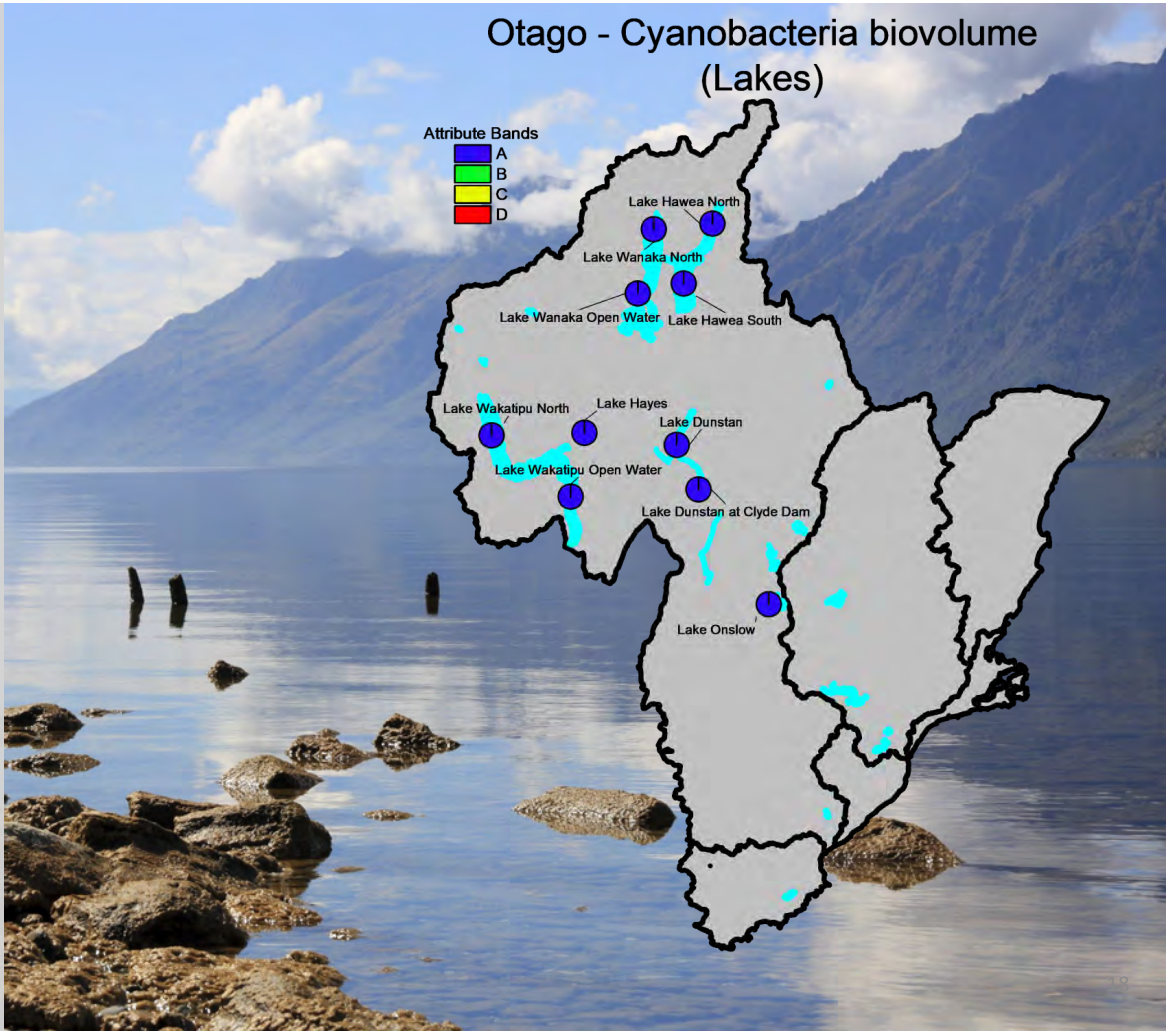
Planktonic Cyanobacteria (Lakes)

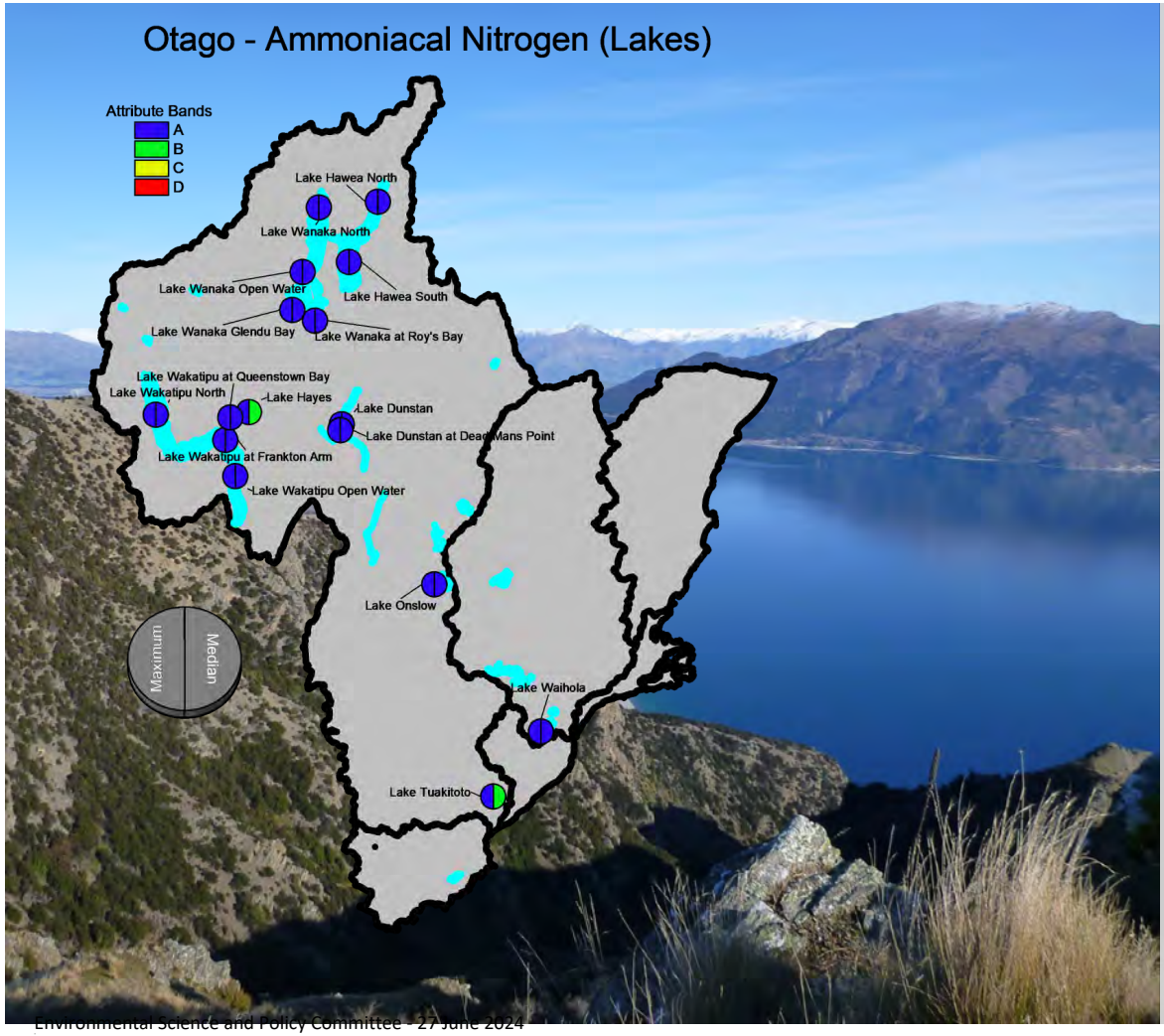
Cyanobacteria are a fast growing, highly competitive group of algae that can harvest energy via photosynthesis and are often able to access nutrient pools that are locked to other algae taxa. In addition, some species can produce toxins that interfere with the growth of other algae species. Due to this combination of traits, and when conditions are right, cyanobacteria can quickly form blooms on the surface of lakes. If these blooms reach a certain size (measured in biovolume) and contain toxin producing species, the toxins they release can be harmful to other aquatic life and terrestrial vertebrates if they use the water for drinking or recreational activities.

The NPS-FM has varying attribute states for the 80th percentile of cyanobacteria biovolume (mm3/L). All monitored lakes that have enough datapoints for band calculation achieve the A band. Lakes Tuakitoto and Waihola are monitored but don't have a data record that is long enough to calculate bands yet.

	Cyanobacteria Lakes mm^3/L	
	Description	numeric attribute state
		80th percentile
A	Risk exposure from cyanobacteria is no different to that in natural conditions (from any contact with freshwater).	≤0.5 mm3/L biovolume equivalent for the combined total of all cyanobacteria
B	Low risk of health effects from exposure to cyanobacteria (from any contact with freshwater).	>0.5 and ≤1.0 mm3/L biovolume equivalent for the combined total of all cyanobacteria
C	Moderate risk of health effects from exposure to cyanobacteria (from any contact with freshwater).	>1.0 and ≤1.8 mm3/L biovolume equivalent of potentially toxic cyanobacteria OR >1.0 and ≤10 mm3/L total biovolume of all cyanobacteria
	National bottom line	1.8 mm3/L biovolume equivalent of potentially toxic cyanobacteria OR 10 mm3/L total biovolume of all cyanobacteria
D	High health risks (for example, respiratory, irritation and allergy symptoms) exist from exposure to cyanobacteria (from any contact with freshwater).	>1.8 mm3/L biovolume equivalent of potentially toxic cyanobacteria OR >10 mm3/L total biovolume of all cyanobacteria

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.





Nitrate toxicity - Ammonia (Lakes)

High levels of ammoniacal nitrogen (NH4-N) in water can create conditions that make it difficult for aquatic insects or fish to survive. The main sources of NNN and NH_4-N are fertilizers, wastewater, and animal waste. NNN and NH_4-N can come from diffuse sources, such as land runoff or point sources, for example, wastewater pipes.

All monitored lakes achieve the A or B band for ammonia.

	Ammonia (toxicity) mg/l		
	Description	numeric attribute state	
		Annual median	Annual maximum
A	99% species protection level: No observed effect on any species tested.	≤0.03	≤0.05
B	95% species protection level: Starts impacting occasionally on the 5% most sensitive species.	>0.03 and ≤0.24	>0.05 and ≤0.40
	National bottom line	0.24	0.4
C	80% species protection level: Starts impacting regularly on the 20% most sensitive species (reduced survival of most sensitive species).	>0.24 and ≤1.3	>0.4 and ≤2.2
D	Starts approaching acute impact level (that is, risk of death) for sensitive species.	>1.3	>2.2

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.

19

E. coli (Lakes)

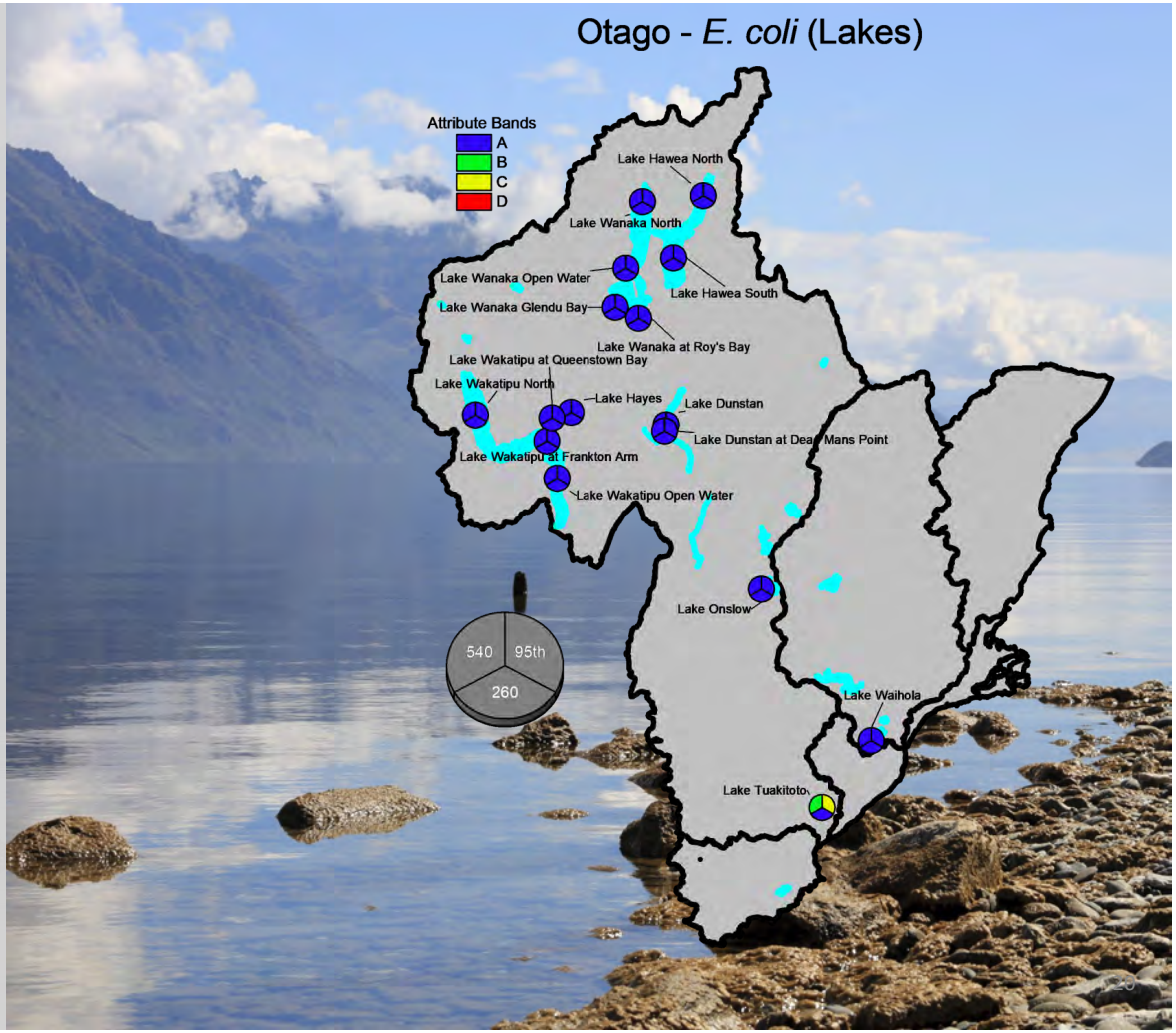
The bacterium *Escherichia coli* (*E. coli*) is naturally present in animal faeces and freshwater and can reach high concentrations due to wastewater or runoff from agricultural pastures to streams. High densities of *E. coli* indicate the presence of other bacteria and the risk of infection with several diseases, such as gastroenteritis, if the waterbody is used for recreational activities.

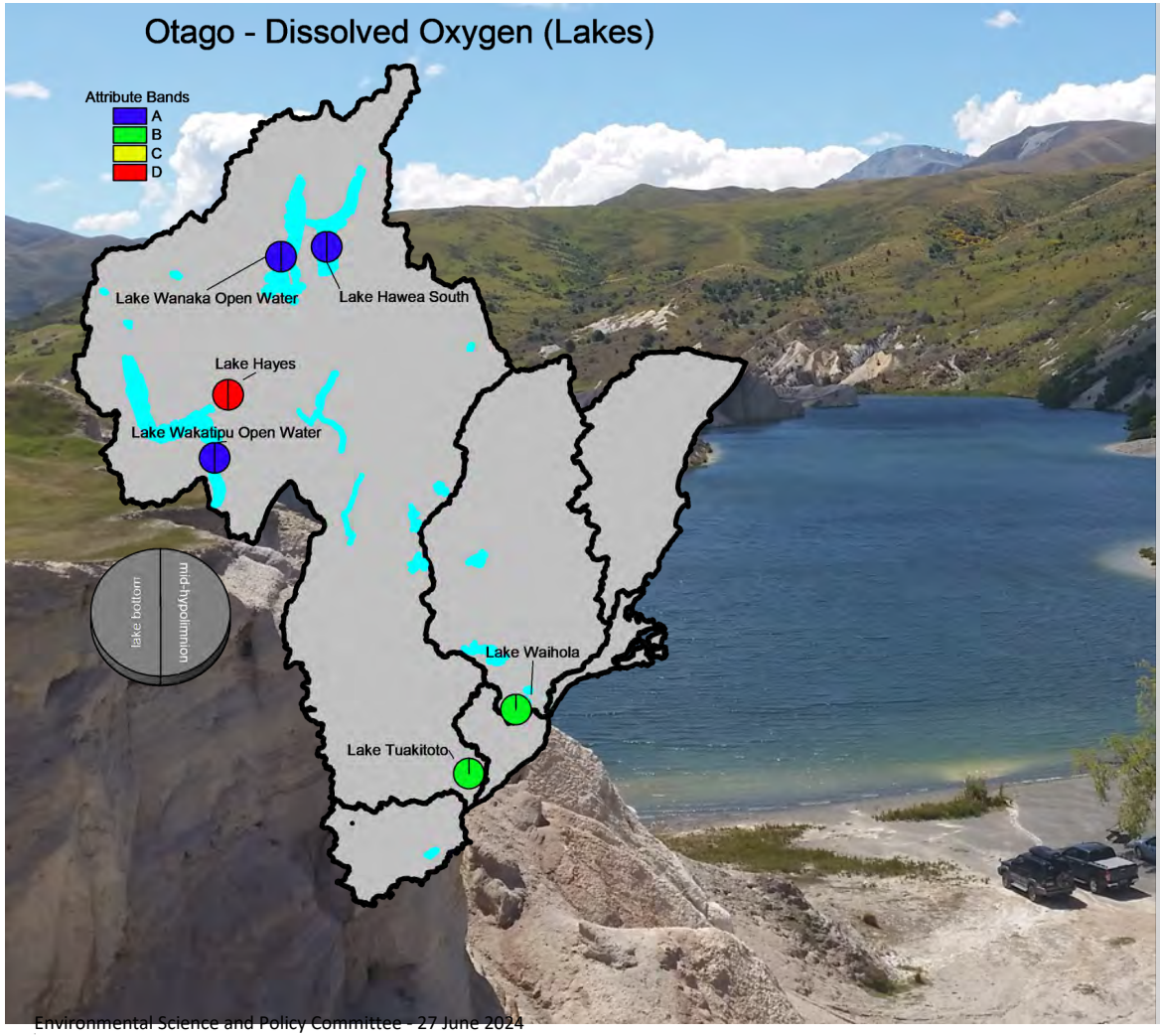
The NPS-FM uses four different metrics to determine the current state of *E. coli* in rivers and lakes: median, 95th percentile, 260 MPN (Most Probable Number)/100mL exceedance, and 540 MPN/100mL exceedance.

All sites achieve median concentrations <130cfu/100ml.

	Escherichia Coli	E.Coli/100ml			
	Description	Numeric attribute state			
	Description of risk of Campylobacter infection (based on E. coli indicator)	% exceedances over 540/100 mL	% exceedances over 260/100 mL	Median concentration /100 mL	95th percentile of E. coli/100 mL
A	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 1%.	<5%	<20%	≤130	≤540
B	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is 2%.	5-10%	20-30%	≤130	≤1000
C	For at least half the time, the estimated risk is <1 in 1,000 (0.1% risk). The predicted average infection risk is >3%.	10-20%	20-34%	≤130	≤1200
D	20-30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >3%.	20-30%	>34%	≤130	>1200
E	For more than 30% of the time the estimated risk is ≥50 in 1,000 (>5% risk). The predicted average infection risk is >7%.	>30%	>50%	>260	>1200

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.





Dissolved Oxygen (DO) (Lakes)

The concentration of dissolved oxygen in water provides information about the oxygen content dissolved in water. While the water molecule consist of 2 hydrogen and one oxygen atom (some cool facts about H_2O here), this oxygen can't be used by aquatic life. Atmospheric oxygen mixed into the water column is what aquatic organisms need to breathe. Therefore, when less mixing occurs (for example in summer when lakes thermally stratify) oxygen becomes consumed in a lake and the concentration of DO drops. If the concentration falls below a certain threshold, species that need oxygen to live (such as fish) won't survive. For most species, this threshold is around 4 to 5 mg/L which is reflected in the NPS-FM bottom line of 4 mg/L for mid-hypolimnetic DO.

	Lake-bottom dissolved oxygen (mg/L)	
	Description	
		Annual minimum
A	No risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments.	≥7.5
B	Minimal risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments.	≥2.0 and < 7.5
C	Risk from lake-bottom dissolved oxygen of biogeochemical conditions causing nutrient release from sediments.	≥0.5 and < 2.0
	Natonal Bottomline	0.5
D	Likelihood from lake-bottom dissolved oxygen of biogeochemical conditions resulting in nutrient release from sediments.	<0.5

	Mid-hypolimnetic dissolved oxygen (mg/L)	
	Description	
		Annual minimum
A	No stress caused to any fish species by low dissolved oxygen.	≥7.5
B	Minor stress on sensitive fish seeking thermal refuge in the hypolimnion. Minor risk of reduced abundance of sensitive fish and macro-invertebrate species.	≥5.0 and < 7.5
C	Moderate stress on sensitive fish seeking thermal refuge in the hypolimnion. Risk of sensitive fish species being lost.	≥4 and < 5
	Natonal Bottomline	4
D	Significant stress on a range of fish species seeking thermal refuge in the hypolimnion. Likelihood of local extinctions of fish species and loss of ecological integrity.	<4.0

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 55.

21

Submerged plants (Lakes)

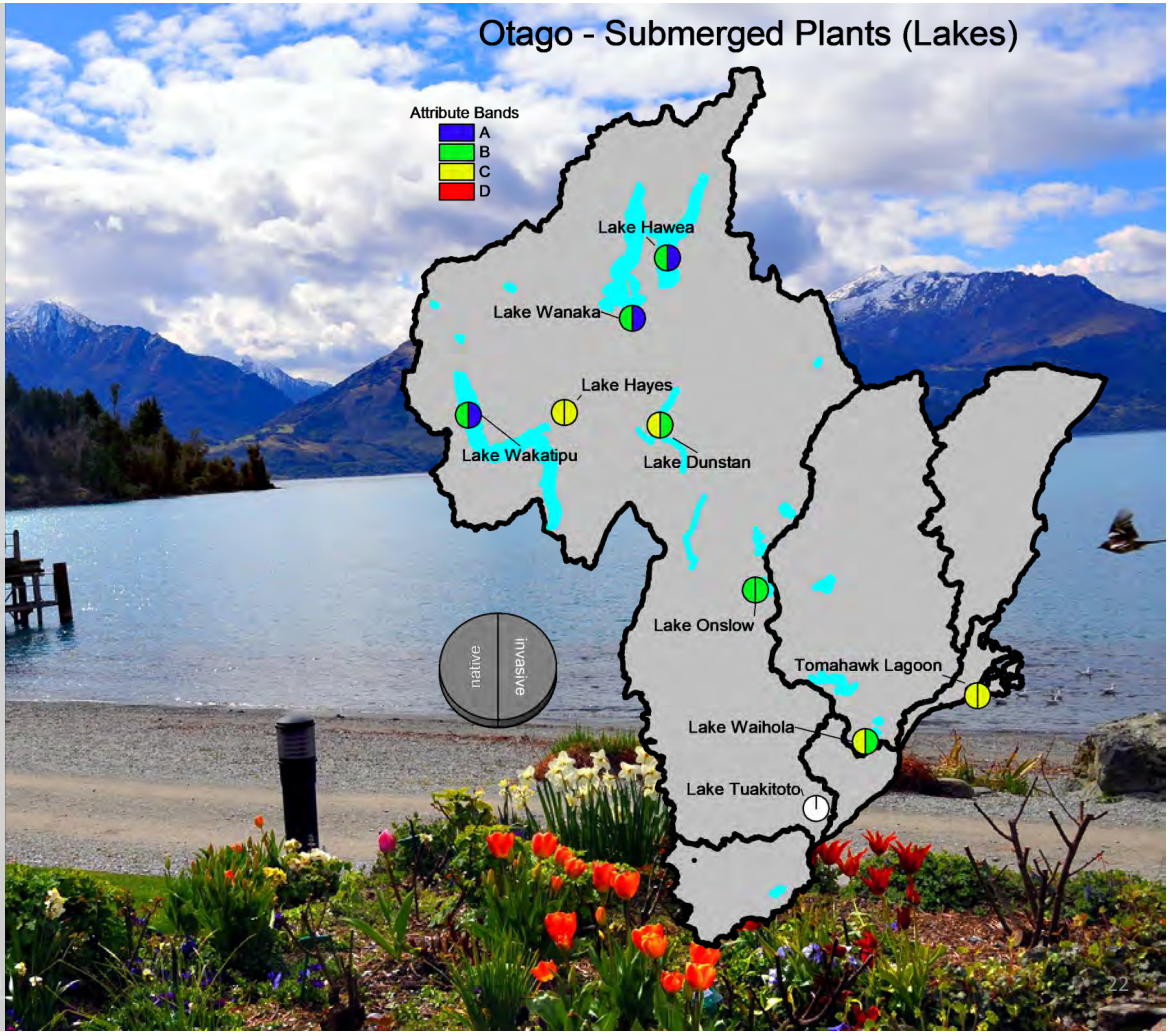
Submerged plants (macrophytes) are plant species that grow naturally in lakes. Their growth depends on the availability of light and nutrients. Therefore, if a lake become more eutrophic, macrophyte growth might increase and diminish habitat variability. In addition, invasive macrophytes can outcompete native species under certain conditions and can therefore become abundant. This has potentially negative effects on habitat variability and the aquatic food chain. Of the lakes assessed for submerged plants, Lake Tuakitoto was found unvegetated and is therefore displayed in white.

The NPS-FM gives independent attribute bands for invasive and native submerged plants.

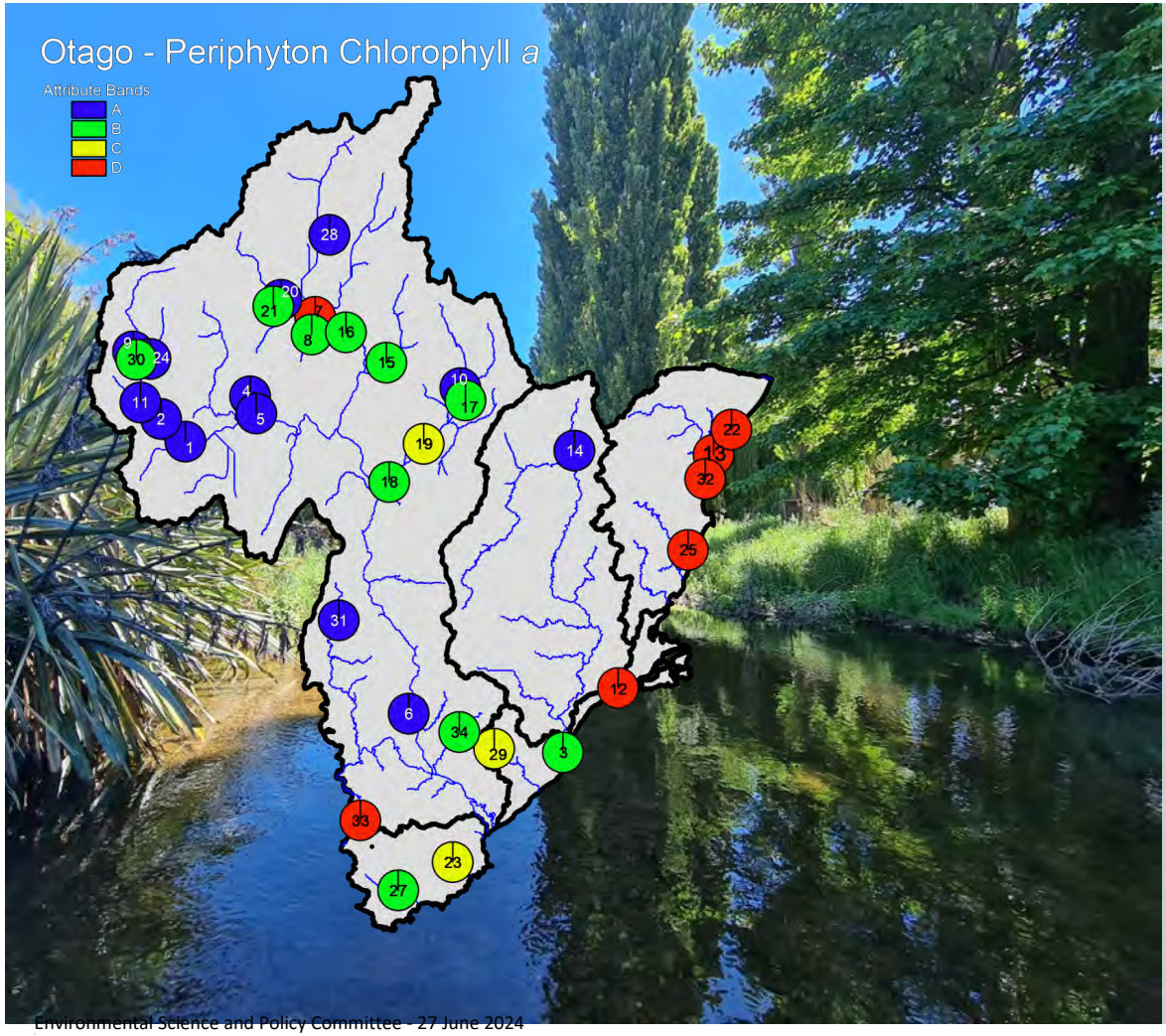
	Submerged Plants (native) Aquatic health	
	Description	numeric attribute state
		% of maximum potential score
A	No invasive plants present in the lake. Native plant communities remain intact.	0%
B	Invasive plants having only a minor impact on native vegetation. Invasive plants will be patchy in nature co-existing with native vegetation. Often major weed species not present or in early stages of invasion.	>1 and ≤25%
C	Invasive plants having a moderate to high impact on native vegetation. Native plant communities likely displaced by invasive weed beds particularly in the 2 – 8 m depth range.	>25 and ≤90%
	National bottom line	90%
D	Tall dense weed beds exclude native vegetation and dominate entire depth range of plant growth. The species concerned are likely hornwort and Egeria.	>90%

	Submerged Plants (native) Aquatic health	
	Description	numeric attribute state
		% of maximum potential score
A	Excellent ecological condition. Native submerged plant communities are almost completely intact.	>75%
B	High ecological condition. Native submerged plant communities are largely intact.	>50 and ≤75%
C	Moderate ecological condition. Native submerged plant communities are moderately impacted.	≥20 and ≤50%
	National bottom line	20%
D	Poor ecological condition. Native submerged plant communities are largely degraded or absent.	<20%

Attribute bands calculated following LakeSPI investigation in March 2020. Lake SPI is assessed every 3 years with the next one done in March 2024.




Otago
Regional
Council
Ecosystem Health
Torrentfish (*Cheimarrichthys fosteri)*
23
Environmental Science and Policy Committee - 27 June 2024



Periphyton (Rivers)

Instream algal growth is commonly assessed via measurements of chlorophyll-*a* (Chl-*a*) as all types of algae contain Chl-*a* and this metric therefore reflects the total amount of live algae biomass in a sample. The NPS-FM 2020 specifies attributes for trophic state based on periphyton (algae) biomass in rivers.

Periphyton sampling was undertaken with one composite sample collected from each site. Samples were collected using the method described by the Ministry for the Environment. The total Chl-*a* was calculated using a standard formula and scaled to the number of milligrams of Chl-*a* per m^2 of the stream bed.

A total of seven sites fail the national bottom line for periphyton Chl-*a*. Of these sites, four are located in the North Otago FMU, one in the Lower Clutha Rohe, one in the Dunstan Rohe and one in the Dunedin & Coast FMU. References to site numbers given on page 23.

	Periphyton (trophic state) Rivers		
	Description	Chlorophyll-*a* mg/m^3	
		numeric attribute state	
		default class	productive class
A	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.	≤50	≤50
B	Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat.	>50 and ≤120	>50 and ≤120
C	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat.	>120 and ≤200	>120 and ≤200
	National bottom line	200	200
D	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat.	>200	>200

Attribute bands are calculated for the period 1st July 2020 to 30th June 2023 for all sites with a minimum sample number of 32.

24

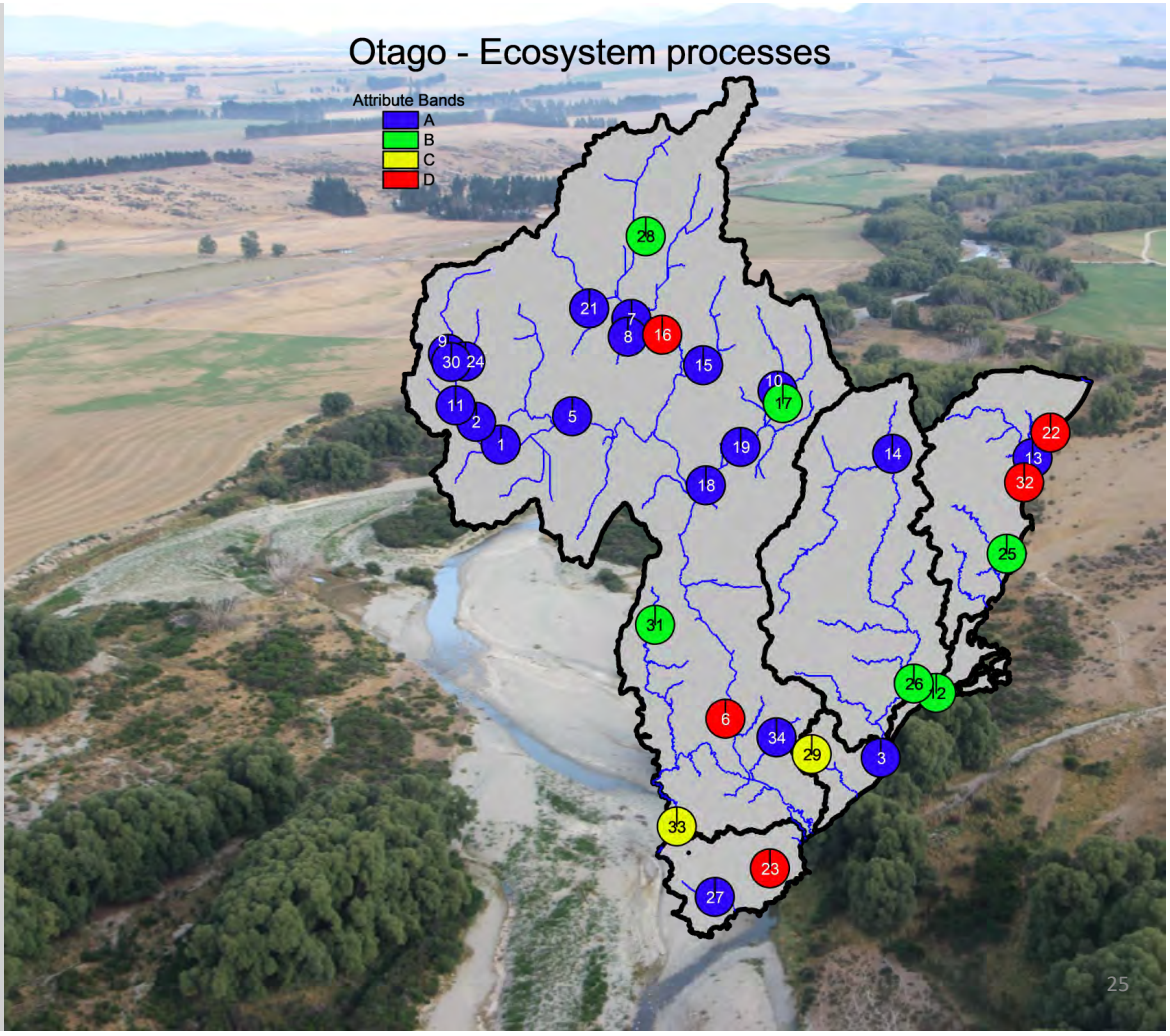
Ecosystem Processes (Rivers)

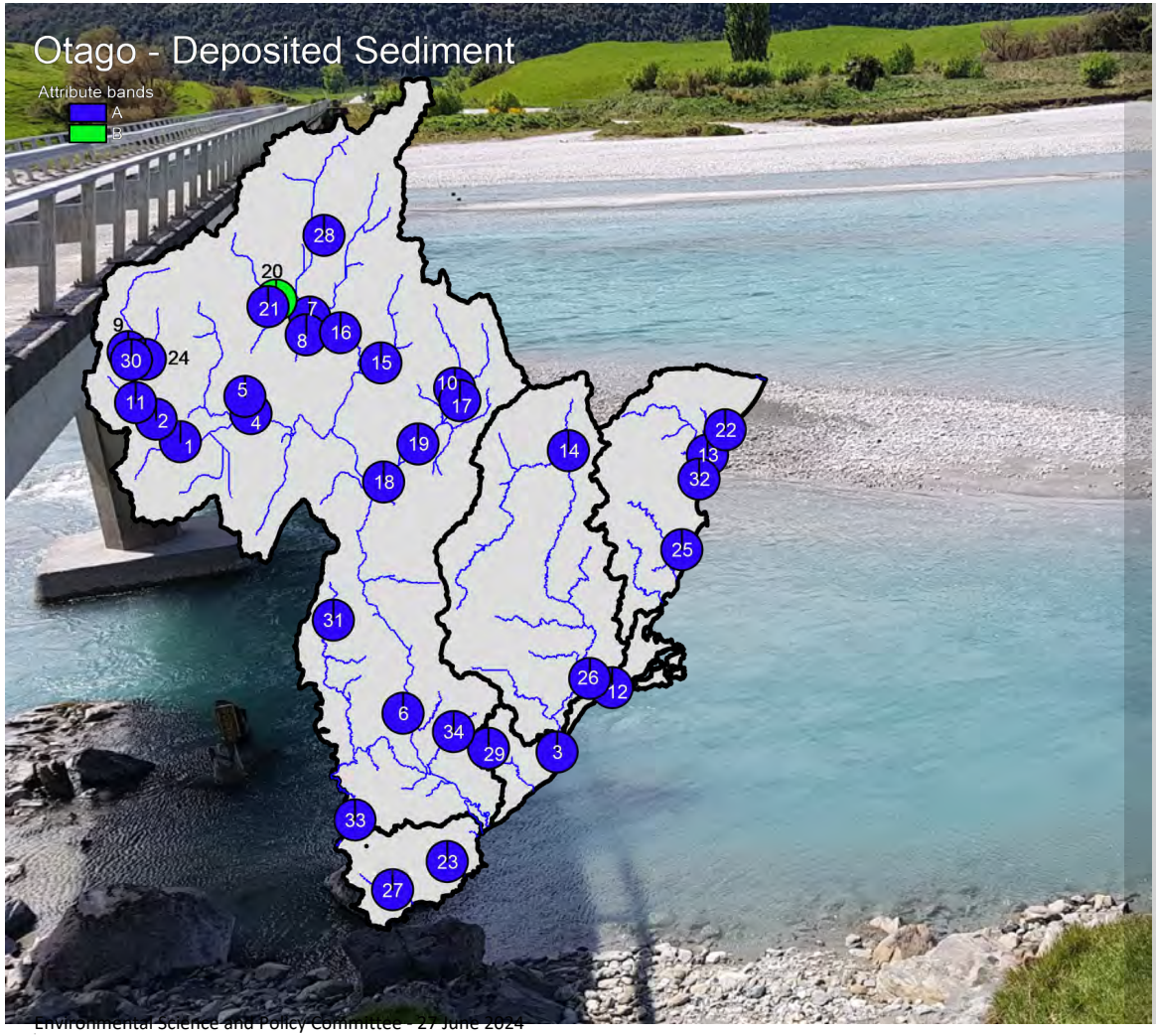
The NPS-FM shows ecosystem metabolism as measured by continuous dissolved oxygen. While the metabolism programme is being implemented in Otago, ecosystem processes are also being assessed via cotton strip asseys (CSA), which provide an estimate of organic matter processing. Cawthron developed interim attribute bands for ORC to use with CSA, these attribute bands are used here and given in the table below. Reference sites (i.e., near pristine sites) are used to validate CSA results and attribute states are assigned on the difference to natural conditions. References to site numbers given on page 23.

Of the sites monitored, the Blackcleugh Burn fails to comply with the C band showing river ecological processes that are unhealthy and significantly impacted by nutrient levels above natural reference conditions.

	Percent cotton tensile strength loss per degree day (%CTSL dd-1)	
	Description	Numeric attribute state
A	River ecological processes are healthy and resilient, like natural reference conditions.	≤0.12
B	River ecological processes are slightly impacted by nutrient levels that are elevated above natural reference conditions and/or by altered flows/habitat due to land use impacts	>0.12 and ≤0.24
C	River ecological processes are moderately impacted by nutrient levels that are elevated above natural reference conditions and/or by altered flows/habitat due to land use impacts.	>0.24 and ≤0.37
D	River ecological processes are unhealthy and significantly impacted by nutrient levels that are elevated above natural reference conditions and/or by altered flows/habitat due to land use impacts.	>0.37

Attribute bands are calculated for the period 1st July 2022 to 30th June 2023 with cotton strips deployed for a minimum 14 days at each site.





Deposited sediment (Rivers)

Excess sediment directly affects the health of a waterway, decreasing its mauri or life-supporting capacity. Deposited fine sediment occurs naturally in the beds of rivers and streams. It usually enters a stream because of terrestrial weathering processes or bank erosion and in-stream fluvial processes. Because sediment is naturally transported longitudinally through a river network, its state at any given point will be influenced by climate, geology, topography, and current velocity. Human activities can affect this natural sediment cycle by accelerating sediment delivery to streams and increasing the quantity of smaller particle sizes. The effect of excess in-stream sedimentation is recognised as a major impact of changing land use on river health. References to site numbers given on page 23.

All monitoring sites achieve the A or B band for deposited sediments. The B band shown for the Matukituki is likely due to glacial flour being deposited.

		% fine sediment cover			
	Description	Numeric attribute state by deposited sediment class			
		1	2	3	4
A	Minimal impact of deposited fine sediment on instream biota. Ecological communities are similar to those observed in natural reference conditions.	≤7	≤10	≤9	≤13
B	Low to moderate impact of deposited fine sediment on instream biota. Abundance of sensitive macroinvertebrate species may be reduced	>7 and ≤14	>10 and ≤19	>9 and ≤18	>13 and ≤19
C	Moderate to high impact of deposited fine sediment on instream biota. Sensitive macroinvertebrate species may be lost.	>14 and ≤21	>19 and ≤29	>18 and ≤27	>19 and ≤27
	National bottom line	21	29	27	27
D	High impact of deposited fine sediment on instream biota. Ecological communities are significantly altered and sensitive fish and macroinvertebrate species are lost or at high risk of being lost.	>21	>29	>27	>27

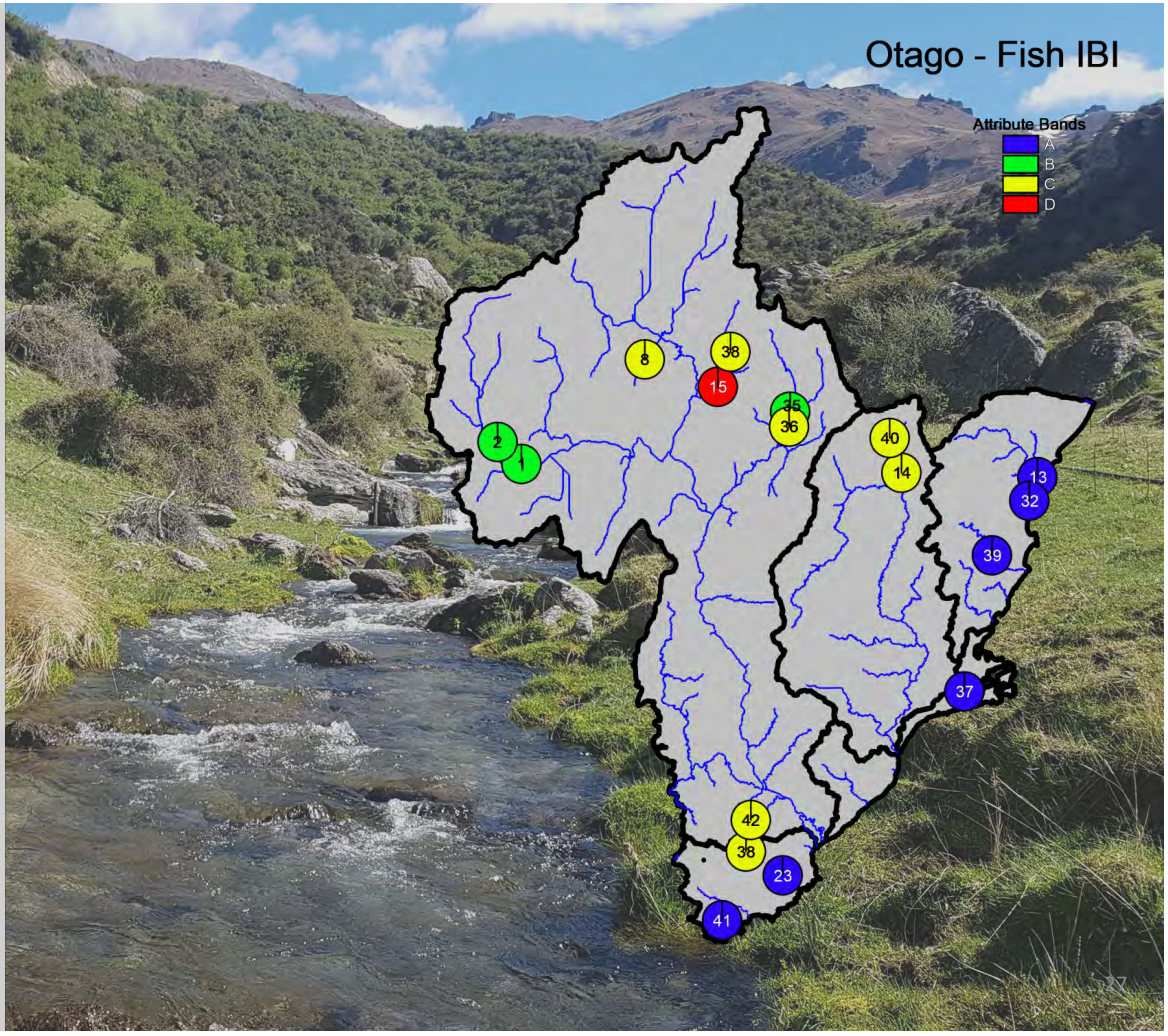
26

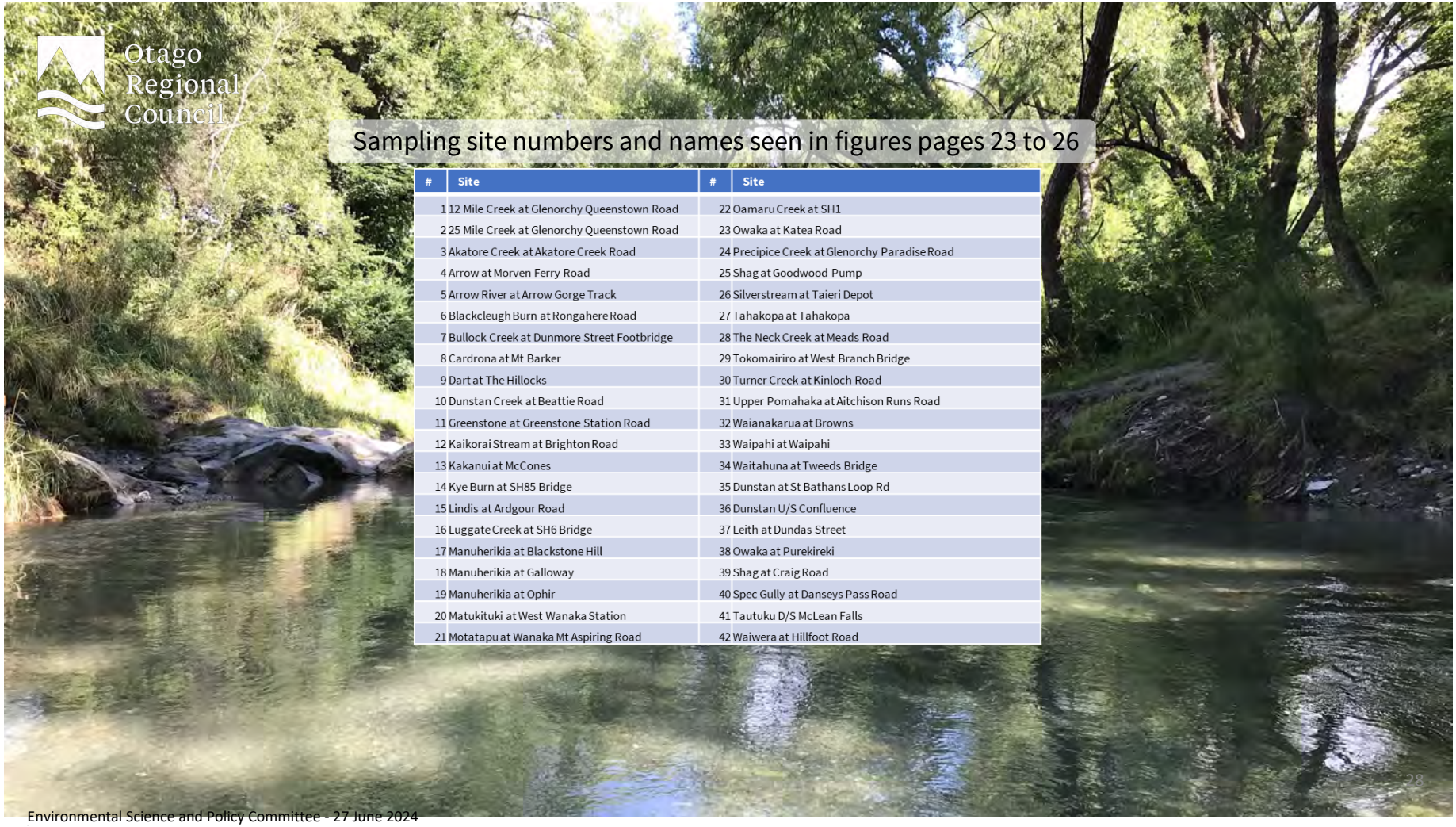
Fish IBI(Rivers)

New Zealand's freshwater environments support more than 50 known native fish species. There is a high degree of endemism, with 92 per cent of New Zealand's named native fish species found nowhere else in the world. New Zealand's native freshwater fish species have several unusual characteristics: most are small, benthic, largely nocturnal, and more than half are diadromous (saline tolerant), moving between the sea and freshwater habitats during their lifecycle. Freshwater fish are an important component of freshwater ecosystems and a valued resource for Māori and recreational fishers. References to site numbers given on page 23.

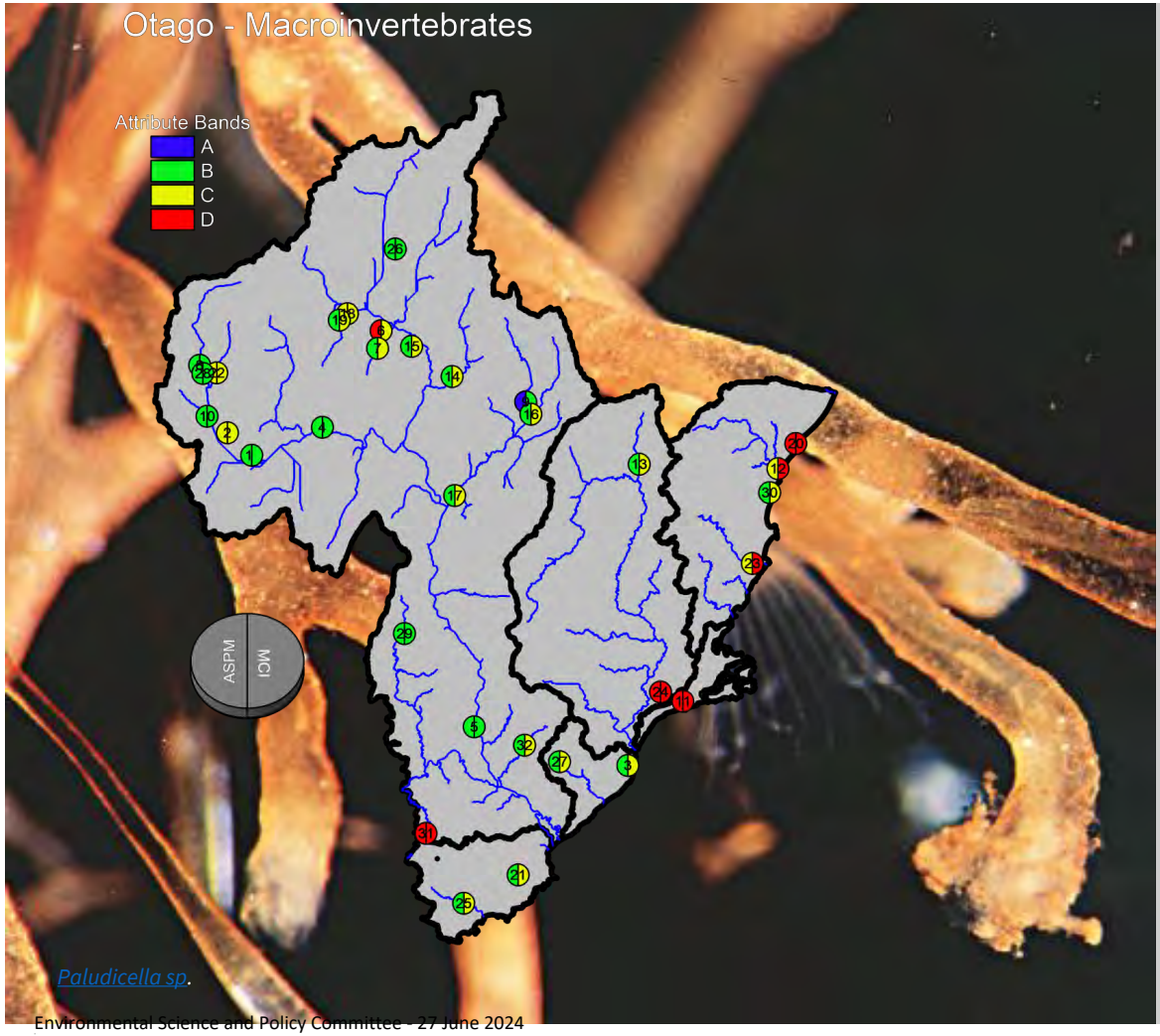
The fish index of biotic integrity (IBI) measures the condition of fish communities at a particular site. Healthy ecosystems depend on and are characterized by a healthy and diverse fish population. Streams further from the coast show lower bands for Fish IBI than compared to streams closer to the coast. This is due to diadromous fish migrating between freshwater and the ocean, but also because human activities, such as stream bed alterations, can prevent the upstream migration of fish, lowering species diversity with distance from the coast.

	Fish Index of Biotic Integrity (F-IBI)	
	Description	
A	High integrity of fish community. Habitat and migratory access have minimal degradation	≥34
B	Moderate integrity of fish community. Habitat and/or migratory access are reduced and show some signs of stress.	<34 and ≥28
C	Low integrity of fish community. Habitat and/or migratory access is considerably impairing and stressing the community	<28 and ≥18
D	Severe loss of fish community integrity. There is substantial loss of habitat and/or migratory access, causing a high level of stress on the community.	<18





#	Site	#	Site
1	12 Mile Creek at Glenorchy Queenstown Road	22	Oamaru Creek at SH1
2	25 Mile Creek at Glenorchy Queenstown Road	23	Owaka at Katea Road
3	Akatore Creek at Akatore Creek Road	24	Precipice Creek at Glenorchy Paradise Road
4	Arrow at Morven Ferry Road	25	Shag at Goodwood Pump
5	Arrow River at Arrow Gorge Track	26	Silverstream at Taieri Depot
6	Blackcleugh Burn at Rongahere Road	27	Tahakopa at Tahakopa
7	Bullock Creek at Dunmore Street Footbridge	28	The Neck Creek at Meads Road
8	Cardrona at Mt Barker	29	Tokomairiro at West Branch Bridge
9	Dart at The Hillocks	30	Turner Creek at Kinloch Road
10	Dunstan Creek at Beattie Road	31	Upper Pomahaka at Aitchison Runs Road
11	Greenstone at Greenstone Station Road	32	Waianakarua at Browns
12	Kaikorai Stream at Brighton Road	33	Waipahi at Waipahi
13	Kakanui at McCones	34	Waitahuna at Tweeds Bridge
14	Kye Burn at SH85 Bridge	35	Dunstan at St Bathans Loop Rd
15	Lindis at Ardgour Road	36	Dunstan U/S Confluence
16	Luggate Creek at SH6 Bridge	37	Leith at Dundas Street
17	Manuherikia at Blackstone Hill	38	Owaka at Purekireki
18	Manuherikia at Galloway	39	Shag at Craig Road
19	Manuherikia at Ophir	40	Spec Gully at Danseys Pass Road
20	Matukituki at West Wanaka Station	41	Tautuku D/S McLean Falls
21	Motatapu at Wanaka Mt Aspiring Road	42	Waiwera at Hillfoot Road



Paludicella sp.

Macroinvertebrates (Rivers)

Macroinvertebrates are animals that lack a backbone and are large enough to see with the naked eye. Examples of macroinvertebrate species in Otago include freshwater crayfish (Kōura) and mayfly larvae. Macroinvertebrates can be used as water quality indicators because different species have different pollution and nutrient tolerances. References to site numbers given on next page.

The Macroinvertebrate Community Index (MCI) is based on the tolerance or sensitivity of species to organic pollution and nutrient enrichment. Higher MCI scores indicate better stream conditions. Average Score Per Metric (ASPM): The ASPM index aggregates three other metrics that are averaged to indicate stream health. The component metrics are the MCI, the richness of Ephemeroptera, Plecoptera and Trichoptera (EPT taxa) and %EPT abundance.

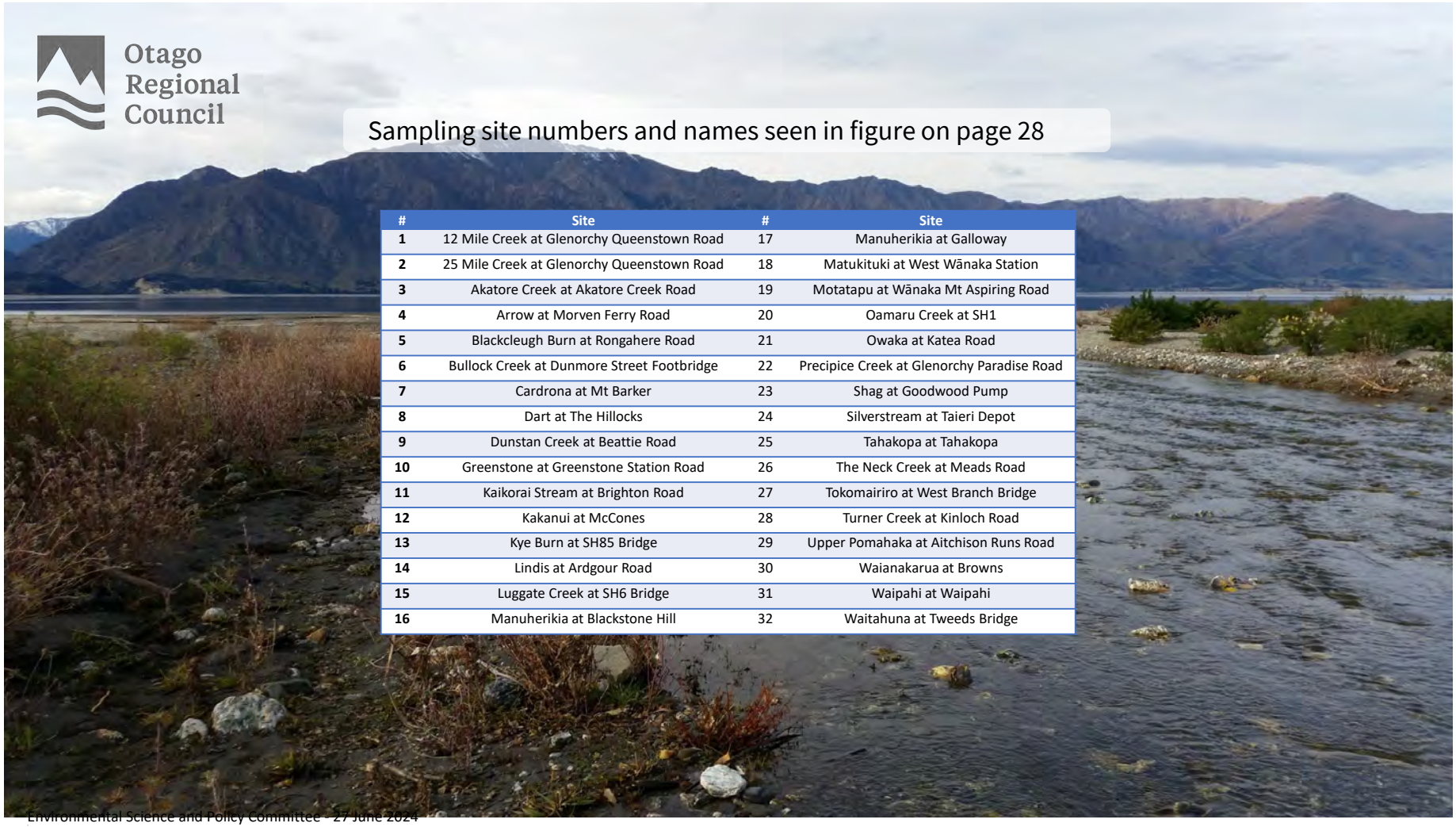
NPS-FM numeric attribute states are applied here. ORC has undertaken work determining interim Otago specific attribute states for MCI in the Otago Region. Although the bottom line remains at 90MCI, it appears the A/B/C bands are naturally lower in Otago than the NPS-FM describes. Further sampling has been undertaken at 'reference' sites to validate model predictions.

	Macroinvertebrate Average Score Per Metric (ASPM)	
	Description	ASPM
A	Macroinvertebrate communities have high ecological integrity, similar to that expected in reference conditions.	>0.6
B	Macroinvertebrate communities have mild-to-moderate loss of ecological integrity.	>0.6 and <0.4
C	Macroinvertebrate communities have moderate-to severe loss of ecological integrity.	>0.4 and <0.3
	National bottom line	**0.3**
D	Macroinvertebrate communities have severe loss of ecological integrity.	<0.3

	Macroinvertebrate Community Index (MCI) score	
	Description	MCI
A	Rare blooms reflecting negligible nutrient enrichment and/or alteration of the natural flow regime or habitat.	≥130
B	Occasional blooms reflecting low nutrient enrichment and/or alteration of the natural flow regime or habitat	≥110 and <130
C	Periodic short-duration nuisance blooms reflecting moderate nutrient enrichment and/or moderate alteration of the natural flow regime or habitat.	≥90 and <110
	National bottom line	**90**
D	Regular and/or extended-duration nuisance blooms reflecting high nutrient enrichment and/or significant alteration of the natural flow regime or habitat	<90

Attribute bands are calculated for the period 1st July 2018 to 30th June 2023 for all sites with a minimum sample number of 5.

29



Sampling site numbers and names seen in figure on page 28

#	Site	#	Site
1	12 Mile Creek at Glenorchy Queenstown Road	17	Manuherikia at Galloway
2	25 Mile Creek at Glenorchy Queenstown Road	18	Matukituki at West Wānaka Station
3	Akatore Creek at Akatore Creek Road	19	Motatapu at Wānaka Mt Aspiring Road
4	Arrow at Morven Ferry Road	20	Oamaru Creek at SH1
5	Blackcleugh Burn at Rongahere Road	21	Owaka at Katea Road
6	Bullock Creek at Dunmore Street Footbridge	22	Precipice Creek at Glenorchy Paradise Road
7	Cardrona at Mt Barker	23	Shag at Goodwood Pump
8	Dart at The Hillocks	24	Silverstream at Taieri Depot
9	Dunstan Creek at Beattie Road	25	Tahakopa at Tahakopa
10	Greenstone at Greenstone Station Road	26	The Neck Creek at Meads Road
11	Kaikorai Stream at Brighton Road	27	Tokomairiro at West Branch Bridge
12	Kakanui at McCones	28	Turner Creek at Kinloch Road
13	Kye Burn at SH85 Bridge	29	Upper Pomahaka at Aitchison Runs Road
14	Lindis at Ardgour Road	30	Waianakarua at Browns
15	Luggate Creek at SH6 Bridge	31	Waipahi at Waipahi
16	Manuherikia at Blackstone Hill	32	Waitahuna at Tweeds Bridge


Otago Regional Council
All technical information, including band calculation, sample statistics and discussion of data, can be found here: orc-river-lake-groundwater-state-and-trends-2017-2022.pdf
Markus Dengg | Author | 08/04/2024
Rachel Ozanne | Reviewer 1 | 12/04/2024
Hugo Borges | Reviewer 2 | 10/04/2024
Jason Augspurger | Reviewer 3 | 12/04/2024
All photos used in this report were sourced from the ORC Daminion library.

Attachment 2: **Details of Attributes in Appendix 2A and 2B of the NPS-FM 2020**

Table 1 Details of the NPS-FM attributes In Appendix 2A

NPS-FM Reference - Appendix 2A	Water body type	Calculation Guidance	Numeric attribute state description	Units
A2A; Table 1 - Phytoplankton	Lakes		Median of phytoplankton chlorophyll-*a*	mg chl-*a* m^{-3}
			Annual maximum of phytoplankton chlorophyll-*a*	mg chl-*a* m^{-3}
A2A; Table 2 - Periphyton	Rivers	Minimum of 3 years of data	92nd percentile of periphyton chlorophyll-a for default river class	mg chl-*a* m^{-3}
			83rd percentile of periphyton chlorophyll-a for productive river class	mg chl-*a* m^{-3}
A2A; Table 3 - Total Nitrogen	Lakes		Median concentration of total nitrogen	mg m^{-3}
A2A; Table 4 - Total Phosphorus	Lakes		Median concentration of total phosphorus	mg m^{-3}
A2A; Table 5 - Ammonia	Lakes and Rivers		Median concentration of Ammoniacal-N	mg l^{-1}
			Maximum concentration of Ammoniacal-N	mg l^{-1}
A2A; Table 6 - Nitrate	Rivers		Median concentration of Nitrate	mg l^{-1}
			95th percentile concentration of Nitrate	mg l^{-1}
A2A; Table 7 - Dissolved Oxygen (below point source)	Rivers		7-day mean minimum	mg l^{-1}
		1 November to 30 April	1-day minimum	mg l^{-1}
A2A; Tabe 8 - Suspended fine sediment	Rivers	Median of 5 years of at least monthly samples (at least 60 samples)	Median	m
A2A; Table 9 - *Escherichia coli*	Lakes and Rivers	Minimum of 5 years of at least monthly samples (at least 60 samples)	% exceedances over 540/100 mL	E. coli/100 mL
			% exceedances over 260/100 mL	E. coli/100 mL
			Median concentration	E. coli/100 mL
			95th percentile of E.coli/100 mL	E. coli/100 mL
A2A; Table 10 - Cyanobacteria (lakes)	Rivers	At least 12 samples collected over 3 years	80th percentile	Biovolume mm^3/L

Table 2 Details of the NPS-FM attributes In Appendix 2B

NPS-FM Reference - Appendix 2B	Water body type	Calculation Guidance	Numeric attribute state description	Units
A2B; Table 11 - Submerged plants (native)	Lakes		% of maximum potential score	%
A2B; Table 12 - Submerged plants (invasive)	Lakes		% of maximum potential score	%
A2B; Table 13 - Fish Index of Biotic Integrity (F-IBI)	Wadeable Rivers		Average	F-IBI
A2B; Table 14 - Macroinvertebrates	Wadeable Rivers	Five year median	Macroinvertebrate Community Index (MCI)	MCI
		Five year median	Quantitative Macroinvertebrate Community Index (QMCI)	QMCI
A2B; Table 15 - Macroinvertebrates	Wadeable Rivers	Five year median	ASPM	ASPM
A2B; Table 16 - Deposited Sediment	Wadeable Rivers	Median of 5 years of at least monthly samples (at least 60 samples)	% fine sediment cover (by sediment class)	%
A2B; Table 17 - Dissolved oxygen	Rivers		7-day mean minimum	$mg\ l^{-1}$
			1-day minimum	$mg\ l^{-1}$
A2B; Table 18 - Lake-bottom dissolved oxygen	Lakes		Annual minimum	$mg\ l^{-1}$
A2B; Table 19 - Mid-hypolimmnetic dissolved oxygen	Lakes		Annual minimum	$mg\ l^{-1}$
A2B; Table 20 - Dissolved Reactive Phosphorus	Rivers		Median	$mg\ l^{-1}$
			95th percentile	$mg\ l^{-1}$
A2B; Table 21 - Ecosystem Metabolism	Rivers	1 November to 30 April	At least 7 days continuous monitoring	$g\ O2\ m^{-2}\ d^{-1}$
A2B; Table 22 - Escherichia coli	Rivers	During the bathing season	95th percentile during bathing season	$g\ O2\ m^{-2}\ d^{-1}$

9.3. Regional conservation statuses in Otago

Prepared for:	Environmental Science and Policy Committee
Report No.	SPS2406
Activity:	Environmental - Biodiversity
Author:	Scott Jarvie, Scientist - Biodiversity
Endorsed by:	Anita Dawe, General Manager Policy and Science
Date:	27 June 2024

PURPOSE

[1] This paper sets out work currently underway in the biodiversity area at ORC to document indigenous biodiversity. It overviews the development of regional threat classifications and includes details of regional conservation statuses for the species groups of indigenous vascular plants and amphibians in Otago.

EXECUTIVE SUMMARY

[2] This report provides an overview of regional conservation assessments, including their key role in monitoring biodiversity and biosecurity, work to formalise their methodology, and how they can be used to inform biodiversity management.

[3] It is an overview of two reports for the taxonomic (species) groups of indigenous vascular plants and amphibians. The report on indigenous vascular plants is a particularly diverse species group in Otago, with almost half of all indigenous vascular plant species found in Aotearoa New Zealand being found in the region.

[4] The regional conservation status assessment for indigenous vascular plant species and amphibians in Otago were recently completed. Standardised methodology was followed to assess the regional threat status of 1242 indigenous vascular plant taxa (species) and three amphibian species.

[5] For the indigenous vascular plant species, a total of 227 were assessed as Regionally Threatened (Regionally Critical = 93; Regionally Endangered = 68; Regionally Vulnerable = 66), 275 as Regionally At Risk (Regionally Declining = 50; Regionally Naturally Uncommon = 225), 614 as Regionally Not Threatened, one as Regionally Non-resident (Regional Coloniser = 1), and 115 as Regionally Data Deficient. An additional 10 species were identified as regionally extinct.

[6] For amphibian species, two are Regionally Introduced and Naturalised, i.e., exotic species from overseas, while one is regionally extirpated.

[7] The information in the report will be used to inform biodiversity and biosecurity management in Otago.

RECOMMENDATION

That the Committee:

1) ***Notes** this report.*
2) ***Notes** that the regional threat assessment for other species (taxonomic) groups will continue as part of the biodiversity work programme.*

BACKGROUND

[8] Regional and district councils have statutory obligations to maintain indigenous biodiversity under the Resource Management Act 1991 (RMA), including to manage the habitats of threatened taxa.

[9] Threat classifications play a key role in monitoring biodiversity and biosecurity. At a national scale, the New Zealand Threat Classification System (NZTCS) is the primary tool used to assign a threat status to candidate species in Aotearoa New Zealand. The NZTCS scores species against criteria based on an understanding of population state, size, and trend, while considering population status, impacts of threat, recovery potential, and taxonomic certainty. The Department of Conservation | Te Papa Atawhai (DOC) administers the NZTCS in Aotearoa New Zealand, with national assessments used to inform conservation action, target resources, and monitor biodiversity trends and conservation effectiveness.

[10] The need for regional threat classifications to help local authorities manage and protect biodiversity within their regions is important work for regional councils. Knowledge of the threatened species present at a site is of particular importance for both RMA consenting processes and conservation planning including work associated with pest control programmes for biodiversity restoration purposes.

[11] Regional council ecologists have worked with DOC to develop a standardised methodology[1] for regional threat classifications. This methodology uses national criteria where appropriate but takes the size of each region into account for some of the decision-making. Regional threat classifications for native flora and fauna, which are under development for some groups, complement the existing NZTCS.

[12] The regional conservation statuses can also be used to help guide decisions on where local authorities spend funding on pest control and/or biodiversity management programmes. Information regarding the species present, as well as their threat status can aid decision-making processes regarding priority sites and guiding management actions to ensure appropriate activities are part of the site restoration programme. An example is the Nationally Critical grassland willowherb (*Epilobium pictum* Petrie) which is only found in one location in the region (even though the species may be found in other parts of the country), and such knowledge could be used to guide appropriate protection, conservation funding and actions.

[1]A manual to document the methodology will be published as a national guideline, along with a locally operated dashboard tool to expediate assessments. The tool is being shared with other councils to assist with their own assessments. Dr Jarvie is a co-author of the manual.

[13] The Otago Regional Council has completed regional conservation statuses for reptiles and bats in Otago. These species were chosen first due to having a manageable size group, and to pilot the approach the regional conservation status by the ORC.

DISCUSSION

[14] The third and fourth regional conservation status reports for taxonomic (species) group have recently been completed for Otago, focusing on all indigenous vascular plant and amphibian species in the region.

[15] For indigenous vascular plant species, an expert panel along with an ORC ecologist identified 1242 taxa in the national assessment. Fourteen other taxa are considered legitimate but are not included in the national assessment. This can be for a number of reasons, such as since the last national assessment these species have only just been described.

[16] The number of Regionally Threatened plant species in the national assessment is 227 (Regionally Critical = 93; Regionally Endangered = 68; Regionally Vulnerable = 66), 275 as Regionally At Risk (Regionally Declining = 50; Regionally Naturally Uncommon = 225), 614 as Regionally Not Threatened, one as Regionally Non-resident (Regional Coloniser = 1), and 115 as Regionally Data Deficient. An additional 10 species were identified that have become regionally extinct.

[17] Of the 14 plant taxa that were identified that are not in the national assessment, five are Regionally Threatened (Regionally Critical = 4; Regionally Endangered = 1), two Regionally At Risk (Regionally Naturally Uncommon = 2), two were Regionally Not Threatened and four were Regionally Data Deficient.

[18] Of the Regionally Threatened and Regionally At Risk taxa in the national assessment, the region had 321 that were a National Stronghold (i.e., containing >20% of the national population). The number of endemic taxa to Otago were identified at being at least 36, i.e., they are found nowhere else than the region. Most of these are Regionally Threatened (20 off the 36), followed by Regionally At Risk (15), then Regionally Data Deficient (1).

[19] The percentage of indigenous vascular plant species in the Regionally Data Deficient, Regionally Threatened and Regionally At Risk categories is slightly higher than the comparable national categories (50.7% cf. with 49.3%).

[20] While only 3.8% of indigenous vascular plants species are Data Deficient nationally, 9.3% of species in Otago were considered Regionally Data Deficient. This suggests comparatively less is known at the regional scale for vascular plant species than is known about plants at the national scale.

[21] The number of indigenous vascular plant species only found in one location in Otago was 35. When assessing these species, there are eight regional endemics, of which all of these taxa are Regionally Critical. The number of taxa with only one location in Otago but also found outside the region was 27.

[22] Of the taxa only found within one location in Otago, 32 taxa are Regionally Threatened (Nationally Critical = 25, Nationally Endangered = 3, Nationally Vulnerable = 4) and three taxa are Regionally At Risk (Naturally Uncommon = 3). This indicates that species with restricted distributions are often more threatened.

[23] In Otago a high proportion of the vascular plant species were originally described from the region (as opposed to elsewhere). Such collection specimens are commonly referred to as a type locality, and form part of biological collections maintained by museums and universities, with various name-bearing types being used. The number of species with type localities was 280.

[24] Type specimens are important for diverse reasons, including for species descriptions, biodiversity inventories, and the identification of areas of endemism. Compared to the reports on Regional Conservation Statuses of Indigenous Vascular Plants in Greater Wellington Regional Council with one type (0.09%) and Auckland Council with 50 types (6.3%), the report for Otago document types for 22.3% species.

[25] For amphibians in Otago, a total of three species were identified. Of these three species, two were Regionally Introduced and Naturalised, while one was Regionally Extirpated, i.e., had disappeared from Otago.

[26] Knowledge of species extinctions or extirpations can be used to inform conservation translocations of species as ecological replacements, i.e. the intentional movement and release of an organism outside its indigenous range to perform a specific ecological function, such as the re-establishment of an ecological function lost through extinction.

OPTIONS

[27] This paper is for noting and therefore does not present options.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[28] The biodiversity programme contributes toward the *Healthy water, soil and coast, and Healthy and diverse ecosystems* strategic priorities. The work outlined in this paper aligns with visions in ORC's Biodiversity Strategy 2018: Our Living Treasure | Tō tatou Koiora Taoka and with visions and outcomes in the Biodiversity Action Plan Te Mahi hei Tiaki i te Koiora 2019–2024.

Financial Considerations

[29] Regional Threat Assessments are budgeted and are a planned activity.

Significance and Engagement Considerations

[30] Engagement will be ongoing between stakeholders and iwi that operate in the biodiversity space and on a project-by-project basis to undertake subsequent surveys and monitoring.

Legislative and Risk Considerations

[31] ORC has legislative responsibilities to protect significant habitats of indigenous fauna and flora as a matter of national importance, as well as its biodiversity and biosecurity functions. This work enables ORC to have a better understanding of the state of our species and ecosystems.

Climate Change Considerations

[32] The report assessed whether the indigenous vascular plant species are vulnerable to human-induced climate change. Of the Regionally Threatened and At-Risk species, 39 were assessed with the qualifier Climate Impact. This is where species were assessed as being adversely affected by long term climate trends and/or extreme climatic events.

Communications Considerations

[33] The reports will be published on the ORC website, where it will be available to key stakeholders (e.g., DOC, iwi, consultants) and the public. The reports will also be provided at the Otago Biodiversity Forum to iwi partners, territorial authorities, and other agencies. Accompanying the publication of each report is a media release.

[34] Guides and/or informatics are in development to accompany the Regional Conservation Status reports. Such documents are being developed to be more accessible to members of the public and can be used in community science initiatives.

NEXT STEPS

[35] The presence of Regionally Threatened and Regionally At Risk indigenous vascular plant species will be assigned to whether they occur in a Territorial Authority and Freshwater Management Unit.

[36] Regional threat assessments for other species groups will continue as part of the biodiversity work programme.

[37] Assessments have started for species groups including birds, Onchyophora (peripatus, or velvet worms), and mushroom fungi (Agaricales, Boletales, Russulales).

[38] Work is underway to compile lists for other species groups, including freshwater fish, marine mammals, mosses, liverworts and hornworts, and lichens. The compilation of such works is a precursor to conducting a Regional Conservation Status for a taxonomic group. Mana whenua have been consulted and are particularly interested to have completed assessments for the freshwater fish and marine mammal, in addition to those already done for reptiles and bats, and those underway for birds and indigenous vascular plants.

[39] Publication of the manual for the Regional Conservation Status methodology.

ATTACHMENTS

1. Conservation Status of Indigenous Vascular Plant Species in Otago - completed [**9.3.1** - 138 pages]
2. Conservation Status of Otago's Amphibians - completed [**9.3.2** - 24 pages]

Regional Conservation Status of Indigenous Vascular Plants in Otago

Scott Jarvie, John Barkla, Brian Rance, Geoff Rogers, Richard Ewans, Mike Thorsen

March 2024

Otago Threat Classification Series 3

Otago Regional Council

orc.govt.nz

Regional conservation status of indigenous vascular plants in Otago

March 2024 – Otago Threat Classification Series 3

Scott Jarvie
Otago Regional Council, Ōtepoti Dunedin

John Barkla
Ōtepoti Dunedin

Brian Rance
Waihōpai Invercargill

Geoff Rogers
Wānaka

Richard Ewans
Otago Regional Council, Ōtepoti Dunedin
Department of Conservation | Te Papa Atawhai, Ōtepoti Dunedin [1]

Mike Thorsen
Ahikā Consulting, Ōtepoti Dunedin

[1]*Current address*

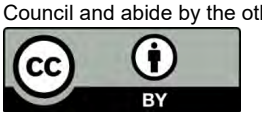
Otago Regional Council
Otago Threat Classification Series 3
ISSN 2816-0983 (web PDF)
ISBN 978-1-7385867-2-1 (web PDF)

Otago Threat Classification Series is a scientific monograph series presenting publications related to regional threats assessments of groups of taxa in the Otago region. Most will be lists providing regional threat assessments of members of a plant or animal group (e.g., reptiles, bats, birds, indigenous vascular plants), and leverages off national assessments for the New Zealand Threat Classification System within the regional context.

Recommended citation
Jarvie, S., Barkla, J., Rance, B., Rogers, G., Ewans, R., Thorsen, M. (2024). Regional conservation status of indigenous vascular plants in Otago. Otago Regional Council, Otago Threat Classification Series, 2024/3

Cover and frontispiece image credits
Helichrysum simpsonii subsp. *tumidum*, Threatened – Regionally Vulnerable. Photograph by John Barkla

Craspedia argentea, Threatened – Regionally Critical. Photograph by John Barkla



Executive Summary

This report provides the first assessment of the regional conservation status of all indigenous vascular plant taxa known in Otago. Standardised methodology was followed to assess the regional threat status of 1242 indigenous vascular plant taxa in the Otago region. Two hundred and twenty-seven indigenous plant taxa were assessed as Regionally Threatened (Regionally Critical = 93; Regionally Endangered = 68; Regionally Vulnerable = 66), 275 as Regionally At Risk (Regionally Declining = 50; Regionally Naturally Uncommon = 225), 614 as Regionally Not Threatened, one as Regional Non-resident Native (Regional Coloniser = 1), and 115 as Regionally Data Deficient. The percentage of indigenous vascular plant taxa in Otago that are Regionally Threatened is 18.2%, Regionally At Risk is 22.3%, and for Regionally Data Deficient is 9.5%. An additional 10 taxa were identified that have become extinct or may have formerly occurred in the region.

Table of Contents

Introduction

Threat classifications play an important role in monitoring biodiversity and informing conservation actions. The New Zealand Threat Classification System (NZTCS) is a tool used to assign a threat status to candidate taxa (species, subspecies, varieties, and forma) in Aotearoa New Zealand (Townsend et al. 2008). The classification system was developed to apply equally to terrestrial, freshwater, and marine biota (flora and fauna). The NZTCS scores taxa at the national scale against criteria based on an understanding of population state, size, and trend, while considering population status, impact of threats, recovery potential, and taxonomic certainty. The Department of Conservation | Te Papa Atawhai (DOC) administers the NZTCS in Aotearoa New Zealand, with national assessments used to inform conservation action, target resources, and monitor biodiversity trends and conservation effectiveness.

While DOC is tasked with managing indigenous taxa nationally, regional and district councils have statutory obligations to maintain indigenous biodiversity under the Resource Management Act 1991 (RMA), including to manage the habitats of threatened taxa. The regional threat status of taxa is particularly important in the context of the RMA and in conservation planning. A key requirement of managing the habitats occupied by taxa is to understand regional population sizes and distributions, and to monitor trends and management effectiveness.

This report is the first regional conservation status assessment for indigenous vascular plants in the Otago region. Regional threat assessments have been completed following a standardised methodology by Otago Regional Council for three taxonomic groups (bats, Jarvie et al. 2023a; reptiles, Jarvie et al. 2023b, amphibians, Jarvie 2024), Greater Wellington Regional Council for five taxonomic groups (birds, Crisp et al. 2024; indigenous freshwater fish, Crisp et al. 2022; indigenous vascular plants, Crisp 2020a; reptiles, Crisp et al. 2023b; bats, Crisp et al. 2023b) and Auckland Council for five taxonomic groups (amphibians, Melzer et al. 2022a; reptiles, Melzer et al. 2022b; indigenous vascular plants, Simpkins et al. 2023; bats, Woolly et al. 2023; freshwater fish, Bloxham et al. 2023) as of March 2024. Regional threat assessments also provide a stronger foundation for assessing the threat status of taxa nationally. The methodology for the regional threat assessments leverages off national threat assessments as determined using the NZTCS (Townsend et al. 2008, Rolfe et al. 2021, Michel 2021), with thresholds for area of occupancy or species numbers adjusted for the land area in the region (Appendix 1). National strongholds and additional regional qualifiers are also considered (Appendix 2).

Methods

The regional threat status of indigenous vascular plants was assessed by a panel of experts (John Barkla, Richard Ewans, Brian Rance, Geoff Rogers, and Mike Thorsen) and an Otago Regional Council (ORC) ecologist (Scott Jarvie) between June 2023 and January 2024. This assessment covers all indigenous vascular plant taxa in the region, following standardised methodology for regional threat assessments as shown in Appendix 1, the list of regional qualifiers in Appendix 2, and the list of national qualifiers in Appendix 3. The national threat assessments and national qualifiers were from de Lange et al. (2018). All the taxa in this regional assessment were classified following de Lange et al. (2018) as: 'taxonomically determinate', i.e., legitimately and effectively published and generally accepted by relevant experts as distinct; and 'taxonomically indeterminate', i.e., used loosely to include both undescribed entities which still require formal taxonomic research to confirm their validity and provide them with a formal name and, occasionally, described species whose taxonomic validity is in question. 'Taxonomically indistinct' are also noted in a separate table.

Following the standardised methodology, indigenous vascular plant taxa recognised in the NZTCS list (de Lange et al. 2018) but not known to occur naturally in Otago were first removed from consideration. The next step was to identify Nationally Threatened and At-Risk taxa that are present in the region. If more than 20% of the national population is breeding or resident for more than half their life cycle in the region, taxa were assigned National Stronghold status and the NZTCS criteria applied. In this exercise, the regional conservation status must not be of a lower threat status than the national status. For example, a Nationally Endangered taxon cannot be assessed as Regionally Vulnerable or lower but could be assessed as Regionally Critical. Due to the timing of this assessment being prior to the national assessment, some applications of the criteria anticipated potential changes to the national status but may not always align to the national status, such as for some of the myrtle species.

Regional thresholds were set at more than 2000 mature individuals present or occupancy of more than 1000 ha. If taxa did not meet the threshold, they were assigned a regional threat status by applying the NZTCS criteria. If taxa meet the threshold and the population trend was ±10% stable or increasing, they were assigned the status Regionally Not Threatened. For Nationally Not Threatened and Non-Resident taxa, the regional population threshold was applied. If the population was not stable to increasing or decreasing by more than 10%, the NZTCS criteria were used to determine the regional threat status. Population trend criteria are applied based on current knowledge, representing trends over the next 10 years or 3 generations, whichever is longer.

Indigenous vascular plant taxa not included in the NZTCS but considered by the expert panel as ‘taxonomically determinate’ or ‘taxonomically indeterminate’ are included in a separate table. Indigenous Aotearoa New Zealand taxa that have been introduced to the Otago region but for which Otago is not part of their natural distribution, are also included in a separate table.

To inform decisions on distributions and area of occupancy for assessment of the regional threat status of indigenous vascular plant taxa, occurrence records from online databases were used (e.g., Auckland Museum Herbarium – Tāmaki Paena Hira, CHR Allan Herbarium – Te Kohinga Tipu o Aotearoa, iNaturalist, National Vegetation Survey). These records were then taxonomically harmonised with the list of indigenous vascular plant taxa in the NZTCS where possible (de Lange et al. 2018). In addition to occurrence records, the panel used plant check lists compiled by themselves or others, e.g., Druce list number 292 for Mountains of Inland Otago and Northern Southland (Druce 2006), Protected National Area Programme (PNAP) reports for Otago, New Zealand Plant Conservation Network, the Flora of New Zealand series, and local, regional, and national personal communications. The PNAP reports for Otago that were checked for species occurrence records were those for the following Ecological Districts: Dansey (Comrie 1992), Dunstan (Ward et al. 1994), Hawkdun (Grove 1994), Lindis (Ward et al. 1994), Macraes (Bibby 1997), Maniototo (Grove 1994), Manorburn (Fagan and Pillai 1992), Nokomai (Dickinson 1989), Old Man (Brumley et al. 1986), Pisa (Ward et al. 1994), Umbrella (Dickinson 1988), and Waipori (Carter 1994). The panel critically assessed the available data and drew on their own expert knowledge to consider current and likely future threats to determine the status and qualifiers for each taxon.

Type localities (TLs) are included as a qualifier and details of the type locality is specified in the notes column of the tables to highlight their scientific significance in the region. There are several different categories of types recognised under the International Code of Nomenclature (ICN; Turland et al. 2017), and are shown in this report where known: ‘holotype’, i.e., the single specimen designated as the type of a species by the original authors at the time the species name and description was published; ‘isotype’, i.e., a duplicate specimen of the holotype; ‘syntype’, i.e., any of two or more specimens listed in the original description of a taxon when a holotype was not designated; isosyntype, i.e., duplicates of a syntype; ‘lectotype’, i.e., a specimen chosen from among the specimens available to the original author of a name when the holotype was either lost or destroyed, or when no holotype was designated; ‘isolectotype’, i.e., duplicate of a lectotype; ‘neotype’, i.e., a specimen chosen by a later researcher to serve in place of a holotype when all specimens available to the original author of a name have been lost or destroyed; and ‘isoneotype’, i.e., duplicate of a neotype.

The following categories have no standing under the ICN, and are therefore not shown in this report: ‘paratype’, i.e., a specimen not formally designated as a type but cited along with the type collection in the original description of a taxon; ‘topotype’, i.e., a specimen of a plant collected from the same locality as the holotype, not necessarily at the same time; ‘cotype’, i.e., an old term used by some authors for additional (different) specimens that supported their taxonomic concept; and lectotype, i.e., a name sometimes used for the unselected remainder when a lectotype is selected from a number of syntypes.

If no specific site for a type locality is known, but could include Otago, this is recorded as ‘TL?’. This was for the taxa where records stated: “likely to occur”, “throughout South Island”, “throughout eastern South Island”, “on and west of Main Divide, even if an Otago locality was not mentioned”, and where “distributions mention “scattered South Island but no Otago locality listed”. Further investigation would especially be needed in such cases. The type locality information was compiled from information curated in the Global Biodiversity Information Facility (GBIF, 2023), the Atlas of Living Australia (ALA, Belbin et al. 2021), the Flora and eFlora Series (Breitweiser et al. 2023; specifically Flora Vol. 1, Vol. 2 and Vol. 3; Allan, 1961; Moore and Edgar, 1976, and Edgar and Connor, 2010, respectively), and also mostly from the following herbaria: Otago Regional Herbarium – Te māra Otaota o Otago (OTA), Allan Herbarium – Te Kohinga Tipu o Aotearoa (CHR), Museum of New Zealand – Te Papa Tongarewa Herbarium (WELT), and Auckland Museum Herbarium – Tāmaki Paena Hira (AK). Other herbarium type localities were noted when reviewing information from eFlora, GBIF and ALA. These include Kew Gardens Herbarium, London (K), the former Wellington Dominion Museum (W), the former DSIR Botany Division (BD), and the former Otago Museum (OM); sometimes registration numbers were not readily available, but the herbarium is still noted. Type locality information was also extracted from recent publications describing new species from the Otago region, including Breitweiser and Ford (2022), Burrows (2008), Burrows (2009), Burrows (2011), de Lange et al. (2013), de Lange and Blanchon (2023), Edgar and Connor (2010), Heads (1998), Heads (1990), Heenan (2017), MacMillan (1991), Meudt and Prebble (2018), Meudt (2008), Meudt et al. (2020), Moore and Edgar (1976), Prebble et al. (2022), Saldivia (2023), and Thorsen and de Lange (2016). The curation of type locality information is often part of an ongoing process at herbara, with updates, new images and records being added regularly. In some cases, such records are yet to be confirmed by herbarium staff, and consequently there could be mistakes or omissions in the information presented. Hyperlinks are provided to institutions with registration numbers to facilitate checking of the source material for type locality information, where known.

For taxa with the qualifiers regional endemic (RE), one location (OL), and designated (De), explanatory information is also provided in the notes column of the tables. For

taxa that have had their taxonomic names changed since de Lange et al. (2018), their previous name and authority are provided in the notes column.

Regional conservation assessments for indigenous vascular plant taxa were completed in a locally operated dashboard using R v. 4.2.2 (R Core Team 2022) via the RStudio platform (Posit Team 2023). The main packages used for the dashboard were 'shiny' (Chang et al. 2021) and 'flexdashboard' (Iannone et al. 2020). Other packages used in the dashboard and for other data wrangling include the ‘tidyverse’ (Wickham et al. 2019), ‘readxl’ (Wickham and Bryan 2022), sf (Pebesma 2018), lubridate (Grolemund and Wickham 2011), leaflet (Cheng et al. 2022), leaflet.extras (Karambelkar and Schloerke 2018), plotly (Sievert 2020), janitor (Firke 2020), ggplot2 (Wickham 2016), and terra (Hijmans 2022). The map layers used to view records in the dashboard were OpenStreetMap (OpenStreetMap Contributors 2017) and Esri World Imagery (Esri 2023).

Results

A total of 1242 indigenous vascular plant taxa were identified as present in the Otago region that were listed in the NZTCS (excluding introduced and naturalised species; Figure 1, Tables 1–4). Of these taxa, 227 are Regionally Threatened, 275 are Regionally At Risk, one is Regionally Non-resident, 614 are Regionally Not Threatened, and 115 are Regionally Data Deficient. Ten taxa were also identified as Regionally Extirpated (likely now extinct in the Otago region). Additionally, 14 taxa were assessed but are not in the NZTCS; four of these were Regionally Data Deficient, five were Threatened, three were At Risk, and two were Not Threatened.

Of the Regionally Threatened taxa in the Otago region in the NZTCS, 93 are Regionally Critical, 68 are Regionally Endangered, 66 are Regionally Vulnerable. Of the 275 Regionally At Risk taxa in the NZTCS, 50 are Regionally Declining and 275 are Regionally Recovering. The number of Regionally Not Threatened was 614. For Regionally Non-resident Native species, only one was identified as a Regional Coloniser. In Otago 10 indigenous vascular plant taxa were identified as likely now extinct in the region, with one being nationally extinct.

The region was identified as a National Stronghold (i.e., containing > 20% of the national population) for around 41% of the Regionally Threatened and Regionally At Risk indigenous vascular plants. Of those taxa with National Strongholds in Otago, at least 36 are Regional Endemics, meaning they are not found elsewhere. The panel noted for Regionally Threatened and Regionally At Risk taxa around 17.4% of taxa were at natural northern and southern limits within the region, excluding the Regional Endemics taxa. Taxa with identified type localities in the Otago region was around 17.2%.

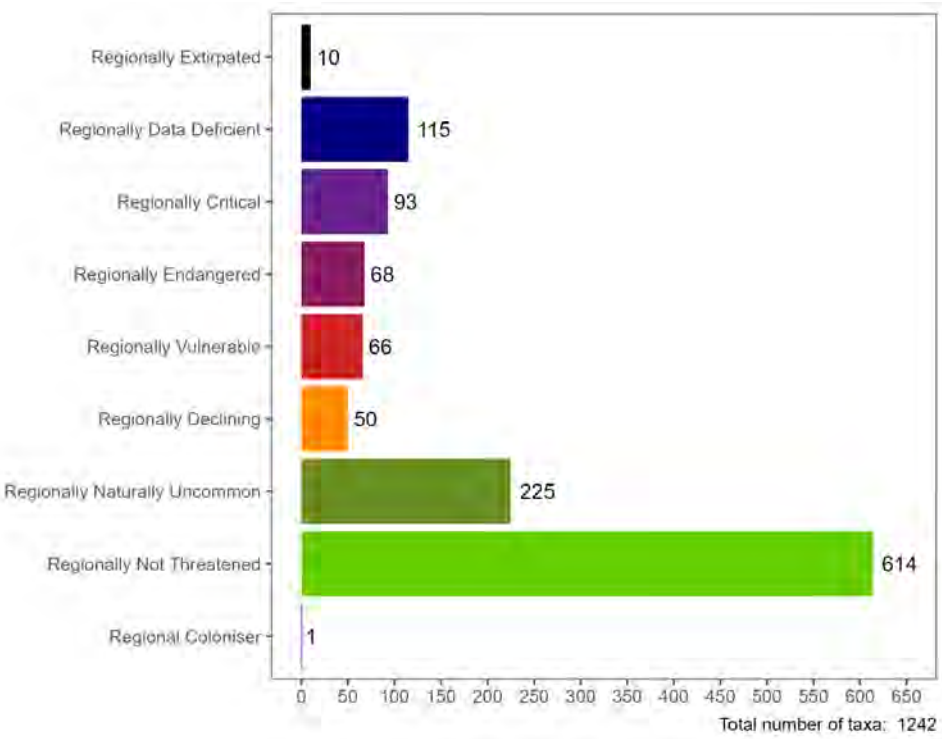


Figure 1: Regional conservation status of indigenous vascular plants in the Otago region. The total of 1242 indigenous vascular plants does not include 14 taxa not included in the national assessment (de Lange et al. 2018). Appendix 4 has figure for these 14 taxa assessed regionally.

Regionally Extirpated (10)

Taxa for which there is no reasonable doubt that the species is no longer present in the wild in Otago.

Table 1: Regionally Extirpated indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY EXTIRPATED (10)					
NATIONALLY EXTINCT (1)					
TAXONOMICALLY DETERMINATE (1)					
Stellaria multiflora subsp. *multiflora* Hook.	chickweed	Extinct	TL		TL = voucher specimens: Eweburn School, near Naseby / Gorge Creek, Clutha/Mata-au River / Spear Grass Flat, Alexandra. Previous Name and Authority: *Stellaria elatinoides* Hook.f. Notes: this taxon was last collected in Aotearoa New Zealand in 1921 (Heenan 2019).
REGIONALLY EXTIRPATED (9)					
TAXONOMICALLY DETERMINATE (8)					
Carmichaelia juncea Hook.f.	tangle broom	Nationally Vulnerable	HR, TL	CD, DP, EF	TL = L, ISL: Otago. Accession numbers: L CHR 45814 C; ISL CHR 45814 A, CHR 45814 B
Chenopodium detestans Kirk	New Zealand fish-guts plant	Nationally Critical	HR	DP, EF, TO	
Pachycladon exile (Heenan) Heenan & A.D.Mitch.	cress	Nationally Critical		CD, OL	
Parapolystichum microsorum (Endl.) Labiak, Sundue & R.C.Moran		Not Threatened			Previous Name and Authority: *Parapolystichum microsorum* subsp. *pentangulare* (Colenso) Labiak, Sundue & R.C.Moran
Poa billardierei (Spreng.) St.-Yves	sand tussock	Declining		PD, RR, SO	
Rytidosperma exiguum (Kirk) H.P.Linder		Declining	HR	DP	
Senecio scaberulus (Hook.f.) D.G.Drury	fireweed	Nationally Critical	HR	EF	
Sophora prostrata Buchanan		Not Threatened			
TAXONOMICALLY INDETERMINATE (1)					
Pimelea aff. *villosa* (AK 216133; southern New Zealand)		Nationally Endangered	HR	DP, RR, RF	

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural State; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Regionally Data Deficient (115)

Taxa that are suspected to be threatened or, in some instances, possibly extinct in Otago but are not definitely known to belong to any particular category due to a lack of current information about their distribution and abundance (for a fuller definition see Townsend et al. 2008).

Table 2: Regionally Data Deficient indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY DATA DEFICIENT (115)					
TAXONOMICALLY DETERMINATE (103)					
Abrotanella rostrata Swenson		Naturally Uncommon		DP, RR, Sp	
Acianthus sinclairii Hook.f.	heart-leaved orchid	Not Threatened			
Aciphylla congesta Cheeseman		Not Threatened		RR	
Aciphylla multisecta Cheeseman		Declining		DP, RR, Sp	
Adiantum diaphanum Blume	small maidenhair fern	Not Threatened			
Agrostis imbecilla Zotov		Data Deficient	TL	Sp	TL = H, I: Macraes, Waihemo County, Otago. Accession numbers: H WELT SP069601; I AK 1434
Agrostis magellanica Lam.		Not Threatened		SO	
Agrostis petriei Hack.		Naturally Uncommon	TL	DP, Sp	TL = H, I: Nevis Valley, Tapuae-o-Uenuku | Hector Mountains, Central Otago / Cromwell, Central Otago. Accession numbers: H W SP036494; I WELT SP068876, CHR 25061 / H: W SP07926, I AK 1425(1), (2), WELT SP068873
Archeria traversii Hook.f. var. traversii		Not Threatened			
Astelia linearis Hook.f. var. *linearis*		Not Threatened			
Botrychium australe R.Br.	parsley fern	Naturally Uncommon		DP, EF, SO, Sp	
Caltha novae-zelandiae Hook.f.	New Zealand marsh marigold	Not Threatened			
Calystegia sepium subsp. *roseata Brummitt*	pink bindweed	Not Threatened			
Cardamine eminentia Heenan	cress	Naturally Uncommon		DP, Sp	
Cardamine grandiscapa	crass	Naturally Uncommon	TL	DP	TL = H: Remarkables, Wye Creek. Accession number: H CHR 617195
Cardamine sinuatifolia Heenan	cress	Naturally Uncommon		DP, RR, Sp	
Carex allanii Hamlin	Allan's sedge	Taxonomically Indistinct	TL		TL = H, I: Old Man Range, Clutha Valley. Accession numbers: H WELT SP005135/A; I WELT SP005135/B, WELT SP005135/C, WELT SP005135/D
Carex astricta K.A.Ford	hook sedge	Not Threatened			
Carex aucklandica (Hamlin) K.A.Ford	subantarctic hook grass	Naturally Uncommon		DP, RR	
Carex cheesemaniana (Boeckeler) K.A.Ford	hook sedge	Not Threatened		SO	
Carex cockayneana Kük.	Cockayne's sedge	Not Threatened			
Carex enysii Petrie	Enys's sedge	Naturally Uncommon		DP, Sp	
Carex erythrovaginata K.A.Ford	lax hook sedge	Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Data Deficient continued

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Carex goyenii Petrie	Goyen's sedge	Not Threatened	TL		TL = L?: forest land at head of Lake Whakatipu. Accession number: L? AK 2616
Carex hamlinii K.A.Ford	Aston's hook sedge	Not Threatened			
Carex healyi K.A.Ford	harsh-leaved hook sedge	Not Threatened			
Carex kirkii var. *kirkii* Petrie	Kirk's sedge	Naturally Uncommon	TL		TL = L: Mount Pisa, head waters of Luggate Creek. Accession number: L AK 2480. Previous Name and Authority: *Carex kirkii* Petrie
Carex lambertiana Boott	forest sedge	Not Threatened			
Carex longifructus (Kük.) K.A.Ford	hook sedge	Naturally Uncommon	TL	DP, Sp	TL = L, ISL: Routeburn. Accession numbers: L WELT SP001778, ISL AK2328
Carex obtusifolia (Heenan) K.A.Ford	fine-leaved hook sedge	Naturally Uncommon		Sp	
Carex silvestris (Hamlin) K.A.Ford	forest hook sedge	Not Threatened			
Carex subviridis K.A.Ford	hook sedge	Not Threatened			
Carmichaelia uniflora Kirk	dwarf broom	Declining		DP	
Celmisia spedenii G.Simpson	Speden's mountain daisy	Naturally Uncommon		RR	
Colobanthus monticola Petrie	colobanthus	Not Threatened	TL		TL = S; Bald Hill Flat, near Clutha/Mata-au River at "Gorge Creek", near Alexandra. Accession number: S WELT SP050960
Convolvulus fractosaxosa Petrie	shingle convolvulus	Naturally Uncommon		DP, Sp	
Coriaria angustissima Hook.f.	small-leaved tutu	Not Threatened	TL		TL = H, S: Otago Lake District / Mount Alta, Wānaka Ecological District. Accession numbers: H K?; S AK 5090
Corybas acuminatus M.A.Clem. & Hatch	spider Orchid	Not Threatened			
Craspedia lanata var. *elongata* Allan		Not Threatened			
Craspedia minor (Hook.f.) Allan		Not Threatened			
Craspedia robusta (Hook.f.) Cockayne var. *robusta*		Not Threatened			
Craspedia uniflora G.Forst. var. *uniflora*		Not Threatened			
Deschampsia chapmanii Petrie		Not Threatened	TL		TL = L, ISL: Tapuae-o-Uenuku | Hector Mountains, *ca.* 5000 ft. Accession numbers: L WELT SP069475/A; ISL CHR 2808, WELT SP069475/B
Deschampsia pusilla Petrie		Naturally Uncommon	TL	Sp	TL = L, ISL, ISL (putative), ISL?: Tapuae-o-Uenuku | Hector Mountains. Accession numbers: L WELT SP069433; ISL CHR 333257; ISL (putative) WELT SP068263, WELT SP069431, WELT SP076980; ISL? AK 223532, AK 1534
Dracophyllum oliveri Du Rietz		Not Threatened			
Dracophyllum traversii Hook.f.	mountain neinei	Not Threatened			
Drymoanthus adversus (Hook.f.) Dockrill		Not Threatened			
Epilobium cockayneanum Petrie		Data Deficient			
Epilobium gracilipes Kirk		Naturally Uncommon			
Epilobium tenuipes Hook.f.		Not Threatened			
Euchiton involucratus (G.Forst.) Holub.		Not Threatened		SO	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Data Deficient continued

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Euchiton japonicus (Thunb.) Holub		Not Threatened		SO	
Festuca matthewsii (Hack.) Cheeseman subsp. *matthewsii*		Not Threatened	TL		TL = ISL: Mount Bonpland, Humboldt Mountains, West of Lake Whakatipu. Accession numbers: ISL AK 1990, AK 212981, CHR 1537, CHR 2870.
Gastrodia minor Petrie		Not Threatened	TL		TL = S: Town Belt, Ōtepoti Dunedin, in shady manuka bush, Dunedin Ecological District / near northern cemetery, Ōtepoti Dunedin. Accession numbers: S AK 3688, WELT SP019064
Geranium cruentum Heenan & G.M.Rogers	Von geranium	Nationally Critical	CD, De, EW, RE	CD, EW	Previous Name and Authority: *Geranium* (c) (CHR 546319; Von)
Geranium potentilloides L'Her. ex DC.		Not Threatened	TL	SO	TL = S: Flagstaff Hill, Ōtepoti Dunedin. Accession numbers S AK 22911, AK 22912
Gleichenia dicarpa R.Br.		Not Threatened			
Gleichenia microphylla R.Br.	carrier tangle fern	Not Threatened		SO	
Glossostigma cleistanthum W.R.Barker		Not Threatened			
Gonocarpus incanus (A.Cunn.) Orchard		Not Threatened			
Hierochloe cuprea Zotov		Not Threatened			
Hierochloe equiseta Zotov		Not Threatened	TL		TL = H: Bold Peak, Humboldt Mountains. Accession number: H CHR 9679
Hierochloe fusca Zotov		Not Threatened			
Hymenophyllum atrovirens Willd.	filmy fern	Naturally Uncommon	TL	DP, RR, SO, Sp	TL = I: near Lake Whakatipu. Accession number: I CHR 293758 Previous Name and Authority: *Hymenophyllum australe* Willd.
Hypericum involutum (Labill.) Choisy		Declining		DP, SO	
Hypolepis dicksonioides (Endl.) Hook.	giant hypolepis	Naturally Uncommon		EF, SO, Sp	
Hypolepis lactea Brownsey & Chinnock		Not Threatened			
Isoetes kirkii A.Braun	quillwort	Declining		RR	
Isolepis inundata R.Br.	sedge	Not Threatened		SO	
Isolepis subtilissima Boeckeler		Not Threatened			
Juncus australis Hook.f.		Not Threatened		SO	
Lachnagrostis glabra (Petrie) Edgar		Data Deficient			
Lachnagrostis littoralis subsp. *salaria* Edgar		Not Threatened			
Lagenophora schmidiae de Lange et Jian Wang ter	papataniwha	Nationally Critical			
Lindsaea linearis Sw.		Not Threatened		SO	
Luzula picta A.Rich. var. *picta*	wood-rush	Not Threatened			
Luzula picta var. *limosa* Edgar	wood-rush	Not Threatened			
Metrosideros perforata (J.R.Forst. & G.Forst.) A.Rich.	akatea	Nationally Vulnerable		DP, De	
Montia calycina (Colenso) Pax & K.Hoffm.		Not Threatened			
Myosotis suavis Petrie		Data Deficient			
Notogrammitis givenii (Parris) Parris		Not Threatened			
Notogrammitis gunnii (Parris) Parris	strap fern	Data Deficient		SO	
Oxalis rubens Haw.		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Data Deficient continued

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Pachycladon fastigiatum (Hook.f.) Heenan & A.D.Mitch.	hairless cress	Not Threatened	TL	DP	TL = H, L: mountains near Lake Wānaka and Lake Ohau / head of Lake Ohau / Three Kings Mountain, Otago. Accession numbers: H WELT SP083897; L WELT SP083898, WELT SP083899
Parsonsia capsularis var. *rosea* (Raoul) Cockayne	New Zealand jasmine	Data Deficient			
Parsonsia capsularis var. *tenuis* G.Simpson & J.S.Thomson	New Zealand jasmine	Data Deficient			
Pentapogon quadriseta (Labill.) P.M.Peterson, Romasch. & Soreng		Declining		DP, EF, SO	Previous Name and Authority: *Deyeuxia quadriseta* (Labill.) Benth.
Picris angustifolia subsp. *merxmuelleri* Lack & S.Holzapfel		Naturally Uncommon		DP, SO	
Pimelea prostrata (J.R.Forst. & G.Forst.) Willd. subsp. *prostrata*		Not Threatened	TL		TL = S: Mount Earnslaw Creek, Otago Lake District, Dart Ecological District. Accession number: S AK 5410
Pimelea prostrata subsp. *ventosa* C.J.Burrows		Declining		Sp	
Poa intrusa Edgar		Data Deficient			
Poa senex Edgar		Naturally Uncommon	TL	DP, RR	TL = H, I: Kopuwai | Old Man Range, Otago. Accession numbers: H CHR 133878; I CHR 133877, CHR 133879, CHR 133880, CHR 133881
Polygonum plebeium R.Br.	small knotweed	Declining		DP, SO	
Pterostylis auriculata Colenso		Naturally Uncommon		DP, Sp	
Pterostylis foliata Hook.f.		Naturally Uncommon		SO, Sp	
Schoenus nitens (R.Br.) Roem. & Schult.		Not Threatened			
Solanum americanum Mill.	small-flowered nightshade	Not Threatened		SO	
Stenostachys gracilis (Hook.f.) Connor	poaceae	Not Threatened		DP	
Thelymitra colensoi Hook.f.	Colenso's sun orchid	Data Deficient			
Thelymitra formosa Colenso	sun orchid	Naturally Uncommon		EF, Sp	
Veronica hookeri (Buchanan) Garn.-Jones		Not Threatened	TL		TL = I, I?, T?: Mount Alta. Accession numbers: T? WELT SP084569; I WELT SP013044; I? WELT SP013043
Veronica macrocalyx var. *humilis* (G.Simpson) Garn.-Jones		Not Threatened	TL		TL = H, L: slopes of Mount French / collected from slopes of Mount French. Accession numbers: H CHR 550051; L CHR 76135
Veronica quadrifaria Kirk		Not Threatened	TL		TL = H: Mount Alta. Accession number: OM?
Zoysia minima (Colenso) Zotov	prickly couch	Declining		DP	
TAXONOMICALLY INDETERMINATE (11)					
Cardamine (m) (OTA 36555; "Eweburn")	cress	Data Deficient			
Cardamine (q) (CHR 591775; west Otago)	cress	Data Deficient			
Carex (a) (AK 30599; *Carex potens* sensu Ford, 2015) (C.B.Clarke) Hamlin	hook sedge	Not Threatened	NStr		
Craspedia (ll) (CHR 629757; Otago)		Not Threatened	NStr, RE		
Craspedia (nn) (CHR 567299; "Rex")		Nationally Vulnerable			
Craspedia (pp) (CHR 673757; Skippers)		Data Deficient	NStr		
Earina aestivalis Cheeseman		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Data Deficient continued

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Melicytus aff. *alpinus* (c) (CHR 541568; Otago)		Data Deficient			
Melicytus aff. *alpinus* (d) (CHR 541567; "dark")		Data Deficient			
Melicytus aff. *alpinus* (f) (CHR 530143; "Brockie")		Data Deficient	OL	OL	

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural State; NStr = National Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Regionally Threatened (227)

Taxa that meet the criteria specified by Townsend et al. (2008) and Michel (2021) for the categories Regionally Critical, Regionally Endangered, Regionally Vulnerable or Regionally Increasing.

Regionally Critical (93)

Criteria for Regionally Critical:

A – very small population (natural or unnatural)
A(1) < 250 mature individuals
A(2) ≤ 2 subpopulations, ≤ 200 mature individuals in the larger subpopulation
A(3) Total area of occupancy ≤ 1 ha (0.01 km^2)

B – small population (natural or unnatural) with a moderate ongoing or predicted decline of 50–70%
B(1) 250–1000 mature individuals
B(2) ≤ 5 subpopulations, ≤ 300 mature individuals in the largest subpopulation
B(3) Total area of occupancy ≤ 10 ha (0.1 km^2)

C – population (irrespective of size or number of subpopulations) with a very high ongoing or predicted decline of > 70%

Table 3.3.1: Regionally Critical indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY CRITICAL (93)													
TAXONOMICALLY DETERMINATE (87)													
Amphibromus fluitans Kirk	water brome	Nationally Vulnerable	A (3)				≤ 1 ha		Low	Medium	DPR, DPS, DPT, EF, NR, RR	DP, TO	
Anemanthele lessoniana (Steud.) Veldkamp	gossamer grass	Relict	A (1)			≤ 250 mature individuals			Low	Low	DPS, DPT, Sp	DP, Sp	
Anogramma leptophylla (L.) Link	Jersey fern	Nationally Vulnerable	A (3)				≤ 1 ha		Low	Low	DPR, DPS, DPT, NR, PF, Sp	DP, RR, SO, Sp	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Asplenium oblongifolium Colenso	shining spleenwort	Not Threatened	A (1)			< 250 mature individuals			Low	Medium	DPR, DPS, DPT, NR, Sp		
Astelia subulata (Hook.f.) Cheeseman		Naturally Uncommon	A (3)				≤ 1 ha		Medium	Medium	DPS, DPT, NS, OL, St	RR, Sp	
Botrychium biforme Colenso	fine-leaved parsley fern	Not Threatened	A (1)			< 250 mature individuals			Low	Low	DPR, DPS, DPT, Sp		
Brachyscome linearis (Petrie) Druce	daisy	Nationally Critical	A (1)			≤ 250 mature individuals			Medium	High	DPT, NR, OL, RR	CD, DP, RR, Sp	
Cardamine dilatata Heenan	cress	Nationally Critical	A (1)	Yes	Yes	≤ 250 mature individuals			Medium	High	DPS, DPT, NStr, OL, RR, Sp	DP	Distributional notes: While currently only known from the Macraes area, it was until recently present in south Canterbury. It was therefore not assigned the Regional Endemic qualifier as could still be found outside Otago
Cardamine mutabilis Heenan	Turf cress	Nationally Critical	A (3)	Yes			≤ 1 ha		Medium	Medium	DPS, DPT, EF, NR, NStr, RR, TL	CD, DP, EF, RR, Sp	TL = H: Lake Onslow, Fortification Stream. Accession number: H CHR 420058
Cardamine sciaphila Heenan	cress	Nationally Critical	A (1)	Yes	Yes	≤ 250 mature individuals			Low	Low	DPR, DPS, DPT, NS, NStr, RE, RR, TL	DP, RR	RE = Central Otago endemic known from the Dunstan Mountains and Pisa Range. TL = H. Dunstan Mountains. Accession number: H CHR 514168
Carex albula Allan	white sedge	Nationally Vulnerable	A (1)	Yes		≤ 250 mature individuals			High	High	DPR, NR, NStr, PF, RF	Sp	
Carex carsei Petrie	Carse's sedge	Declining	A (3)				≤ 1 ha		Low	Medium	DPS, DPT, PF, RR	DP	
Carex cirrhosa Berggr.	curly sedge	Nationally Endangered	A (3)				≤ 1 ha		Low	Low	DPS, DPT, RR	RR	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Carex cyanea K.A.Ford		Declining	A (3)				≤ 1 ha		High	High	DPR, NR, NS, OL	DP, Sp	
Carex dallii Kirk	Dall's sedge	Naturally Uncommon	A (3)	Yes			≤ 1 ha		Low	Low	DPR, DPS, DPT, NR, NStr, RR, Sp	DP	
Carex inopinata V.J.Cook	grassy mat sedge	Nationally Vulnerable	A (3)	Yes			≤ 1 ha		Medium	Medium	DPR, DPS, DPT, NR, NStr, PF, Sp	DP, Sp	
Carex strictissima (Kük.) K.A.Ford	hook sedge	Nationally Endangered	A (1)	Yes		≤ 250 mature individuals			Medium	Low	DPR, DPS, DPT, NStr, PF, RF, Sp, TL	DP	TL = H, I: Waitahuna, Tuapeka County, Otago. Accession numbers: H WELT SP001494; I CHR 294890
Carex uncifolia Cheeseman	sedge	Nationally Vulnerable	A (3)	Yes			≤ 1 ha		Medium	Medium	DPT, NStr, PF, RR, TL	RR, St, Sp	TL = H: Mount Cardrona. Accession number: H WELT 01891/A
Carmichaelia corrugata Colenso	common dwarf broom	Nationally Vulnerable	A (3)				≤ 1 ha		Low	Medium	DPS, DPT, PF, Sp	RF, Sp	
Carmichaelia curta Petrie	Waitaki broom	Nationally Critical	A (1)			≤ 250 mature individuals			Medium	High	DPS, DPT, NR, PF	DP, RF	
Carmichaelia nana (Hook.f.) Hook.f.	Dwarf carmichaelia	Nationally Vulnerable	A (3)				≤ 1 ha		Low	Medium	DPS, DPT, PF, RR, TL	DP	
Centipeda aotearoana N.G.Walsh	New Zealand sneezewort	Not Threatened	A (3)				≤ 1 ha		Low	High	DPR, DPT, NR, OL		
Ceratocephala pungens Garn.-Jones	Ranunculaceae	Nationally Critical	B (3)	Yes			≤ 10 ha		Medium	Low	DPS, DPT, EF, NR, NStr, TL	DP, EF, PD	TL = I: Bald Hill Flats, Clutha/Mata-au River. Accession number: I WELT SP061962
Chaerophyllum colensoi var. *delicatulum* (Allan) K. F. Chung		Nationally Endangered	A (3)				≤ 1 ha		Low	Medium	DPR, DPS, DPT, NS, RR	DP, EF, RR	Previous Name and Authority: *Chaerophyllum colensoi* var. *delicatulum* (CHR 73872; Hauhungaroa Range) (Allan) K. F. Chung

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Clematis quadribracteolata Colenso	clematis	Naturally Uncommon	A (1)			≤ 250 mature individuals			Low	Low	DPR, DPS, DPT, PF, Sp	DP, Sp	
Convolvulus verecundus f. *verecundus* Allan	trailing bindweed	Nationally Vulnerable	A (3)	Yes			≤ 1 ha		High	High	DPT, NStr, PD, PF, RR	DP	Previous Name and Authority: *Convolvulus verecundus* Allan
Coprosma obconica Kirk	coprosma	Nationally Vulnerable	A (1)	Yes		≤ 250 mature individuals			Low	Medium	DPT, NStr, PF, RF, RR	Sp	
Coprosma pedicellata Molloy, de Lange & B.D.Clarkson	coprosma	Declining	A (1)			≤ 250 mature individuals			Medium	High	DPT, PF, RR	CD, DP, RR	
Craspedia argentea Breitw. & K.A.Ford, sp. nov.		Nationally Critical	A (1)	Yes	Yes	≤ 250 mature individuals			High	High	CD, NStr, OL, RE, TL	DP, OL	RE = only known from one location in Central Otago. Previous Name and Authority: *Craspedia* (a) (CHR 511522; Clutha River) TL = H: Pisa Flats. Accession number: H CHR 588519
Crassula multicaulis (Petrie) A.P.Druce & Given		Nationally Endangered	A (3)	Yes			≤ 1 ha		Low	Medium	DPR, DPS, DPT, NR, NStr, PF, RR, TL	EF, PD, RR, Sp	TL = H, I, S, T?: Maniototo Plain, near Naseby / Lake Waihola / Tokomairiro Ecological District. Accession numbers: H WELT SP050121/A; I WELT SP050121/B; S AK 4553; T? WELT SP050119
Crassula peduncularis (Sm.) F.Meigen	shore stonecrop	Nationally Critical	A (3)	Yes			≤ 1 ha		Low	Low	DPS, DPT, NStr, RR	EF, RR, SO	
Crassula ruamahanga A.P.Druce emend de Lange & Heenan		Naturally Uncommon	A (3)				≤ 1 ha		Low	Low	DPR, DPS, DPT, PF, Sp	DP, Sp	

Continued on next page

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Cyathea medullaris (G.Forst.) Sw.		Not Threatened	A (1)			< 250 mature individuals			Medium	Medium	Sp		
Daucus glochidiatus (Labill.) Fisch., C.A.Mey. & Avé-Lall.	New Zealand carrot	Declining	A (3)				≤ 1 ha		High	High	OL	EF, SO	
Epilobium pictum Petrie	grassland willowherb	Nationally Critical	A (1)	Yes		≤ 250 mature individuals			Low	Low	DPR, DPS, DPT, NStr, OL, PF, TL	DP, Sp	TL = L, ISL, NT: Lowburn Creek, near Cromwell / Mountain valleys of Central Otago / Pisa Ecological District. Accession numbers: L WELT SP041030; ISL AK 5678
Eryngium vesiculosum Labill.	sea holly	Nationally Vulnerable	A (3)				≤ 1 ha		High	High	CI, NR, OL	DP, RR, SO, Sp	
Euchiton paludosus (Petrie) Holub		Data Deficient	A (3)				≤ 1 ha		Low	Low	DPR, DPS, DPT, PF, RR, Sp	Sp	
Euphorbia glauca G.Forst.	shore spurge	Declining	A (3)				≤ 1 ha		High	High	CI, PF, RF, RR	CD	
Ficinia spiralis (A.Rich.) Muasya & de Lange	pīngao	Declining	B (1)			250–1000 mature individuals			High	High	CI, PF, RF, RR	PD, RR	
Gastrodia cooperae Lehnebach & J.R.Rolfe		Nationally Critical	A (3)				≤ 1 ha		Low	Low	DPR, DPS, DPT, NR, OL	DP	
Geranium retrorsum L'Hér. ex DC.		Nationally Vulnerable	A (3)				≤ 1 ha		Low	Medium	DPR, DPS, DPT, NR, Sp	DP, SO	
Geranium sessiliflorum var. *arenarium* G.Simpson & J.S.Thomson		Declining	A (3)				≤ 1 ha		High	High	CI, PF, RR	CD, DP, RR	
Hypericum rubicundulum Heenan		Nationally Endangered	A (3)	Yes			≤ 1 ha		Medium	Medium	DPR, DPS, DPT, NR, NStr, PF, RR, Sp	DP, RR	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Hypolepis amaurorachis (Kunze) Hook.		Naturally Uncommon	A (1)			≤ 250 mature individuals			Low	Low	DPR, DPS, DPT, Rel, Sp	DP, EF, SO, Sp	
Juncus pauciflorus R.Br.		Nationally Vulnerable	A (1)			≤ 250 mature individuals			Low	Low	DPR, DPS, DPT, Sp	DP, SO, Sp	
Lachnagrostis ammobia Edgar		Declining	A (3)				≤ 1 ha		Low	Low	CI, DPR, DPS, DPT, NR, PF, RR	DP, Sp	
Lachnagrostis billardierei (R.Br.) Trin. subsp. billardierei		Not Threatened	A (1)			< 250 mature individuals			Low	Medium	CI, DPR, DPS, DPT, RR, Sp	SO	
Lastreopsis velutina (A.Rich.) Tindale		Not Threatened	A (1)			< 250 mature individuals			Low	High	DPS, DPT, NR, OL		
Lepidium juvencum Heenan & de Lange	scurvy grass	Nationally Critical	A (3)	Yes			≤ 1 ha		Medium	High	DPR, NR, NStr, PF, RR, TL	CD, DP, RR	TL = H, I: Long Beach, Purakanui. Accession numbers: H CHR 609785 B; I CHR 609785 A
Lepidium kirkii Petrie	salt-pan cress	Nationally Critical	A (3)	Yes	Yes		≤ 1 ha		High	High	CD, NStr, PF, RE, RF, RR, TL	CD, EF	RE = found only in Central Otago. TL = H, S, L?: Gimmerburn district, Maniototo Plains / Maniototo plain below Gimmerburn farms. Accession numbers: H W; S AK 4477, WELT SP030096, WELT SP030099; L? WELT SP030098

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Lepidium sisymbrioides Hook.f.	peppercress	Nationally Critical	A (1)	Yes		≤ 250 mature individuals			High	High	NR, NStr, PF, RF, RR, TL	DP	TL = H, S, ISN (putative): Kawerau River, near Gibbston / 2 miles west of Victoria Bridge over Kawarau River / Kawarau River, near Nevis Bluff / Kawarau River, west of Cromwell. Accession numbers: H W; S WELT SP028588, WELT SP028587, WELT SP028592/A, WELT SP028592/B, WELT SP028593; ISN (putative) WELT SP028596, WELT SP028602
Lepidium solandri Kirk	Maniototo peppercress	Nationally Critical	A (1)	Yes		≤ 250 mature individuals			Medium	High	DPT, NR, NStr, PF, RF, RR, TL	RF, Sp	TL = H, S, L: Maniototo Plain / Alexandra South. Accession numbers: H Uni. Zurich; L WELT SP028621; S AK 4488, AK 209545
Leptinella conjuncta Heenan		Nationally Critical	A (3)	Yes			≤ 1 ha		Medium	High	DPR, NR, NStr, PF, RF, RR, TL	Sp	TL = H: Pisa Flat, Clutha/Mata-au River. Accession number: H CHR 592259
Libertia peregrinans Cockayne & Allan		Nationally Vulnerable	A (3)				≤ 1 ha		Low	High	DPT, PF, RR	DP, PD	
Lobelia arenaria (Hook.f.) Heenan & de Lange		Naturally Uncommon	A (3)				≤ 1 ha		Medium	Low	CI, DPS, DPT, PF, RR, Sp	DP	
Luzula decipiens Edgar	wood-rush	Not Threatened	A (1)			< 250 mature individuals			Low	Low	CI, DPR, DPS, DPT, NR, OL		

Continued on next page

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Mazus arenarius Heenan, P.N.Johnson & C.J.Webb		Declining	A (3)				≤ 1 ha		High	High	CI, DPT, NR, PF, RR, TL	DP, RR, Sp	TL = H, I: False Islet, southeast Otago / Tahakopa Ecological District. Accession numbers: H CHR 494723 CHR 494723 B; I AK 229880, MO 102097055, AD 99646366, OTA 061154, CHR 532707, WELT SP080009, K
Mazus novaezeelandiae subsp. *impolitus* Heenan f. impolitus		Nationally Endangered	A (3)	Yes			≤ 1 ha		High	High	NR, NStr, OL, PF	DP, RR	
Muehlenbeckia ephedroides Hook.f.		Nationally Vulnerable	A (1)			≤ 250 mature individuals			High	Medium	DPR, PF, RF, RR	DP, Sp	
Myosotis albosericea Hook.f.		Nationally Critical	A (3)	Yes	Yes		≤ 1 ha		High	High	NS, NStr, OL, RE, St, TL	OL	RE = one known location from Central Otago, southern Dunstan Range. TL = H: Dunstan Gorge on the Clutha/Mata-au River. Accession number: H K?
Myosotis cheesemanii Petrie	Forget-me-not	Nationally Critical	A (3)	Yes			≤ 1 ha		High	Medium	DPR, DPS, DPT, NS, NStr, RR, St, TL	DP, RR, Sp	TL = H, L, ISL, TF: Mount Pisa Range, north of Cromwell. Accession numbers: L WELT SP002696/A; ISL AK 7447, SP002696/B; TF CHR 97407

Continued on next page

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Myosotis glabrescens L.B.Moore	Forget-me-not	Data Deficient	A (3)	Yes	Yes		≤ 1 ha		Low	Medium	DPR, DPS, DPT, NS, NStr, RE, RR, Sp, St, TL		RE = known only from one site and a few gatherings made in the Hector Range, east of Lake Whakatipu. TL = H: Tapuae-o-Uenuku | Hector Mountains, east of Lake Whakatipu. Accession number: H WELT SP004736
Myosotis hikuwai Meudt, Prebble & G.M.Rogers		Nationally Critical	A (3)	Yes	Yes		≤ 1 ha		High	Medium	DPT, EF, NStr, OL, RE, TL	DP, OL	RE = one known location from the Clutha/Mata-au River, near Wānaka. TL = H: Clutha/Mata-au River. Accession number: H WELT SP0108906 Previous Name and Authority: *Myosotis* aff. *glauca* (a) (WELT SP104520; "Mata-Au")
Myosotis oreophila Petrie		Nationally Critical	A (3)	Yes	Yes		≤ 1 ha		High	Medium	DPR, DPS, DPT, NS, NStr, RE, RR, St, TL	EF, St, Sp	RE = known only from Central Otago. Although localised to one or a few known populations, recent research suggests it could now be known from one site only (Stanley, pers. comm, cited in NZPCN website, 2023). TL = H, I: Mount Ida, near Naseby. Accession numbers: H WELT SP002393/A; I WELT SP002393/B
Myosotis spathulata G.Forst.		Naturally Uncommon	A (1)			≤ 250 mature individuals			Low	Low	DPS, DPT, OL	DP, EF, Sp	

Continued on next page

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Myosotis tenericaulis Petrie		Naturally Uncommon	A (3)	Yes			≤ 1 ha		Low	Medium	DPR, DPT, NStr, PF, RR, Sp, TL	DP, Sp	TL = L, ISL: edge of Inch Clutha, near Romahapa, Clutha County / Inch Clutha, about a mile (~1.6 km) from the Romahapa Station on the Catlins River railway line, where the railway crosses the Puerua Stream and enters the alluvial plan of the Inch-Clutha / Tokomairiro Ecological District. Accession numbers: L WELT SP002689/A, WELT SP002689/B; ISL CHR 295327
Myosotis umbrosa Meudt, Prebble & Thorsen		Nationally Critical	A (1)	Yes	Yes	≤ 250 mature individuals			Low	Low	DPR, DPS, DPT, NStr, PF, RE, Sp, TL	DP, RR, Sp	RE = known only from the Rock and Pillar and Lammerlaw Ranges. TL = H: Rock and Pillar Range. Accession number: H WELT SP089905
Olearia hectorii Hook.f.	Hector's tree daisy	Nationally Endangered	C	Yes					High	High	CD, NStr, RF, TL	CD, De, RF	TL = H: Otago Lakes District. Accession number: H K?
Ourisia modesta Diels		Nationally Critical	A (3)	Yes			≤ 1 ha		Low	Medium	DPT, NStr, OL	DP, PD, Sp	
Pentapogon youngii (Hook.f.) de Lange & L.M.H.Schmid		Naturally Uncommon	A (1)			≤ 250 mature individuals			Low	Low	DPR, DPS, DPT, NR, PF, Sp, TL	DP, Sp	Previous Name and Authority: *Deyeuxia youngii* (Hook.f.) Buchanan TL = H, I: Swampy Hill, near Ōtepoti Dunedin / Otago Coast Ecological Region. Accession numbers: H W 29192; I AK 1508. WELT SP069693, WELT SP069694, WELT SP069696,

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Pimelea lyallii Hook.f.		Declining	A (1)			≤ 250 mature individuals			High	High	CI, DPT, PF, RF, RR	CD, DP, RR, Sp	
Pittosporum obcordatum Raoul	heart-leaved kohuhu	Nationally Vulnerable	A (1)			≤ 250 mature individuals			High	High	NR, PF, RF, RR	PD, RF	
Pittosporum patulum Hook.f.	pitpat	Nationally Vulnerable	A (1)			≤ 250 mature individuals			High	High	NR, Sp	CD, PD, RF, Sp	
Puccinellia raroflorens Edgar	saltgrass	Nationally Critical	A (3)	Yes			≤ 1 ha		Medium	High	CD, NR, NStr, PF, RR, TL	CD, DP, RR	TL = H: Alexandra, Conroys Road. Accession number: H CHR 402693
Puccinellia walkeri (Kirk) Allan		Naturally Uncommon	A (3)				≤ 1 ha		Low	Low	CI, DPR, DPS, DPT, PF, RR, Sp	DP, Sp	
Ranunculus brevis Garn.-Jones	aquatic buttercup	Nationally Endangered	A (3)				≤ 1 ha		Low	Low	DPS, NR, NS, RR, St	DP, RR, Sp	
Ranunculus macropus Hook.f.		Data Deficient	A (3)				≤ 1 ha		Low	Medium	CR, DPR, DPS, DPT, PF, RF		
Ranunculus recens Kirk		Nationally Vulnerable	A (3)	Yes			≤ 1 ha		High	High	NStr, PF, RR, Sp, TL	CD, RR, Sp, St	TL = H, S, L: coastal sands near Ōtepoti Dunedin to Fortrose, Otago. Accession numbers: H W; S WELT SP000361/B; L WELT SP000361/A
Raoulia monroi Hook.f.	fan-leaved mat daisy	Nationally Vulnerable	A (3)				≤ 1 ha		High	Medium	CD, DPS, DPT, NR, PF, RR	DP, PD, RR, Sp	
Rytidosperma horrens Connor & Molloy		Nationally Critical	A (3)				≤ 1 ha				DPS, DPT, DPR, NR	RR, St	
Rytidosperma telmaticum Connor & Molloy		Declining	A (3)				≤ 1 ha		Low	Low	DPR, DPS, DPT, NR, RR	DP, RR	
Scleranthus biflorus (J.R.Forst. & G.Forst.) Hook.f.		Not Threatened	A (3)				≤ 1 ha		Medium	High	CI, DPR, NR, OL, PF	SO	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Simplicia felix de Lange, J.R.Rolfe, Smissen & Ogle		Nationally Critical	A (3)				≤ 1 ha		Medium	Medium	DPR, DPS, DPT, NR, OL, PE	DP, RR	
Simplicia laxa Kirk		Nationally Critical	A (1)	Yes		≤ 250 mature individuals			Low	Low	DPS, DPT, NR, NStr, PF, RF, Sp, TL	CD, RR, Sp	TL = L, ISL, ISN: Waikouaiti, Otago / northeast from Waikouaiti, Otago east coast / Waikouaiti, Deep Stream / Rock and Pillar Road [Old Dunstan Road], near Deep Stream Hotel, not far from roadside. Accession numbers: L WELT SP043017, WELT SP043021; ISL AK 1370, AK 1371, AK 1372; ISN WELT SP043019
Solenogyne christensenii (Petrie) de Lange, Jian Wang ter & Barkla, comb. nov.		Nationally Critical	A (3)	Yes	Yes		≤ 1 ha		High	High	NS, NStr, OL, RE	DP, EF	RE = The one location where this taxon was previously found outside Otago is believed to have gone extinct. The remaining known habitat is in the upper Clutha Valley,Otago. Previous Name and Authority: *Abrotanella christensenii* Petrie
Triglochin palustris L.	marsh arrow-grass	Nationally Critical	A (3)	Yes			≤ 1 ha		Medium	Low	DPS, DPT, NR, NStr, RR	DP, RR, SO, Sp	
Trithuria brevistyla (K.A.Ford) de Lange & Mosyakin	hydatella	Nationally Vulnerable	A (3)	Yes			≤ 1 ha		Low	Low	DPR, DPS, DPT, NR, NS, NStr, RR	DP, PD	Previous Name and Authority: *Trithuria* aff. *inconspicua* (CHR 502359; South Island)
Veronica lilliputiana Stearn		Declining	A (3)				≤ 1 ha		Low	High	DPT, RR, Sp	DP	

Continued on next page

Regionally Critical continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
TAXONOMICALLY INDETERMINATE (5)													
Acaena aff. *rorida* (OTA 59561; Pool Burn)	bidibidi	Nationally Critical	A (3)	Yes	Yes		≤ 10 ha	Decline: 10–30%	Medium	Medium	De, DPR, DPS, DPT, NStr, PF, RE, RR, Sp	DP, OL	RE = known Ida Valley and Macraes
Craspedia (gg) (CHR 472168; Mararoa)		Nationally Critical	A (1)	Yes		≤ 250 mature individuals			Medium	Medium	DPS, DPT, DPR, OL, Sp	DP, OL	
Craspedia (y) (CHR 516260; Cape Saunders)		Nationally Critical	A (3)	Yes	Yes		≤ 1 ha		Low	Medium	DPS, DPT, NStr, OL, RE		Recent surveys in 2024 have found *ca.* 250 mature individuals
Leptinella aff. *pectinata* (a) (CHR 580894; Nevis)		Nationally Critical	A (3)	Yes	Yes		≤ 1 ha		Low	High	DPT, NStr, OL, RE	DP, OL	OL = Found in an outcrop of fragmenting finely eroding schist
Melicytus (a) (CHR 355077; Matiri Range)		Nationally Endangered	A (1)			≤ 250 mature individuals			Low	Medium	DPR, DPS, DPT, NR, OL	CD, DP, RF, Sp	OL = Only one plant known in Otago, from the Upper Long Burn, Eyre Mountains. This record from >20 years ago

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural State; NStr = National Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Regionally Endangered (68)

Criteria for Regionally Endangered:

A – small population (natural or unnatural) that has a low to high ongoing or predicted decline
A(1) 250–1000 mature individuals, predicted decline 10–50%
A(2) ≤ 5 subpopulations, ≤ 300 mature individuals in the largest subpopulation, predicted decline 10–50%
A(3) Total area of occupancy ≤ 10 ha (0.1 km^2), predicted decline 10–50%

B – small stable population (unnatural)
B(1) 250–1000 mature individuals, stable population
B(2) ≤ 5 subpopulations, ≤ 300 mature individuals in the largest subpopulation, stable population
B(3) Total area of occupancy ≤ 10 ha (0.1 km^2), stable population

C – moderate population and high ongoing or predicted decline
C(1) 1000–5000 mature individuals, predicted decline 50–70%
C(2) ≤ 15 subpopulations, ≤ 500 mature individuals in the largest subpopulation, predicted decline 50–70%
C(3) Total area of occupancy ≤ 100 ha (1 km^2), predicted decline 50–70%

Table 3.3.2: Regionally Endangered indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY ENDANGERED (68)													
TAXONOMICALLY DETERMINATE (66)													
Acaena microphylla var. *pauciglochidiata* Bitter	bidibidi	Declining	A (3)	Yes			≤ 10 ha	Decline: 10-30%	Low	Low	CI, DPS, DPT, NR, NStr, PF, RR, Sp	DP, RR, Sp	
Acaena pallida (Kirk) Allan	sand bidibid	Declining	B (3)	Yes			≤ 10 ha	Stable: ±10%	Medium	Medium	CI, NStr, PF, RR, St	DP, RR, SO	
Achnatherum petriei (Buchanan) S.W.L.Jacobs & J.Everett		Declining	A (1)	Yes		250–1000 mature individuals		Decline: 10–30%	Low	Low	DPR, DPS, DPT, NR, NStr, RR	DP, EF, Sp	
Anisotome lyallii Hook.f.	Lyall's carrot	Relict	B (3)				≤ 10 ha	Stable: ±10%	Medium	Medium	CI, PF, RR, St	RR	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Endangered continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Atriplex buchananii (Kirk) Cheeseman		Nationally Vulnerable	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NS, PF, RR	DP, RR, Sp	
Bolboschoenus caldwellii (V.J.Cook) Soják	Caldwell's clubrush	Not Threatened	B (3)				≤ 10 ha	Stable: ±10%	Low	Medium	CI, DPS, DPT, NR, RR	SO	
Brachyglottis sciadophila (Raoul) B.Nord.	climbing groundsel	Declining	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Medium	DPT, NR, NStr, PF, Sp	DP	
Cardamine thalassica Heenan	cress	Nationally Endangered	B (1)	Yes		250–1000 mature individuals		Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, RR, Sp, TL	DP	TL = H: Hawkdun Range, Rambling Stream. Accession number: H CHR 619275
Carex applanata Thorsen & de Lange		Naturally Uncommon	B (3)	Yes	Yes		≤ 10 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RE, RR, Sp, St	DP, RR	RE = only known from the Old Woman, Old Man, Umbrella, Garvie, Pisa and The Remarkables Range. TL = H: Central Otago Ecological Region, Old Man Ecological District, Old Woman Range. Accession number: H AK 302066
Carex capillacea Boott	sedge	Nationally Vulnerable	A (3)				≤ 10 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, PF, RR	DP, SO, Sp	
Carex decurtata Cheeseman	sedge	Data Deficient	A (3)	Yes			≤ 10 ha	Decline: 10–30%	High	Medium	DPT, NR, NStr, PF, RR, Sp	Sp	
Carex edgariae Hamlin	Edgar's sedge	Naturally Uncommon	B (3)	Yes			≤ 10 ha	Stable: ±10%	Low	Medium	De, DPR, DPS, DPT, NR, NS, NStr, Sp, St, TL	DP, Sp	TL = H: Nevis Valley, east of Tapuae-o-Uenuku | Hector Mountains. Accession numbers: H WELT SP002007/A and WELT SP002007/B

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Endangered continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Carex *kaloides* Petrie	sedge	Declining	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Low	Medium	DPT, NR, NStr, PD, Sp, TL	DP, Sp	TL = H, L, T: Carrick Range. Accession numbers: H WELT SP002007/B; L WELT SP021726/A; T WELT SP021726/B
Carex litorosa L.H.Bailey	sea sedge	Declining	B (3)	Yes			≤ 10 ha	Stable: ±10%	Medium	Medium	CI, DPS, DPT, NStr, RR	DP, RR	
Carex rubicunda Petrie		Nationally Vulnerable	B (3)	Yes			≤ 10 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RR	DP, EF, RR	
Carex subtilis K.A.Ford	handsome hook sedge	Naturally Uncommon	B (3)	Yes			≤ 10 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, NStr, PF, Sp, TL	DP, SO, Sp	TL = I: Blacks, Ophir, Manuherikia Valley. Accession number: I WELT SP001761
Carex tenuiculmis (Petrie) Heenan & de Lange	red-leaved swamp sedge	Declining	B (3)	Yes			≤ 10 ha	Stable: ±10%	Medium	Medium	DPT, NStr, RR, Sp, TL	DP, Sp	TL = S (possible): Lammerlaw Range. Accession numbers: S (possible) WELT SP021591, WELT SP021592
Carmichaelia kirkii Hook.f.	climbing broom	Nationally Vulnerable	A (1)	Yes		250–1000 mature individuals		Decline: 10–30%	Medium	Medium	DPS, DPT, NR, NStr, PF, RF, Sp, TL	DP, RF	TL = H, S, L, ISL: Cardrona Valley / Otepopo. Accession numbers: H K; L CHR 45771 A; S WELT SP026733; ISL WELT SP026731, WELT SP026732, WELT SP026737, CHR 45771 C, CHR 45771 D, CHR 213042 A, CHR 213042 B, WELT SP079537
Connorochloa tenuis (Buchanan) Barkworth, S.W.L.Jacobs & H.Q.Zhang	Prostrate bluegrass	Data Deficient	A (1)	Yes		250–1000 mature individuals		Decline: 10–30%	Low	Low	DPR, DPS, DPT, NS, PF, Sp		

Continued on next page

Regionally Endangered continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Coprosma acerosa A.Cunn.	sand coprosma	Declining	A (3)				≤ 10 ha	Decline: 10–30%	Medium	Medium	DPT, PF, RF, RR	PD	
Coprosma wallii Petrie in Cheeseman	Wall's coprosma	Declining	A (1)			250–1000 mature individuals		Decline: 10–30%	Medium	High	PF, RF, Sp	CD, RF	
Crassula mataikona A.P.Druce		Naturally Uncommon	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Low	DPR, DPS, DPT, EF, NR, NStr, PF, RR, Sp	DP, Sp	
Deschampsia cespitosa (L.) P.Beauv.	Tufted hair grass	Declining	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Medium	NStr, RR, Sp	DP, PD, SO	
Drosera binata Labill.		Not Threatened	B (3)				≤ 10 ha	Stable: ±10%	Low	Medium	DPS, DPT, RR, Sp	SO	
Epilobium angustum (Cheeseman) P.H.Raven & Engelhorn		Naturally Uncommon	A (3)				≤ 10 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NR, PF, RR, Sp	DP, RR	
Euchiton ensifer (D.G.Drury) Holub		Nationally Endangered	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, NStr, PD, PF, RR, Sp	DP, PD, RR, Sp	
Gentianella lineata (Kirk) T.N.Ho & S.W.Liu		Relict	B (3)	Yes			≤ 10 ha	Stable: ±10%	High	Medium	NStr, RR, Sp, St	PD, RR, Sp	
Gentianella saxosa (G.Forst.) Holub		Naturally Uncommon	B (3)				≤ 10 ha	Stable: ±10%	Medium	Medium	DPS, DPT, PF, RR, Sp, St	DP, RR	
Gingidia enysii (Kirk) J.W.Dawson var. enysii		Nationally Endangered	A (3)				≤ 10 ha	Decline: 10–30%	Medium	Medium	DPT, Sp, NR	DP, RR	
Gratiola concinna Colenso		Nationally Endangered	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Medium	DPS, NStr, PF, RR	CD, DP, PD, RR	
Isolepis basilaris Hook.f.	Pygmy clubrush	Declining	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Medium	DPR, NStr, PF, RR	EF, RR, Sp	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Endangered continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Juncus kraussii subsp. *australiensis* (Buchenau) Snogerup	sea rush	Not Threatened	B (3)				≤ 10 ha	Stable: ±10%	High	Medium	OL, RR, NR	SO	
Korthalsella clavata (Kirk) Cheeseman		Declining	B (3)				≤ 10 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, PF, Sp	DP	
Lagenophora barkeri Kirk		Naturally Uncommon	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NStr, PF, RR, Sp	DP, Sp	
Lepidium crassum Heenan & de Lange	thick-leaved scurvy grass	Nationally Endangered	B (3)	Yes	Yes		≤ 10 ha	Stable: ±10%	High	High	CD, DPR, NStr, PF, RE, RR, TL	CD, DP, EF, RR	RE = Once found in the Waitaki Valley, now only found in Otago, most common on Otago Peninsula, but occurs in small populations from near Kakanui to The Nuggets. TL = H, I: Otago Peninsula, Aramoana, Mole. Accession number: H CHR 609777 A
Lepidothamnus intermedius (Kirk) Quinn		Not Threatened	B (3)				≤ 10 ha	Stable: ±10%	Medium	Low	DPR, DPS, DPT, OL, Sp		
Leptinella maniototo (Petrie) D.G.Lloyd & C.J.Webb		Relict	A (3)				≤ 10 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, PF, RR, TL		TL = H: Maniototo Plains. Accession number: H WELT SP057515
Leptinella pusilla Hook.f.		Declining	A (3)				≤ 10 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, PF, Sp		
Lobelia ionantha Heenan		Declining	A (3)				≤ 10 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, PF, RR, Sp	DP	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Endangered continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Luzula celata Edgar	dwarf wood-rush	Declining	A (3)				≤ 10 ha	Decline: 10–30%	Medium	Medium	CD, DPS, DPT, PF, RR, Sp	DP, RR	
Luzula rufa var. *albicomans* Edgar	wood-rush	Not Threatened	C (3)	Yes			≤ 100 ha	Decline: 50–70%	High	High	NStr, RR		
Luzula traversii var. *tenuis* Edgar	wood-rush	Naturally Uncommon	A (1)	Yes	Yes	250–1000 mature individuals		Decline: 10–30%	Low	Low	DPR, DPS, DPT, NStr, RE, RF, Sp, TL	DP, RR	RE = Central Otago endemic found on rock, from 200–450 m asl. TL = H: Cromwell Gorge. Accession number: H CHR 113666
Melicytus flexuosus Molloy & A.P.Druce		Nationally Vulnerable	B (1)	Yes		250–1000 mature individuals		Stable: ±10%	Medium	Medium	DPR, NStr, PF, RF, RR	CD, RF	
Montia angustifolia Heenan		Naturally Uncommon	B (3)	Yes			≤ 10 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, PF, RR	DP, RR, Sp	
Montigena novae-zelandiae (Hook.f.) Heenan	scree pea	Declining	A (1)			250–1000 mature individuals		Decline: 10–30%	Medium	Medium	DPS, DPT, NR, PF, RR, TL	RF, Sp	TL = L, ISL: Mount Ida, north of Naseby. Accession numbers: L CHR 48114; ISL CHR 48139
Myosotis antarctica subsp. *traillii* Kirk		Declining	A (1)	Yes		250–1000 mature individuals		Decline: 10–30%	High	Medium	CI, DPS, NStr, PF, RR, TL	Sp	TL = H: 3 miles S of Luggate, Central Otago. Accession number: H CHR 75720 Previous Name and Authority: *Myosotis pygmaea* Colenso
Myosotis brevis de Lange & Barkla		Nationally Vulnerable	A (3)	Yes			≤ 10 ha	Decline: 10–30%	High	Medium	EF, NStr, PF, RR, Sp	EF, Sp	
Myosotis glauca (G.Simpson & J.S.Thomson) de Lange & Barkla	Kaimanawa forget-me–not	Nationally Vulnerable	A (3)	Yes			≤ 10 ha	Decline: 10–30%	High	Medium	NR, NStr, PF, Sp, TL	DP, Sp	TL = H, T?: base of Mount Ida. Accession numbers: H: CHR 75722; T? CHR 550036

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Endangered continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Myosotis rakiura L.B.Moore		Naturally Uncommon	A (3)				≤ 10 ha	Decline: 10–30%	Low	High	DPT, NR, PF, RR	RR, Sp	
Myosotis uniflora Hook.f.		Naturally Uncommon	A (3)				≤ 10 ha	Decline: 10–30%	Medium	High	CD, DPT, OL	DP, Sp	
Myosurus minimus subsp. *novae-zelandiae* (W.R.B.Oliv.) Garn.-Jones	New Zealand mousetail	Nationally Vulnerable	A (3)	Yes			≤ 10 ha	Decline: 10–30%	High	High	EF, NR, NStr, PF, RR	DP, EF, RR, Sp	
Oxybasis ambigua (R.Br.) de Lange & Mosyakin	amaranthaceae	Declining	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Medium	CI, DPS, DPT, NStr, PF, RR	DP, PD, SO	Previous Name and Authority: *Oxybasis glauca* subsp. *ambigua* (R.Br.) Mosyakin
Pachycladon cheesemanii Heenan & A.D.Mitch.	dryland cress	Nationally Endangered	C (1)	Yes		1000–5000 mature individuals		Decline: 50–70%	Medium	Low	DPS, NStr, PF, RF	DP, RR, Sp	
Pimelea poppelwellii Petrie		Naturally Uncommon	B (1)	Yes		250–1000 mature individuals		Stable: ±10%	Low	Low	DPS, DPT, NR, NStr, RR, Sp, TL	DP, RR, Sp, TL	TL = S: Symmetry Peaks, Eyre Mountains, near Lake Whakatipu. Accession number: S WELT SP044228
Pimelea pseudolyallii Allan		Naturally Uncommon	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NR, NStr, RR	DP, Sp	
Pimelea sericeovillosa subsp. *pulvinaris* (C.J.Burrows) C.J.Burrows		Nationally Vulnerable	A (3)	Yes			≤ 10 ha	Decline: 30–50%	High	High	NR, NStr, PF, RF, RR, CD	DP	
Ranunculus ternatifolius Kirk		Nationally Vulnerable	B (3)	Yes			≤ 10 ha	Stable: ±10%	Medium	Medium	NStr, PF, RR, TL	DP, Sp	TL = H?, S: Catlins River. Accession numbers: H W?; S WELT SP000335, WELT SP000341, WELT SP000343, WELT SP026422
Ruppia megacarpa R.Mason		Naturally Uncommon	B (3)				≤ 10 ha	Stable: ±10%	Low	Low	CI, DPR, DPS, DPT, PF, RR, Sp, EF	RR, SO	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Endangered continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Rytidosperma thomsonii (Buchanan) Connor & Edgar		Declining	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NR, NStr, PF, Sp, TL	DP	TL = H, I (possible): Mount St. Bathans. Accession numbers: H WELT SP059624; I (possible) WELT SP068111/A, WELT SP068111/B
Senecio dunedinensis Belcher		Nationally Endangered	A (1)	Yes		250–1000 mature individuals		Decline: 10–30%	Low	Low	DPS, DPT, NR, NStr, PF, RF, Sp, TL	DP, EF, Sp	TL = H?, T?: hills near Ōtepoti Dunedin. Accession numbers: H? W; T? WELT SP031853, WELT SP031627
Sonchus kirkii Hamlin	pūhā	Declining	A (1)			250–1000 mature individuals		Decline: 10–30%	Medium	Low	CI, DPS, DPT, PF, RR, Sp		
Tetrachondra hamiltonii Petrie ex Oliv.		Nationally Vulnerable	B (3)	Yes			≤ 10 ha	Stable: ±10%	Low	Medium	DPT, NStr, PD, RR	DP, Sp	
Teucrium parvifolium (Hook.f.) Kattari & Salmaki	native verbena	Declining	A (1)			250–1000 mature individuals		Decline: 10–30%	Medium	Medium	DPS, DPT, NR, PF, RF, Sp	Sp	Previous Name and Authority: *Teucridium parvifolium* Hook.f.
Urtica perconfusa Grosse-Veldmann & Weigend	swamp nettle	Declining	B (3)				≤ 10 ha	Stable: ±10%	Medium	Medium	DPS, DPT, PF, RR, Sp, St	Sp	
Veronica cupressoides Hook.f.	whipcord hebe	Nationally Endangered	C (1)	Yes		1000–5000 mature individuals		Decline: 50-70%	Medium	Medium	NR, NStr, PF, RF	DP, RF	
Wurmbea novae-zelandiae (Hook.f. ex Kirk) Lekhak, Survesw. & S.R.Yadav		Nationally Endangered	A (3)	Yes			≤ 10 ha	Decline: 10–30%	Medium	Low	DPS, NStr, PF, Sp	DP, RR	
TAXONOMICALLY INDETERMINATE (2)													
Coprosma brunnea (Kirk) Cockayne ex Cheeseman	coprosma	Declining	A (1)	Yes		250–1000 mature individuals		Decline: 10–30%	Medium	Medium	DPT, NStr, PF, RF, RR, Sp	DP, Sp	

Continued on next page

Regionally Endangered continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Myosotis saxatilis Petrie		Naturally Uncommon	B (3)	Yes			≤ 10 ha	Stable: ±10%	Low	Low	De, DPS, DPT, NR, NStr, Sp	DP, Sp	Previous Name and Authority: *Myosotis* aff. *australis* (d) (WELT SP02612; "saxatilis Petrie")

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural State; NStr = National Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Regionally Vulnerable (66)

Criteria for Regionally Vulnerable:

A – small, increasing population (unnatural)
A(1) 250–1000 mature individuals, predicted increase > 10%
A(2) ≤ 5 subpopulations, ≤ 300 mature individuals in the largest subpopulation, predicted increase > 10%
A(3) Total area of occupancy ≤ 10 ha (0.1 km^2), predicted increase > 10%

B – moderate, stable population (unnatural)
B(1) 1000–5000 mature individuals, stable population
B(2) ≤ 15 subpopulations, ≤ 500 mature individuals in the largest subpopulation, stable population
B(3) Total area of occupancy ≤ 100 ha (1 km^2), stable population

C – moderate population, with population trend that is declining
C(1) 1000–5000 mature individuals, predicted decline 10–50%
C(2) ≤ 15 subpopulations, ≤ 500 mature individuals in the largest subpopulation, predicted decline 10–50%
C(3) Total area of occupancy ≤ 100 ha (1 km^2), predicted decline 10–50%

D – moderate to large population and moderate to high ongoing or predicted decline
D(1) 5000–20,000 mature individuals, predicted decline 30–70%
D(2) ≤ 15 subpopulations, ≤ 1000 mature individuals in the largest subpopulation, predicted decline 30–70%
D(3) Total area of occupancy ≤ 1000 ha (10 km^2), predicted decline 30–70%

E – large population and high ongoing or predicted decline
E(1) 20,000–100,000 mature individuals, predicted decline 50–70%
E(2) Total area of occupancy ≤ 10,000 ha (100 km^2), predicted decline 50–70%

Table 3.3.3: Regionally Vulnerable indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY VULNERABLE (66)													
TAXONOMICALLY DETERMINATE (63)													
Acaena buchananii Hook.f.	bidibidi	Declining	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	Low	DPS, DPT, NR, NStr, PF, Sp, TL	DP	TL = H, S, S?: Otago Lake District / Tarras and Luggate, Upper Clutha / Mount Ida Valley / Cardrona Mountains. Lake Hāwea, Tarras and Luggate. Accession numbers: H K?, CHR 9358 (as *Acaena buchananii* Hook.f. f. *erubescens* Bitter); S CHR 330983, CHR 330984, WELT SP028922, WELT SP028945; S? WELT SP028925, WELT SP028935

Continued on next page

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Aciphylla subflabellata W.R.B.Oliv.	speargrass	Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Medium	Low	DPS, DPT, NStr, PF, Sp	DP, Sp	
Actinotus novae-zelandiae Petrie	New Zealand flannel flower	Not Threatened	B (3)				≤ 100 ha	Stable: ±10%	High	Medium	DPS, NR, NS, RR	DP	
Alepis flavida (Hook.f.) Tiegh.	yellow mistletoe	Declining	C (1)			1000–5000 mature individuals		Decline: 10–30%	Medium	Low	CD, DPS, PF, Sp	CD	
Althenia bilocularis (Kirk) Cockayne		Nationally Vulnerable	B (3)	Yes			≤ 100 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NStr, TL	EF, RR, SO, Sp	TL = S, T?: Lake Waihola, eastern Otago. Accession numbers: S AK 1255, WELT SP063601, WELT SP063602, WELT SP063603; T? WELT SP060350, WELT SP060351, WELT SP060352, WELT SP060353, WELT SP060354 Previous Name and Authority: *Lepilaena bilocularis* Kirk
Anisotome capillifolia (Cheeseman) Cockayne		Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Low	Low	DPS, DPT, NR, NStr, RR, Sp	DP, PD, RF	
Anisotome cauticola J.W.Dawson		Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Low	Low	DPS, DPT, NR, NStr, PF, RR, Sp, TL	DP, RR, Sp	TL = H: Nevis Valley. Accession numbers: WELT SP00515/A, WELT SP005155/B
Anisotome pilifera (Hook.f.) Cockayne & Laing		Declining	D (3)				≤ 1000 ha	Decline: 30–50%	Low	Low	DPS, DPT, Sp	DP, PD	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Anthosachne aprica (Á.Löve & Connor) C.Yen & J.L.Yang	blue wheat grass	Naturally Uncommon	C (3)	Yes	Yes		≤ 100 ha	Decline: 10–30%	Low	Medium	DPR, DPS, DPT, NStr, PF, RE, Sp, TL	DP, Sp	RE = known only from Central Otago. TL = H: Hillside to west of Roxburgh. Accession numbers: H CHR 370822
Asplenium subglandulosum (Hook. & Grev.) Salvo, Prada & T.E.Diaz		Naturally Uncommon	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	Low	DPS, DPT, NR, NStr, PF, RR, Sp	DP, SO, Sp	
Astelia petriei Cockayne		Not Threatened	C (1)			1000–5000 mature individuals		Decline: 10–30%	Low	Low	DPS, DPT, Sp		
Australina pusilla (Poir.) Gaudich. subsp. pusilla		Not Threatened	B (3)				≤ 100 ha	Stable: ±10%	Medium	Medium	DPS, DPT, Sp	SO	
Azorella nitens Petrie		Not Threatened	C (3)				≤ 100 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, RR		
Carex appressa R.Br.	southern cutty grass	Not Threatened	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NStr, RR	SO	
Carex buchananii Berggr.	Buchanan's sedge	Declining	B (3)	Yes			≤ 100 ha	Stable: ±10%	Low	Medium	DPS, DPT, NStr, Sp	DP	
Carex maorica Hamlin	Māori sedge	Not Threatened	C (3)				≤ 100 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, RR, Sp		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Carex talbotii Kottaim	Berggren's sedge, Talbot's sedge	Declining	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Low	Medium	DPS, DPT, NStr, RR, TL	PD, Sp	TL = L, ISL, ISL (possible), T?: Mount Pisa / summit of Mount Pisa / Top of Mount Pisa Range, north from Cromwell. Accession numbers: L WELT SP011974; ISL WELT SP011952, ISL (possible): WELT SP011978/A, WELT SP011949; ISL? AK199699, AK 2693; T? WELT SP011978/B Previous Name and Authority: *Carex berggrenii* Petrie
Carmichaelia crassicaulis subsp. *racemosa* (Kirk) Heenan	slender coral broom	Nationally Vulnerable	C (1)	Yes		1000–5000 mature individuals		Decline: 30–50%	High	Medium	DPR, DPS, NR, NStr, PF, RF, Sp, TL	DP, RF	TL = H: near the Lindis Pass / Lindis Pass. Accession numbers: WELT SP084571; ISL AK 4815
Chaerophyllum novae-zelandiae K.F.Chung	apiaceae	Not Threatened	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, NR, NStr, Sp		
Chiloglottis valida D.L.Jones	bird orchid	Vagrant	A (3)				≤ 10 ha	Increasing : >10%	Low	Medium	DPT, OL	SO	
Chionochloa ovata (Buchanan) Zotov	Fiordland snow tussock	Declining	C (1)			1000–5000 mature individuals		Decline: 30–50%	Low	Low	DPR, DPS, DPT, NR, Sp	CD, DP, RR, Sp	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Clematis afoliata Buchanan	leafless clematis	Not Threatened	C (3)				≤ 100 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NR, Sp	DP	
Colobanthus brevisepalus Kirk	pin cushion	Declining	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	Low	CD, DPS, NR, NStr, PF, RR, TL	DP, Sp	TL = H, S: Bald Hill flat near Alexandra, Clutha/Mata-au River, Gorge Creek / Old Man Ecological District. Accession numbers: H W?: S AK 4075, WELT SP050959
Coprosma intertexta G.Simpson	coprosma	Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Medium	Low	DPS, DPT, NR, NStr, PF, RF, Sp, TL	DP, Sp	TL = S, T?: Swinburne Valley, near Kyeburn / Central Otago Ecological Region. Accession numbers: S AK 22885, AK 211649; T? = CHR 63000 A, CHR 63000 B, CHR 550909

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Coprosma virescens Petrie	coprosma	Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Medium	Medium	DPT, NR, NStr, PF, Sp, TL	DP, RF	TL = H, S, S?: near Ōtepoti Dunedin / Dunedin Ecological District. Accession numbers: H W?; S SP048838/A, SP048838/B; S? AK 8933, AK 8934, AK 8935, AK 8936, AK 8937, AK 211964
Drymoanthus flavus St George & Molloy		Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Low	Low	DPS, DPT, NStr, Sp, TL	DP, Sp	TL = H, I: Tahakopa Bay Scenic Reserve. Accession numbers: H CHR 482355; I WELT SP080019, K 000891455
Eleocharis sphacelata R.Br.	tall spike sedge	Not Threatened	B (3)				≤ 100 ha	Stable: ±10%	Low	Low	DPS, DPT, OL	SO	
Epilobium chionanthum Hausskn.	marsh willowherb	Not Threatened	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	Low	DPR, DPS, DPT, NStr, RR, Sp	DP	
Epilobium insulare Hausskn.		Declining	C (3)				≤ 100 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NR, RR, Sp, TL	DP, RR, Sp	TL = L: Town Belt, Ōtepoti Dunedin. Accession numbers: WELT SP042073
Epilobium rostratum Cheeseman		Not Threatened	C (3)				≤ 100 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, NR, RR, Sp		
Euchiton delicatus (D.G.Drury) Holub		Not Threatened	B (3)				≤ 100 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, RR, Sp	SO	

Continued on next page

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Euchiton polylepis (D.G.Drury) Breitw. & J.M.Ward		Naturally Uncommon	C (3)				≤ 100 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, PF, Sp	DP, PD, Sp	
Helichrysum simpsonii subsp. *tumidum* (Cheeseman) de Lange & Blanchon		Nationally Vulnerable	B (3)	Yes	Yes		≤ 10 ha	Stable: ±10%	High	High	NStr, RE, RR, TL	DP, RR	RE = known from near Cape Saunders. TL = L, ISL: near Cape Saunders. Accession numbers: L WELT SP058412; ISL WELT SP058411, WELT SP058413 Previous Name and Authority: *Helichrysum* aff. *intermedium* (c) (*Helichrysum selago* var. *tumidum* Cheeseman; WELT SP058412)
Juncus pusillus Buchenau	dwarf rush	Naturally Uncommon	C (3)				≤ 100 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, PF, RR, Sp	DP, SO, Sp	
Lachnagrostis filiformis (G.Forst.) Trin.		Not Threatened	B (1)			1000–5000 mature individuals		Stable: ±10%	Low	Low	DPR, DPS, DPT, EF	SO	
Lachnagrostis striata (Colenso) Zotov		Not Threatened	C (3)				≤ 100 ha	Decline: 10–30%	Medium	Low	DPR, DPS, DPT, RR		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Lachnagrostis tenuis (Cheeseman) Edgar		Nationally Vulnerable	B (3)	Yes			≤ 100 ha	Stable: ±10%	Medium	Medium	CI, DPR, DPS, DPT, NStr, RR, St, TL	RR	TL = H, I: Catlins River. Accession numbers: H WELT SP077014/A; I WELT SP077014/B
Lepidium tenuicaule Kirk	shore cress	Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 30–50%	High	High	CI, NR, NStr, PF, RR, TL	DP, RR	TL = H, S?, S (possible); L, T?: Cape Wanbrow, near Ōamaru / Ōamaru Ecological District. Accession numbers: H W?; S? AK 4482, AK 4483; S (possible) WELT SP030071; L WELT SP030070; T? WELT SP030069
Linum monogynum G.Forst. var. monogynum		Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Medium	Medium	CI, DPS, DPT, NStr, PF, RR	DP	
Lobelia perpusilla Hook.f.		Not Threatened	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	High	DPS, DPT, NStr, RR	Sp	
Luzula ulophylla (Buchenau) Cockayne & Laing	wood–rush	Declining	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Low	Medium	DPS, DPT, NR, NStr, PF, Sp	DP	
Microlaena polynoda (Hook.f.) Hook.f.		Not Threatened	B (3)				≤ 100 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, Sp		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Olearia fimbriata Heads		Nationally Vulnerable	B (1)	Yes		1000–5000 mature individuals		Stable: ±10%	Medium	Medium	NR, NStr, PD, PF, TL	PD, RF	TL = H, I: Devil's Gorge, Pomahaka River, Umbrella Ecological District. Accession numbers: H OTA 043292; I OTA 043293, OTA 043295, OTA 043296
Olearia laxiflora Kirk		Not Threatened	B (3)	Yes			≤ 100 ha	Stable: ±10%	Medium	High	DPT, NStr, RF, RR		
Peraxilla tetrapetala (L.f.) Tiegh.	red mistletoe	Declining	C (1)			1000–5000 mature individuals		Decline: 10–30%	Medium	Medium	CD, DPS, DPT, PD, Sp	CD	
Pimelea aridula Cheeseman subsp. *aridula*		Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 30–50%	Medium	Low	DPS, NR, NStr, PF, RF, Sp, TL	RR, Sp	TL = I, L: Clyde Hospital Grounds / Old Man Ecological District. Accession numbers: I CHR 6344; L AK 101181
Pseudopanax ferox Kirk		Naturally Uncommon	B (1)	Yes		1000–5000 mature individuals		Stable: ±10%	Medium	High	NR, NStr, PF, Sp, TL	PD, Sp	TL = H: "valley of the Poulter, near the junction of the Matukituki"? Accession numbers: H W?
Pterostylis tanypoda D.L.Jones, Molloy & M.A.Clem.		Declining	C (3)				≤ 100 ha	Decline: 10–30%	Medium	Low	DPS, DPT, NR, PF, Sp	DP, EF, Sp	
Pterostylis tristis Colenso		Declining	C (3)				≤ 100 ha	Decline: 10–30%	Medium	Low	DPS, DPT, PF, Sp	DP, EF, Sp	

Continued on next page

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Ranunculus acraeus Heenan & P.J.Lockh.		Nationally Endangered	C (1)			1000–5000 mature individuals		Decline: 10–30%	Medium	Low	De, DPS, DPT, NR, RF, RR, Sp	DP, RF	
Ranunculus buchananii Hook.f.		Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Medium	Medium	DPS, DPT, NR, NStr, RR, Sp, TL	DP, RR	TL = H, I: Bold Peak, Humboldt Mountains / Otago Lakes District. Accession numbers: H CHR 5338 A; I CHR 5338 B
Ranunculus royi G.Simpson		Data Deficient	B (3)	Yes			≤ 100 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NStr, RR, Sp, TL		TL = H: Mount Roy, near Lake Wānaka. Accession number: H CHR 75712
Raoulia beauverdii Cockayne		Declining	D (3)	Yes			≤ 1000 ha	Decline: 30–50%	Medium	Medium	DPS, DPT, NR, NStr, PF, RR, Sp	DP, Sp	
Raoulia parkii Buchanan	celadon mat daisy	Declining	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	Low	DPS, DPT, NR, NStr, RR, Sp, TL		TL = H: Mount Alta range. Accession number: H OM?
Rytidosperma maculatum (Zotov) Connor & Edgar		Data Deficient	D (3)	Yes			≤ 1000 ha	Decline: 30–50%	Low	Low	CD, DPR, DPS, DPT, NR, NStr, PD, PF, RR, Sp, TL		TL = H: Gallaway, Central Otago. Accession number: H CHR 3660
Rytidosperma merum Connor & Edgar		Declining	C (3)	Yes			≤ 100 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, NR, NStr, PF, RR	DP, Sp	
Schizacme novae-zelandiae (Hook.f.) K.L.Gibbons		Not Threatened	B (3)				≤ 100 ha	Stable: ±10%	Medium	Low	OL, RR, NS, DPS		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Senecio carnosulus (Kirk) C.J.Webb		Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 10–30%	Medium	Medium	CI, DPR, DPS, DPT, EF, NStr, PF, RR, Sp, TL	DP, EF, Sp	TL = ISN: Cultivated ex Ōtepoti Dunedin, Black Head. Accession number: ISN AK 264208
Stenostachys laevis (Petrie) Connor	grassland wheatgrass	Naturally Uncommon	B (3)	Yes			≤ 100 ha	Stable: ±10%	Low	Low	CI, DPR, DPS, DPT, NStr, RR, Sp, TL	DP, Sp	TL = L, S: Matukituki Valley, west of Lake Wānaka / Wānaka Ecological District. Accession numbers: L WELT SP068353; ISL AK 2038, AK 223528, AK 223527
Stuckenia pectinata (L.) Börner	fennel-leaved pondweed	Naturally Uncommon	C (3)				≤ 100 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NR, OL, RR	SO, Sp	
Tupeia antarctica (G.Forst.) Cham. & Schltdl.	white mistletoe	Declining	C (1)	Yes		1000–5000 mature individuals		Decline: 30–50%	Medium	Medium	DPS, DPT, NR, NStr, PF, Sp	PD	
Veronica annulata (Petrie) Cockayne ex Cheeseman		Naturally Uncommon	B (2)	Yes		subpopulations ≤ 15, ≤ 500 mature individuals in largest subpopulation		Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, NStr, PF, Sp, St	RR, St, Sp	
Veronica dilatata (G.Simpson & J.S.Thomson) Garn.-Jones		Naturally Uncommon	C (2)	Yes		subpopulations ≤ 15, ≤ 500 mature individuals in largest subpopulation		Decline: 10–30%	Low	Low	DPR, DPS, DPT, NR, NStr, PF, Sp	Sp	

Continued on next page

Regionally Vulnerable continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
TAXONOMICALLY INDETERMINATE (3)													
Dracophyllum uniflorum var. *frondosum* G.Simpson	sprawling inaka	Naturally Uncommon	B (1)	Yes		1000–5000 mature individuals		Stable: ±10%	Low	Low	DPS, DPT, NR, NS, NStr, Sp, St, TL	DP, Sp	TL = H, I: Deep Stream, Otago / Deep Stream, Lammermoor Range to Taiari/Taieri River; Deep Stream, Ōtepoti Dunedin - Middlemarch Road, near bridge. Accession numbers: H CHR 47407 A, CHR 47407 B; I WELT SP033375
Pimelea carnosa C.J.Burrows		Not Threatened	C (3)				≤ 100 ha	Decline: 10–30%	Medium	Medium	CI, DPR, DPS, DPT, NR, RR, Sp		
Sonchus aff. *novae-zelandiae* (a) (CHR 517718; "grassland")		Nationally Vulnerable	B (3)	Yes			≤ 100 ha	Stable: ±10%	Low	Low	DPS, DPT, NStr, Sp	DP, Sp	Previous Name and Authority: *Sonchus novae-zelandiae* (Hook.f.) Garn.-Jones

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural State; NStr = National Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

.

Regionally At Risk (275)

Taxa that meet the criteria specified by Townsend et al. (2008) and Michel (2021) for the statuses Regionally Declining, Regionally Recovering, Regionally Relict or Regionally Naturally Uncommon.

Regionally Declining (50)

Criteria for Regionally Declining:

A – moderate to large population and low ongoing or forecast decline of 10–30%
A(1) 5000–20,000 mature individuals
A(2) Total area of occupancy ≤ 1000 ha (10 km^2)

B – large population and low to moderate ongoing or forecast decline of 10–50%
B(1) 20,000–100,000 mature individuals
B(2) Total area of occupancy ≤ 10,000 ha (100 km^2)

C – very large population and low to high ongoing or forecast decline of 10–70%
C(1) > 100 000 mature individuals
C(2) Total area of occupancy > 10,000 ha (100 km^2)

Table 3.4.1: Regionally Declining indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY DECLINING (50)													
TAXONOMICALLY DETERMINATE (49)													
Acaena caesiiglauca (Bitter) Bergmans	glaucus bidibid	Not Threatened	C (2)	Yes			> 10000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NStr		
Acaena inermis Hook.f.	blue mountain bidibid	Not Threatened	C (2)	Yes			> 10000 ha	Decline: 10–30%	Medium	Low	DPS, DPT, NStr, RR		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Aciphylla lecomtei J.W.Dawson		Declining	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Medium	DPS, DPT, NR, NStr, Sp, TL	DP, RR, Sp	TL = H, I: Tapuae-o-Uenuku | Hector Mountains. Accession numbers: H WELT SP065502; I WELT SP065503
Agrostis muscosa Kirk	pincushion grass	Not Threatened	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Medium	Medium	CI, DPS, DPT, NStr, PF, Sp, TL		TL = L, ISL: Lake Wānaka. Accession numbers: L WELT SP069300; ISL WELT SP06925
Anisotome brevistylis (Hook.f.) Poppelw.	native carrot	Not Threatened	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NR, NStr, RR, Sp, TL		TL = H: Otago Lakes District. Accession number: H K?
Anthosachne falcis (Connor) Barkworth & S.W.L.Jacobs	grass	Declining	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, NR, NStr, Sp	DP, Sp	
Carex colensoi Boott	Colenso's sedge	Not Threatened	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NStr, Sp		
Carex dipsacea Berggr.	teasel sedge	Not Threatened	A (2)				≤ 1000 ha	Decline: 10–30%	Low	Low	DPS, DPT, RR, Sp		
Carex fretalis Hamlin	curly sedge	Declining	A (2)				≤ 1000 ha	Decline: 10–30%	Medium	High	DPR, NR	DP, Sp	
Carex muelleri Petrie	Mueller's sedge	Not Threatened	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	High	Medium	DPS, NR, NStr, Sp, TL		TL = L, ISL, T?: Nevis Valley, east of Tapuae-o-Uenuku | Hector Mountains. Accession numbers: L WELT SP021679/A; ISL WELT SP021679/B; T? WELT SP021679/C

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Carex resectans Cheeseman	desert sedge	Not Threatened	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, NR, N NStr Str, Sp		
Carmichaelia compacta Petrie	Cromwell broom	Naturally Uncommon	A (2)	Yes	Yes		≤ 1000 ha	Decline: 10–30%	High	High	NStr, PD, PF, RE, RF, RR, TL	RR	RE = known only from Central Otago, centred on the Kawarau and Cromwell Gorges and immediate surrounding area, also near Alexandra, Omakau, and Cromwell. TL = H, L, ISL: Dunstan Gorge / Clyde / Rock and sandstone faces, near Alexandra / Old Man Ecological District. Accession numbers: H W?; L CHR 45904 B, WELT SP053661; ISL AK 4929, AK 211346, WELT SP026306
Carmichaelia crassicaulis Hook.f. subsp. *crassicaulis*	coral broom	Declining	B (1)	Yes		20000–100000 mature individuals		Decline: 30–50%	Medium	Medium	NR, NStr, PF, RF, TL	RF	

Continued on next page

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Carmichaelia petriei Kirk	desert broom	Declining	B (1)	Yes		20000–100000 mature individuals		Decline: 10–30%	Medium	Medium	NStr, RF, TL	DP, RF	TL = H, L, ISL: Dunstan Gorge / between Dansy's Pass and Livingstone / Cromwell Gorge / flats at the Matukituki River, Wānaka, near the forks to East and West / Central Otago Ecological Region. Accession numbers: H W?; L CHR 45748 A, CHR 45809 C, CHR 213070; ISL AK 4873, AK 209787, CHR 45809 B
Carmichaelia vexillata Heenan	dwarf broom	Declining	B (1)	Yes		20000–100000 mature individuals		Decline: 10–30%	High	Medium	NR, NStr, RF, Sp	DP, RF	
Chenopodium allanii Aellen		Naturally Uncommon	A (1)	Yes		5000–20000 mature individuals		Decline: 10–30%	Medium	Low	DPS, DPT, NR, NStr, PF, Sp, TL	DP, Sp	TL = L: Lammermoor Mountains. Accession number: L CHR 1064
Chionochloa rigida (Raoul) Zotov subsp. *rigida*	narrow-leaved snow tussock	Not Threatened	C (2)	Yes			> 10000 ha	Decline: 10–30%	Medium	Medium	NStr, TL		TL = L: Otago Lakes District. Accession number: L W?
Colobanthus strictus Cheeseman	colobanthus	Not Threatened	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Low	Medium	DPR, DPS, DPT, NStr, Sp		
Dolichoglottis scorzoneroides (Hook.f.) B.Nord.		Not Threatened	C (2)	Yes			> 10000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NStr, Sp	DP	

Continued on next page

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Epilobium elegans Petrie		Data Deficient	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NStr, Sp		
Epilobium hectorii Hausskn.		Not Threatened	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NR, NStr, RR, Sp, TL		TL = H: Lindis Pass, Otago. Accession number: H CHR 76098
Festuca matthewsii subsp. *latifundii* Connor		Not Threatened	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Low	Medium	DPR, DPS, DPT, NR, NStr, TL		TL = H: Mount Longslip, Lindis Pass. Accession number: H CHR 98244
Gingidia amphistoma Heenan		Not Threatened	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Medium	Low	DPS, DPT, NR		Previous Name and Authority: *Gingidia* aff. *montana* (c) (CHR 505502; Mt Cook)
Gingidia baxterae (J.W.Dawson) C.J.Webb		Naturally Uncommon	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Low	DPS, DPT, NR, NStr, PF, Sp, TL	DP, Sp	TL = H: Rock and Pillar Range. Accession number: H OTA 004685
Gingidia grisea Heenan		Naturally Uncommon	B (2)	Yes	Yes		≤ 10000 ha	Decline: 10–30%	Medium	Low	DPS, DPT, NStr, PF, RE, RR, TL	DP, RR	TL = H, I: Trotters Gorge Scenic Reserve / Waianakarua Ecological District. Accession numbers: H CHR 565624; I AK 288114
Gingidia montana (J.R.Forst. & G.Forst.) J.W.Dawson		Not Threatened	C (2)	Yes			> 10000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NStr, Sp	DP	
Juncus distegus Edgar		Naturally Uncommon	A (1)	Yes		5000–20000 mature individuals		Decline: 10–30%	Low	Medium	DPR, DPS, DPT, NR, NStr, PF, RR, Sp	DP, Sp	

Continued on next page

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Leptinella serrulata (D.G.Lloyd) D.G.Lloyd & C.J.Webb	dryland button daisy	Declining	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	High	Medium	DPR, DPS, NStr, PF, Sp	DP, Sp	
Mentha cunninghamii Benth.		Declining	A (2)				≤ 1000 ha	Decline: 10–30%	Low	Low	DPS, DPT, PD, PF, Sp	PD	
Microlaena stipoides (Labill.) R.Br.		Not Threatened	A (2)				≤ 1000 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, Sp	SO	
Myosotis macrantha (Hook.f.) Benth. & Hook.f.		Not Threatened	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	High	Medium	DPS, NStr, Sp, TL		TL = H, T?: Mount Pollux, head of Wilkin River, Lake Wānaka, Arawata Ecological District. Accession numbers: H CHR 75723; T? CHR 549662
Gratiola sexdentata R.Cunn. ex A.Cunn.		Not Threatened	A (2)				≤ 1000 ha	Decline: 10–30%	Medium	Medium	DPR, DPS, DPT, RR, Sp		

Continued on next page

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Olearia fragrantissima Petrie		Declining	A (1)	Yes		5000–20000 mature individuals		Decline: 10–30%	Medium	High	DPT, NR, NStr, PD, PF, Sp, TL	PD	TL = S?, S (possible): near Ōtepoti Dunedin / Tomahawk, near Ōtepoti Dunedin / Vauxhall, near Ōtepoti Dunedin, Catlins River / Otago Coast Ecological Region. Accession number: S? AK 9627; S (possible) WELT SP032533, WELT SP032529, WELT SP032535, WELT SP032528, WELT SP032534, WELT SP032516/A, WELT SP032516/B, WELT SP032516/C
Olearia lineata (Kirk) Cockayne		Declining	A (1)	Yes		5000–20000 mature individuals		Decline: 10–30%	Medium	High	NStr, PD, PF, RF, Sp	RF	
Pachycladon wallii (Carse) Heenan & A.D.Mitch.		Declining	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NR, NStr, RR, Sp, TL	DP, RR, Sp	TL = H, I: Bold Peak and Mount Bonpland / Cecil Peaks, Lake Wakitipu. Accession numbers: H CHR 331403, CHR 329555; I CHR 329556
Peraxilla colensoi (Hook.f.) Tiegh.	scarlet mistletoe	Declining	A (1)			5000–20000 mature individuals		Decline: 10–30%	Medium	Medium	CD, DPS, DPT, NR, PD, SP	CD	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Plantago spathulata Hook.f.		Not Threatened	A (2)				≤ 1000 ha	Decline: 10–30%	Medium	Low	DPR, DPS, DPT, NR, Sp	DP	
Poa lindsayi Hook.f.		Not Threatened	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	High	Medium	DPR, DPS, NStr, Sp, TL		TL = L: northern slopes of Saddle Hill, near Ōtepoti Dunedin. Accession number: L K?
Poa maniototo Petrie		Not Threatened	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NR, NStr, Sp, TL		TL = L, ISL (possible), S: Maniototo Plain, Upper Clutha, Otago / Mount Cardrona / Maniototo Plains / Maniototo Ecological District. Accession numbers: L AK 1940; S WELT SP066146; ISL (possible) WELT SP066145, WELT SP07607
Puccinellia stricta (Hook.f.) C.H.Blom		Not Threatened	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Medium	CI, DPR, DPS, DPT, NStr, PF, RR, TL	SO	TL = I, TF: Ōamuru / Ōamaru Ecological District. Accession numbers: I SP068569; TF CHR 42730
Ranunculus lyallii Hook.f.		Not Threatened	C (2)	Yes			> 10000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NStr		
Ranunculus pilifera (F.J.F.Fisher) Heenan & P.J.Lockh.		Declining	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Medium	DPS, DPT, NR, NStr, RF, RR. TL	DP, RR, RF	TL = L: head of Hut Creek, branch of Lochy River, Eyre Mountains, Rough Peaks Range. Accession numbers: L CHR 158126 C

Continued on next page

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Rumex neglectus Kirk		Not Threatened	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Medium	CI, DPS, DPT, NStr, PF, RR, Sp		
Rytidosperma buchananii (Hook.f.) Connor & Edgar		Declining	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Low	DPR, DPS, DPT, NStr, PF, Sp, TL	DP	TL = H: Otago. Accession number: H K?
Rytidosperma pumilum (Kirk) Connor & Edgar		Not Threatened	C (2)	Yes			> 10000 ha	Decline: 10–30%	Low	Medium	DPR, DPS, DPT, NR, NStr, Sp, TL	SO	TL = L, ISL, TF: Macraes, Otago / Macraes, Waihemo County, northeast Otago. Accession numbers: L WELT SP039891; ISL CHR 4152, WELT SP039871, WELT SP039907; TF CHR 236573
Senecio matatini subsp. *basinudus* Ornduff		Naturally Uncommon	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Medium	Medium	CI, DPS, DPT, NStr, PF, RR, Sp	DP, RR	Previous name: *Senecio glaucophyllus* subsp. *basinudus* Ornduff
Urtica aspera Petrie	nettle	Naturally Uncommon	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Low	DPS, DPT, NR, NStr, PF, Sp, TL	Sp	TL = H, S, S?: Firewood Creek, Dunstan Range near Cromwell / Maniototo Ecological District / Central Otago Ecological Region. Accession numbers: H W?; S WELT SP017831, WELT SP017838; S? AK 210752, AK 210751, AK 3784, AK 3785

Continued on next page

Regionally Declining continued

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Veronica pimeleoides Hook.f. subsp. *pimeleoides*		Not Threatened	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Low	Low	DPS, DPT, NR, NStr, RR, Sp		
Veronica pimeleoides subsp. *faucicola* (Kellow & Bayly) Garn.-Jones		Naturally Uncommon	A (2)	Yes			≤ 1000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NR, NStr, PF, RR, Sp, TL	RR, Sp	Distributional notes: Mostly found in central Otago in the Manuherikia, Kawarau and Clutha River valleys. Not considered a RE as may be more widespread. TL = H: lookout point *ca.* 300 m northeast of dam wall, near Clyde Accession number: H WELT SP082445
TAXONOMICALLY INDETERMINATE (1)													
Raoulia australis Hook.f. ex Raoul		Declining	B (2)	Yes			≤ 10000 ha	Decline: 10–30%	Medium	Medium	DPS, DPT, NR, NStr	DP	

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural state; NStr = Natural Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Regionally Naturally Uncommon (225)

Criteria for Regionally Naturally Uncommon:

Taxa whose distribution is confined to a specific geographical area or which occur within naturally small and widely scattered populations, where this distribution is not the result of human disturbance.

Table 3.4.2: Regionally Naturally Uncommon indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY NATURALLY UNCOMMON (225)												
TAXONOMICALLY DETERMINATE (218)												
Abrotanella linearis Berggr.		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, Sp		
Abrotanella patearoa Heads		Naturally Uncommon	Yes	Yes	250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, RE, Sp, St, TL	DP, Sp	RE = known only from Eastern and Central Otago: Rock and Pillar Range, Lammerlaw Top, Umbrella Mountains, Garvie Mountain TL = H: Rock and Pillar Range. Accession number: H OTA 023132
Acaena dumicola B.H.Macmill.	bidibidi	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, Sp		
Acaena glabra Buchanan	bidibidi	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, NS, Sp		
Acaena tesca B.H.Macmill.	bidibidi	Not Threatened	Yes	Yes		< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, RE, Sp, TL		TL = H, I: Kopuwai | Old Man Range. Accession numbers: H CHR 391420; I OTA 046286, WELT SP078896
Aciphylla divisa (Cheeseman) Cheeseman		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, NS, NStr, Sp	DP	
Aciphylla dobsonii Hook.f.		Not Threatened			250–20000 mature individuals		Stable: ±10%	Medium	Low	DPS, DPT, NR, NS, RR	DP	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Aciphylla hectorii Buchanan		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp, TL	DP	TL = S? or IS?: Hector Col, Mount Aspiring Range / St. Mary Ecological District / Nokomai Ecological District / Garvie Mountains. Accession numbers: S? or IS AK 6525
Aciphylla horrida W.R.B.Oliv.	speargrass	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, Sp		
Aciphylla kirkii Buchanan		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp, TL	DP	TL = H, S, type (possible), T?: Mount Alta / Wānaka Ecological District. Accession numbers: H OM?; S AK 6541; type (possible) WELT SP011641, WELT SP013819; T? WELT SP011640
Aciphylla lyallii Hook.f.		Not Threatened			250–20000 mature individuals		Stable: ±10%	High	Low	DPS, NR, NS, Sp	DP	
Aciphylla montana Armstr. var. *montana*		Not Threatened	Yes		250–20000 mature individuals		Stable: ±10%	Medium	Low	DPR, DPS, DPT, NR, NS, NStr, Sp	DP	
Aciphylla montana var. *gracilis* (W.R.B.Oliv.) J.W.Dawson		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, Sp, St, RR	DP, RR	
Aciphylla pinnatifida Petrie		Not Threatened	Yes			< 100000 ha	Stable: ±10%	High	Medium	NR, NS, NStr, RR	DP	
Aciphylla scott-thomsonii Cockayne & Allan	giant speargrass	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, Sp, TL		TL = H, T?: Mount Maungatua, near Ōtepoti Dunedin. Accession numbers: H CHR 11226, CHR 11227; T? CHR 521532
Aciphylla simplex Petrie		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	DP, RR, Sp	TL = H, S, L: Mount Cardrona, Lake County / Lakes Ecological District. Accession numbers: H W?; S AK 6543; L WELT SP002123/A, WELT SP002123/B
Aciphylla spedenii Cheeseman		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	RR	TL = S: Cecil Peak, near Lake Whakatipu / Eyres Ecological District. Accession numbers: S AK 6538, AK 6536, AK 6537

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Agrostis dyeri Petrie		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, Sp		
Agrostis pallescens Cheeseman		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, NStr, RR, St		
Anaphalioides hookeri (Allan) Anderb.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, RR, Sp		
Anemonastrum tenuicaule (Cheeseman) de Lange et Mosyakin	New Zealand anemone	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, Sp	DP, Sp	Previous Name and Authority: *Anemone tenuicaulis* (Cheeseman) Parkin & Sledge
Anisotome lanuginosa (Kirk) J.W.Dawson		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr NS, NS, RR, Sp, St, TL	DP, Sp	TL = H or L, S or ISN, L: Tapuae-o-Uenuku | Hector Mountains or Kopuwai | Old Man Range & Tapuae-o-Uenuku | Hector Mountains. Accession numbers: H or L WELT SP001166; S or ISN AK 6676
Argyrotegium mackayi (Buchanan) J.M.Ward & Breitw.	matt daisy	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPR, DPS, DPT, NStr, RR		
Asplenium bulbiferum G.Forst.	hen and chicken fern	Not Threatened			250–20000 mature individuals		Stable: ±10%	Low	Low	DPR, DPS, DPT, Sp		
Asplenium obtusatum G.Forst.	shore spleenwort	Not Threatened	Yes			< 100000 ha	Stable: ±10%	High	High	NStr, RR, Sp	SO	
Asplenium polyodon G.Forst.	sickle spleenwort	Not Threatened			250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPS, DPT, Sp	SO	
Astelia linearis var. *novae-zelandiae* Skottsb.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NS, RR		
Austroblechnum durum (T.Moore) Gasper et V.A.O.Dittrich		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, RR		Previous Name and Authority: *Blechnum durum* (T.Moore) C.Chr.

Continued on next page

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Austroblechnum membranaceum (Colenso ex Hook.) Gasper et W.A.O.Dittrich		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, Sp, NR		
Azorella cockaynei Diels		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, NStr, RR, Sp		
Azorella exigua (Hook.f.) Drude		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	RR	TL = H: Otago Lake District. Accession numbers: H K?
Azorella haastii subsp. *haastii* (Hook.f.) Drude		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Low	DPR, DPS, DPT, NS, Sp		
Azorella hydrocotyloides (Hook.f.) Kirk		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp		
Brachyglottis cassinioides (Hook.f.) B.Nord.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, Sp		
Brachyglottis southlandica (Cockayne) B.Nord.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NStr, Sp, TL		TL = H: Whisky Gully, near Tapanui. Accession number: H CHR 24175
Brachyscome humilis G.Simpson & J.S.Thomson	daisy	Naturally Uncommon	Yes	Yes		< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NS, NStr, RE, RR, Sp, St, TL	DP, Sp	TL = N, ISN: Rock and Pillar Range. Accession numbers: N CHR 199636; ISN WELT SP041374
Brachyscome longiscapa G.Simpson & J.S.Thomson	daisy	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	DP, Sp	TL = N: Dunback - Kyeburn road, near Kyeburn. Accession number: N CHR 112471
Brachyscome montana G.Simpson	daisy	Data Deficient	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NR, NStr, NS, RR, Sp, St		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Bulbinella gibbsii var. *balanifera* L.B.Moore	Gibbs's onion	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, Sp		
Cardamine dimidia Heenan	cress	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, NStr, Sp, TL		TL = H: Lauder Creek, Dunstan Mountains. Accession number: H CHR 586035
Cardamine dolichostyla Heenan	New Zealand bitter cress	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, Sp		
Cardamine exigua Heenan	crass	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Medium	DPR, DPS, DPT, NR, NS, NStr, Sp, St, TL	DP	TL = H: Rock and Pillar Range. Accession number: H CHR 199634
Cardamine intonsa Heenan	cress	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, Sp		
Cardamine reptans Heenan	cress	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NS, NStr, RR, Sp, St, TL	DP	TL = H: Dunstan Mountains, Fairfax Spur, near Leaning Rock. Accession number: H CHR 514169
Carex hectorii Petrie	Hector's sedge	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, NS, NStr, Sp, St, TL	Sp	TL = I, ISL, L: Kopuwai | Old Man Range / Kopuwai, summit of Mount Pisa / Old Man Ecological District. Accession numbers: L WELT SP011957; I = CHR 288717; ISL AK 223516, AK 2695, WELT SP014641
Carex lachenalii subsp. *parkeri* (Petrie) Toivonen	sedge	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RR, Sp, St, TL	Sp	TL = N: head of Lake Whakatipu / Richardson Ecological District. Accession numbers: N AK 2564, AK 223517, AK 223518
Carex lessoniana Steud.	cutty grass	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, Sp		
Carex parvispica K.A.Ford	Sinclair's hook sedge	Declining	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, RR	DP, Sp	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Carex pterocarpa Petrie	sedge	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	RR, Sp	TL = H or L, ISL, L (possible): Mount Pisa, north from Cromwell, west side of Clutha/Mata-au River. Accession numbers: H or L WELT SP021489; ISL CHR 73159; L (possible) WELT SP021488
Carex purpurata (Petrie) K.A.Ford	tussock hook sedge	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NStr, Sp, St, TL	Sp	TL = I, CT, ISL?, T?: Signal Hill, Ōtepoti Dunedin / Dunedin Ecological District. Accession numbers: I CHR 294811; ISL? AK 2353; T? WELT SP001693/A, WELT SP001693/B, WELT SP001693/C; CT WELT SP001695
Carex raoulii Boott	coastal forest sedge	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, Sp		
Carex trifida Cav.	mutton-bird sedge	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	CI, DPS, DPT, NStr, RR, Sp	SO	
Celmisia argentea Kirk	silver cushion mountain daisy	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, Sp, TL		TL = H or T (possible), I, S: swampy ground summit of Maungatua / Maungatua Hill, Taiari/Taieri County / Otago. Accession numbers: H or T (possible) WELT SP045695; I WELT SP001693/B; S AK 9970
Celmisia bellidioides Hook.f.	green cushion mountain daisy	Not Threatened				< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, RR, Sp		
Celmisia bonplandii (Buchanan) Allan	mountain daisy	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, Sp, TL		TL = N: Bold Peak, Humboldt Mountains (original type locality Mount Bonpandt). Accession number: N CHR 6301
Celmisia brevifolia Cockayne	common shrub mountain daisy	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, Sp, TL		TL = S, S (possible): Mount Ernest and summit of Kopuwai | Old Man Range / Huxley Ecological District. Accession numbers: S AK 34925; S (possible) WELT SP045774

Continued on next page

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Celmisia coriacea (G.Forst.) Hook.f.	Fiordland mountain daisy	Not Threatened			250–20000 mature individuals		Stable: ±10%	Medium	Low	DPS, DPT, NR, NStr, RR, Sp		
Celmisia haastii var. *tomentosa* G.Simpson & J.S.Thomson	daisy	Naturally Uncommon	Yes	Yes		< 100000 ha	Stable: ±10%	Medium	Medium	NS, NStr, RE, RR, St, TL	RR	TL = H, S, T?: Rock and PIllar Range. Accession numbers: H CHR 50011; S AK 106430; T? CHR 549665
Celmisia hookeri Cockayne	Hooker's mountain daisy	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	NR, NStr, RR	Sp	TL = NT: north-east Otago
Celmisia lindsayi Hook.f.	Lindsay's Daisy	Naturally Uncommon	Yes	Yes		< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, RE, RR, St, TL	RR, Sp	TL = H: Trap Cliffs at Shaw's Bay, the Nuggets. Accession number: H K340033
Celmisia philocremna Given	Eyre Mountains daisy	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	DP, RR, Sp	TL = H: Windley branch of Eyre Creek, Eyre Mountain. Accession number: H CHR 166411 A
Celmisia prorepens Petrie	daisy	Not Threatened	Yes		250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, Sp, TL		TL = H or L, S, I (possible): Kopuwai | Old Man Range, Otago / ex Kopuwai | Old Man Range, Otago. Accession numbers: H or L: WELT SP002151; S AK 9762; I (possible) WELT SP084084
Celmisia ramulosa var. *tuberculata* G.Simpson & J.S.Thomson	mountain daisy	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, Sp, TL		TL = H, S, T?: Rough Peaks, Lake Whakatipu / Eyre Ecological District. Accession numbers: H CHR 50003; S AK 170505; T? CHR 550039
Celmisia semicordata subsp. *aurigans* Given	large mountain daisy	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT NS NR, NStr, Sp		
Celmisia thomsonii Cheeseman	Thomson's mountain daisy	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	DP, RR, Sp	TL = S: Eyre Mountains. Accession number: S AK 9976
Centrolepis pallida (Hook.f.) Cheeseman	centrolepis	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RR		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Cheilanthes sieberi subsp. *sieberi* Kunze	rock fern	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, Sp	SO	Previous Name and Authority: *Cheilanthes sieberi* Kunze
Chionochloa vireta Connor	snow tussock	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RR, St	DP, RR, Sp	
Colobanthus apetalus (Labill.) Druce	colobanthus	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, RR, Sp	SO	
Colobanthus muelleri Kirk	colobanthus	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, RR, TL	DP	TL = S?: Otago? Accession number: S? AK 4071
Coprosma elatirioides de Lange & A.S.Markey	coprosma	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, RR, Sp		
Cordyline indivisa (G.Forst.) Steud.	mountain cabbage tree	Not Threatened			250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPS, DPT, NS, Sp		
Corybas cryptanthus Hatch		Naturally Uncommon				> 1000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, Sp	DP, Sp	
Cranfillia nigra (Colenso) Gasper et V.A.O.Dittrich	black hard fern	Not Threatened			250–20000 mature individuals		Stable: ±10%	Medium	Low	DPS, DPT, NS, RR		
Crassula colligata Toelken subsp. *colligata*		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, Sp	EF, SO	
Crassula moschata G.Forst.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	CI, DPS, DPT, NS, NStr, RR	SO	
Cystopteris tasmanica Hook.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, Sp	SO	
Dracophyllum menziesii Hook.f.		Not Threatened	Yes		250–20000 mature individuals		Stable: ±10%	High	Medium	DPS, NS, NStr	DP	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Dracophyllum politum (Cheeseman) Cockayne		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, RR, TL		TL = H, L, I or ISL: Maungatua, / Mount Maungatua, near Ōtepoti Dunedin / Maungatua Hill, Taiari/Taieri County / Dunedin Ecological District. Accession numbers: H A?; L AK 7033; I or ISL WELT SP033366
Dracophyllum prostratum Kirk		Not Threatened	Yes		250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, RR, Sp, TL		TL = H, L, ISL: mountains above Lake Harris, Otago-Southland boundary / near falls above Lake Harris. Accession numbers: H W?; L WELT SP032884; ISL CHR 332686, WELT SP032883, WELT SP032882
Epilobium komarovianum H.Lév.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	CI, DPS, DPT, NStr, RR		
Epilobium matthewsii Petrie		Naturally Uncommon				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, Sp	DP, RR, Sp	
Epilobium microphyllum A.Rich.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, RR, Sp		
Epilobium pallidiflorum A.Cunn.	swamp willowherb	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, RR	SO	
Epilobium porphyrium G.Simpson		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NStr, Sp, TL		TL = H. I: Hector Col / Arawata Ecological District. Accession numbers: H CHR 90790; I AK 22888
Epilobium purpuratum Hook.f.		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, RR, Sp, St, TL	RR, Sp	TL = NT: Alps of Otago. Accession number: NT K?
Euchiton traversii (Hook.f.) Holub		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, Sp	SO	
Euphrasia dyeri Wettst.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RR, TL		TL = H, I, I (possible): Mount Kyeburn / Kyeburn Hill, Maniototo County. Accession numbers: H K?; I WELT SP004855; I (possible) WELT SP104461

Continued on next page

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Euphrasia integrifolia Petrie		Naturally Uncommon				< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NR, NS, RR, Sp, St	DP, RR, Sp	
Euphrasia petriei Ashwin		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RR, Sp		
Exocarpos bidwillii Hook.f.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, Sp		
Festuca madida Connor		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NStr, Sp		
Festuca matthewsii subsp. *pisamontis* Connor		Naturally Uncommon	Yes	Yes		< 100000 ha	Stable: ±10%	Low	Medium	DPR, DPS, DPT, NStr, RE, RR, St, TL	RR	RE = known only from Central Otago: Dunstan, Pisa, and Kopuwai | Old Man Range TL = H: Mount Pisa, Pisa Range. Accession number: H CHR 74046
Forstera purpurata Glenny		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, Sp		
Gahnia procera J.R.Forst. & G.Forst.	giant sedge	Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, Sp		
Gaultheria nubicola D.J.Middleton		Not Threatened	Yes			< 100000 ha	Stable: ±10%	High	High	NS, NStr, RR		
Gaultheria rupestris (L.f.) D.Don		Not Threatened			250–20000 mature individuals		Stable: ±10%	Low	Medium	DPR, DPS, DPT, NS, Sp		
Gentianella amabilis (Petrie) Glenny		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, RR		
Gentianella lilliputiana (C.J.Webb) Glenny		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NS, Sp, St	DP, Sp	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Gentianella serotina (Cockayne) T.N.Ho & S.W.Liu		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, Sp		
Geum pusillum Petrie		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	DP, RR, Sp	TL = H, L, ISL: Kopuwai | Old Man Range, Clutha Basin. Accession numbers: H W?; L WELT SP030388/A; ISL WELT SP030388/B
Gunnera dentata Kirk		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, RR, TL		TL = S or ISN: Lake Wānaka, Lake Hāwea. Accession numbers: S or ISN AK 6025, AK 6026
Haastia sinclairii Hook.f. var. *sinclairii*		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, Sp		
Hiya distans (Hook.) Brownsey & Perrie		Not Threatened			subpopulations ≤ 15, ≤ 1000 mature individuals in largest subpopulation		Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, Sp	TO	Previous Name and Authority: *Hypolepis distans* Hook.
Hydrocotyle dissecta Hook.f.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, Sp		
Hydrocotyle robusta Kirk		Not Threatened				< 100000 ha	Stable: ±10%	Low	Medium	DPR, DPS, DPT, NR, Sp	DP	
Hymenophyllum minimum A.Rich.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, Sp		
Isolepis praetextata (Edgar) Soják		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	CI, DPR, DPS, DPT, NS, RR, Sp		
Isolepis reticularis Colenso		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, Sp		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Kelleria childii Heads		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, TL		TL = H: Rock and Pillar Range. Accession number: H OTA 37813
Kelleria croizatii Heads		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, Sp		
Kelleria paludosa Heads		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RR, TL		TL = H: Teviot Swamp, Lammerlaw Range. Accession number: H OTA 34004
Kelleria villosa var. *barbata* Heads		Naturally Uncommon	Yes	Yes		< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NS, NStr, RE, RR, Sp, St, TL	RR, Sp	TL = H: Rock and Pillar Range. Accession number: H OTA 009887
Korthalsella salicornioides (A.Cunn.) Tiegh.	dwarf mistletoe	Nationally Critical	Yes			< 100000 ha	Stable: ±10%	Medium	Low	De, DPS, DPT, NStr, PF, Sp	DP, Sp	
Lachnagrostis uda Edgar		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPR, DPS, DPT, NS, NStr, RR, Sp, St	DP, RR, Sp	
Lagenophora pinnatifida Hook.f.		Not Threatened			250–20000 mature individuals		Stable: ±10%	Low	Low	DPS, DPT, Sp, St		
Leptinella albida (D.G.Lloyd) D.G.Lloyd & C.J.Webb		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NS, NStr, RR, Sp, St, TL	DP, RR, Sp	Distributional notes: near regional endemic, only because range could extend into Garvie Mountains, Southland. TL = lost, L, ISL, ISL?: Mount Cardrona, north of Arrowtown, Lake Whakatipu. Accession numbers: L CHR 68186; ISL AK 212127, AK 10388; ISL ? WELT SP057714, WELT SP057712

Continued on next page

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Leptinella goyenii (Petrie) D.G.Lloyd & C.J.Webb		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, NStr, TL		TL = H, I, L (possible), ISL, ISL (possible), ISL?: Mount Pisa, north of Cromwell / Pisa Ecological District. Accession numbers: H W?; I CHR 68173; L (possible) WELT SP057612; ISL (possible) WELT SP057709; ISL? AK 10391
Leptinella pectinata (Hook.f.) D.G.Lloyd & C.J.Webb subsp. *pectinata*		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, NStr, Sp, TL		
Lilaeopsis ruthiana Affolter		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, RR, Sp	SO	
Lobelia glaberrima Heenan		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp, TL		TL = H: Long Burn, Eyre Mountains. Accession number: H CHR 468987
Lobelia linnaeoides (Hook.f.) Petrie		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp		
Lobelia roughii Hook.f.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, Sp		
Lophomyrtus obcordata (Raoul) Burret	rohutu	Nationally Critical			250–20000 mature individuals	NA	Stable: ±10%	Medium	Medium	De, DPS, PF, Sp	DP	
Luzula banksiana var. *acra* Edgar	wood-rush	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, RR, Sp		
Luzula banksiana var. *rhadina* (Buchenau) Edgar	wood-rush	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NStr, Sp		
Luzula colensoi Hook.f.	wood-rush	Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, Sp		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Luzula crenulata Buchenau	wood-rush	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NR, NS, NStr, RR, Sp, TL	RR	TL = H: Kopuwai | Old Man Range, Central Otago. Accession number: H WELT SP012358
Luzula leptophylla Buchenau & Petrie	wood-rush	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, NS, RR, Sp, St, TL	DP, RR, Sp	TL = H, I, T?: Mount Kyeburn, Central Otago / Maniototo County / St. Mary Ecological District. Accession numbers: H WELT SP012654; I AK 223509, AK 3068; T? CHR 491870
Luzula subclavata Colenso	wood-rush	Not Threatened				< 100000 ha	Stable: ±10%	Medium	Low	DPR, DPS, DPT, NR, Sp		
Lycopodiella diffusa (R.Br.) B.Øllg.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, RR, Sp	SO	
Machaerina rubiginosa (Spreng.) T.Koyama	baumea	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, RR, Sp	SO	
Machaerina tenax (Hook.f.) T.Koyama		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NS, RR, Sp		
Melicytus micranthus (Hook.f.) Hook.f.		Not Threatened			250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPS, DPT, NR, Sp		
Myosotis antarctica subsp. *antarctica* Hook.f.		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, Sp	DP, Sp, TO	Previous Name and Authority: *Myosotis antarctica* Hook.f.
Myosotis bryonoma Meudt, Prebble & Thorsen	forget-me-not	Naturally Uncommon	Yes	Yes		< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RE, RR, Sp, TL	DP, RR, Sp	RE = known from high-elevation bogs and wet places in mountain ranges of Otago TL = H: Otago, Garvie Mountains, east of Lake Laura, Old Man Ecological District. Accession number: H WELT SP104478
Myosotis drucei (L.B.Moore) de Lange & Barkla	Druce's forget-me-not	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, Sp		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Myosotis lyallii subsp. *elderi* (L.B.Moore) Meudt & Prebble		Nationally Vulnerable				< 100000 ha	Stable: ±10%	Medium	Medium	De, DPR, NS, Sp, St, TL	DP, Sp	TL = H: Mountains near Arrowtown, Lake County. Accession number: H WELT SP002648 Previous Name and Authority: *Myosotis elderi* L.B.Moore
Myosotis lyalli Hook.f. subsp. *lyalli*		Naturally Uncommon				< 100000 ha	Stable: ±10%	Medium	Medium	De, DPR, NS, Sp, St	DP, Sp	
Myosotis pulvinaris Hook.f.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, Sp, TL		TL = H, I: Middle Island, alps of Otago / Otago Lake District, alpine. Accession numbers: H K000787905, K000787903; I CHR 97409
Myosotis retrorsa Meudt, Prebble & Hindmarsh-Walls		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, NR, NS, NStr, RR, St	DP, Sp	
Myosotis traversii var. *cantabrica* L.B.Moore		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPT, NR, NS, Sp	DP	
Myriophyllum pedunculatum subsp. *novae-zelandiae* Orchard		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, RR		
Myriophyllum votschii Schindl.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, RR, Sp	Sp	
Nertera balfouriana Cockayne		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RR, Sp		
Nertera scapanioides Lange		Not Threatened			subpopulations ≤ 15, ≤ 1000 mature individuals in largest subpopulation		Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, RR, Sp		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Notogrammitis ciliata (Colenso) Parris		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, OL, Sp		
Notothlaspi rosulatum Hook.f.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, OL, Sp	DP	
Olearia bullata H.D.Wilson & Garn.-Jones		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, TL		TL = L, ISL, ISL?: Flagstaff Hill, Ōtepoti Dunedin / Dunedin Ecological District. Accession numbers: L CHR 75715; ISL AK 210589; ISL? AK 22899
Olearia cymbifolia (Hook.f.) Cheeseman		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, Sp		
Olearia lacunosa Hook.f.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, Sp		
Ourisia confertifolia Arroyo		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, NStr, RR, Sp, St	RR, Sp	
Pachycladon enysii (Cheeseman) Heenan & A.D.Mitch.	high alpine cress	Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, Sp		
Pachycladon novae-zelandiae (Hook.f.) Hook.f.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp, TL		TL = H: Mount Alta, Otago. Accession number: H K?
Parietaria debilis G.Forst.		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NR, Sp	DP	
Pellaea calidirupium Brownsey & Lovis		Not Threatened	Yes		250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, Sp	DP	
Phyllachne rubra (Hook.f.) Cheeseman		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, Sp, TL	DP	TL = H: Lake District. Accession number: H K?

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Pilularia novae-hollandiae A.Braun	pillwort	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, NS, RR, Sp		
Pimelea notia C.J.Burrows & Thorsen		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, Sp, TL	DP	TL = H: Remarkables Range, Rastus Burn Recreational Area. Accession number: H OTA 60767
Pimelea sericeovillosa subsp. *alta* C.J.Burrows		Naturally Uncommon	Yes	Yes		< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, RE, RR, Sp, St, TL	DP	RE = known from Pisa Range. TL = H: Pisa Range, Central Otago. Accession number: H CHR 669170
Pimelea traversii Hook.f. subsp. *traversii*		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, Sp	DP	
Pittosporum divaricatum Cockayne		Not Threatened			250–20000 mature individuals		Stable: ±10%	Low	Low	DPR, DPS, DPT, PF, Sp	DP, RR	
Plantago obconica Sykes		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, RR, St	DP	
Poa astonii Petrie		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	CI, DPS, DPT, NR, NStr, RR, TL		TL = L: Brighton, near Ōtepoti Dunedin. Accession number: L WELT SP066186
Poa incrassata Petrie		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	DP, RR, Sp	TL = H: Otago, Lake district, alpine. Accession number: H K?
Poa pusilla Berggr.		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, Sp	RR	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Poa pygmaea Buchanan		Naturally Uncommon	Yes	Yes		< 100000 ha	Stable: ±10%	High	High	CI, NS, NStr, RE, RR, St, TL		RE = known from Pisa Range and Mount St Bathans. TL = H, I: Mount Pisa, near Cromwell / Pisa Ecological District. Accession numbers: H WELT SP059606; I AK 223876, AK 1902, AK 223877, WELT SP015854, WELT SP066744, WELT SP066745, WELT SP066746, WELT SP066747, WELT SP066748
Poa schistacea Edgar & Connor		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, RR, Sp, TL		TL = H, I: "Two mile" Valley, Tāpuae-O-Uenuku | Hector Mountains Accession numbers: H CHR 395536 A; I CHR 395536 B, CHR 395537, CHR 395538
Poa sudicola Edgar		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Medium	DPR, DPS, DPT, NS, NStr, RR, St		
Poa tonsa Edgar		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr, Sp, TL	DP, Sp	TL = H, I: Ōmārama Saddle, Central Otago. Accession numbers: H CHR 175630; I OTA 018377
Potamogeton suboblongus Hagstr.	mud pondweed	Not Threatened				≤ 1000 ha	Stable: ±10%	Medium	Low	RR, DPR, DPT, DPS, Sp	DP, Sp	
Prumnopitys taxifolia (Sol. ex D.Don) de Laub.	matai	Not Threatened			250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPS, Rel, Sp		
Ranunculus enysii Kirk		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, Sp, TL		TL = I, ISL, T?: summit of Rock and Pillar Range / Carrick Range, near Cromwell / Old Man Ecological District. Accession numbers:; I CHR 334225; ISL AK 4242, AK 4243, AK 4245; T? WELT SP00347/A, WELT SP000347/B, WELT SP000354, WELT SP000355/A, WELT SP000355/B, WELT SP000356

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Ranunculus limosella F.Muell. ex Kirk	mud buttercup	Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, RR, Sp	SO	
Ranunculus maculatus Cockayne & Allan		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, RR, Sp, St, TL	SO	TL = H, I, N: Mount Cardrona / Rock and Pillar Range. Accession numbers: H WELT SP000340; N CHR 199637; I AK 4313
Ranunculus membranifolius (Kirk) Garn.-Jones		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	TL		TL = T?: Valley of the Dart [Dart Valley]. Accession number: WELT SP000357
Ranunculus pachyrrhizus Hook.f.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, NStr, Sp, TL		TL = H: Otago Lake District. Accession number: H K?
Ranunculus scrithalis Garn.-Jones		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	RR	TL = H: Hummock Peak; Eyre Mountains. Accession number: H OTA 027279
Raoulia apicinigra Kirk		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Low	Medium	DPR, DPS, DPT, NStr, PD, Sp		
Raoulia eximia Hook.f.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, Sp		
Raoulia haastii Hook.f.		Not Threatened				≤ 1000 ha	Stable: ±10%	Medium	Low	RR, Sp, DPS		
Raoulia hectorii var. *mollis* Buchanan		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL		TL = H: Mount St Bathans. Accession number: H W?
Raoulia petriensis Kirk		Naturally Uncommon				< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NS, RR, St, TL		TL = H, S, S?, T?,: Mount St Bathans / St Bathans Ecological District.Accession numbers: H W?; S AK 10127; S? AK 30643; T? WELT SP048520
Raoulia subulata Hook.f.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, RR, Sp		

Continued on next page

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Raoulia youngii (Hook.f.) Beauverd		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp, TL		TL = H: mountains above Lake Hāwea. Accession number: H K?
Rostkovia magellanica (Lam.) Hook.f.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, RR	DP, Sp	
Rumex flexuosus Spreng.		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, Sp	DP, Sp	
Scandia geniculata (G.Forst.) J.W.Dawson		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, Sp		
Schoenus maschalinus Roem. & Schult.		Not Threatened				< 100000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, Sp		
Scleranthus brockiei P.A.Will.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, Sp		
Selliera microphylla Colenso		Not Threatened				≤ 1000 ha	Stable: ±10%	Low	Low	DPT, DPS, Sp		
Senecio biserratus Belcher		Declining	Yes		250–20000 mature individuals	NA	Stable: ±10%	Low	Low	DPS, DPT, NStr, PF, Sp	DP	
Senecio matatini subsp. *discoideus* (Cheeseman) Courtney, de Lange & Pelser		Not Threatened				≤ 1000 ha	Stable: ±10%	Low	Low	DPT, DPS, Sp		Previous Name and Authority: *Senecio glaucophyllus* subsp. *discoideus* (Cheeseman) Ornduff
Stackhousia minima Hook.f.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, Sp	DP	
Stylidium subulatum Hook.f.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp	Sp	
Thyridia repens (R.Br.) W.R.Barker & Beardsley		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	CI, DPS, DPT, NStr, PF, RR, Sp	Sp	
Trichomanes colensoi Hook.f.		Not Threatened				≤ 1000 ha	Stable: ±10%	Low	Low	DPT, DPS, DPR, Sp		

Continued on next page

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Trichomanes endlicherianum C.Presl		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, OL, Sp	DP, Sp	
Trisetum youngii Hook.f.		Not Threatened				< 100000 ha	Stable: ±10%	Medium	Low	DPR, DPS, DPT, NS, Sp	RR, Sp	
Veronica biggarii Cockayne		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NR, NStr, RR, Sp, TL	Sp	TL = L, S: originally from Eyre Mountains / Eyre Mountains, Lake Whakatipu, subalpine belt. Accession numbers: L CHR 332289; S AK 107833
Veronica birleyi N.E.Br.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, RR, Sp, TL		TL = H, !: Mount Bonpland, near Lake Whakatipu / Dart Ecological District. Accession numbers: H K?; I AK 8415
Veronica chionohebe Garn.-Jones	plantaginaceae	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPR, DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	SO	TL = L, L?. Mount Pisa / Mount Pisa, west of Clutha/Mata-au River and north of Cromwell / Pisa Ecological District. Accession numbers: L AK 8335, L? WELT SP014128
Veronica ciliolata (Hook.f.) Cheeseman subsp. *ciliolata*	plantaginaceae	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NStr, NStr, Sp		
Veronica ciliolata subsp. *fiordensis* (Ashwin) Meudt	plantaginaceae	Naturally Uncommon				< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, Sp		
Veronica cockayneana Cheeseman		Not Threatened				≤ 1000 ha	Stable: ±10%	Medium	Low	DPS, DPR, Sp, NS, TL		TL = H, ISL, T?: Humboldt Mountains, Lake Whakatipu / Serpentine Mountains, Routeburn valley, near Lake Harris /Earnslaw Creek, below the Glacier / Dart Ecological District. Accession numbers: H A?; ISL CHR 331810, CHR 331811, WELT SP047652; T? WELT SP012435

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Veronica colostylis Garn.-Jones		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NS, NStr, Sp		
Veronica hectorii subsp. *demissa* (G.Simpson) Garn.-Jones		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, Sp, TL		TL = H, I, L, ISL?, T?: ex Rock and Pillar Range / Rock and Pillar Ecological District / Kopuwai | Old Man Range, Central Otago. Accession numbers: H CHR 48080 A; I CHR 48080 B; ISL? AK 22921; T? CHR 195571
Veronica petriei (Buchanan) Kirk		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Low	Medium	DPS, DPT, NR, NS, NStr, RR, Sp, St, TL	RR	TL = H, ISL, ISL?, T?: Mount Bonpland, Humboldt Mountains / Dart Ecological District. Accession numbers: H OM? ISL WELT SP005119; ISL? AK 8283; T? WELT SP084567
Veronica pinguifolia Hook.f.		Not Threatened				≤ 1000 ha	Stable: ±10%	Low	Medium	DPT, Sp, NR	Sp	
Veronica planopetiolata G.Simpson & J.S.Thomson		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NR, NS, NStr, Sp, St, TL	RR, Sp	TL = H, I: Hector Col, Matukituki Valley, Mount Aspiring / Arawata Ecological District. Accession numbers: H OM? I WELT SP041436
Veronica poppelwellii Cockayne		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NR, NS, NStr, Sp	DP, RR, Sp	
Veronica propinqua Cheeseman		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, NStr, Sp, TL		TL = L: Mount Maungatua / Waipori Ecological District. Accession number: I AK 8258
Veronica rakaiensis J.B.Armstr.		Not Threatened	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, Sp, TL		TL = H, T?: Deep Stream, North Otago. Accession numbers: H CHR 18230; T? CHR 549649
Veronica treadwellii (Cockayne & Allan) Garn.-Jones		Not Threatened				≤ 1000 ha	Stable: ±10%	Low	Medium	DPT, Sp, NR		
Veronica trifida Petrie		Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPS, DPT, NR, NS, NStr, RR, Sp, St	DP, RR, Sp	

Continued on next page

Regionally Naturally Uncommon continued

Name and Authority	Common Name	National Conservation Status	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Viola lyallii Hook.f.	New Zealand violet	Not Threatened				≤ 1000 ha	Stable: ±10%	Low	Low	DPT, DPS, DPR, Sp		
Vittadinia australis A.Rich.	white fuzzweed	Not Threatened	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NR, NStr, Sp	SO	
Zostera muelleri subsp. *novazelandica* (Setch.) S.W.L.Jacobs	eelgrass	Declining				< 100000 ha	Stable: ±10%	Low	Low	CI, DPS, DPT, EF, PF, RR	DP, RR, Sp	
TAXONOMICALLY INDETERMINATE (7)												
Aciphylla aff. *horrida* (a) (CHR 511521; Lomond)	speargrass	Naturally Uncommon	Yes			< 100000 ha	Stable: ±10%	Medium	Medium	DPR, DPS, DPT, NS, NStr	DP	
Anisotome (b) (CHR 511716); "Otago bog")		Naturally Uncommon	Yes	Yes		> 1000 ha	Stable: ±10%	Medium	Medium	DPR, NS, RE, RR, Sp	DP	
Asplenium aff. *trichomanes* (WELT P031321; "hexaploid")	spleenwort	Not Threatened	Yes		250–20000 mature individuals		Stable: ±10%	Medium	Medium	DPS, DPT, NR, NStr, Sp		Previous Name and Authority: *Asplenium* aff. *trichomanes* (AK 168112; "hexaploid") L.
Chaerophyllum aff. *colensoi* (CHR 215836; "bog")		Data Deficient	Yes			< 100000 ha	Stable: ±10%	Medium	Low	DPR, DPS, DPT, NS, NStr, RR, Sp, St		
Corybas aff. *trilobus* (b) (CHR 534742; Trotters Gorge)		Naturally Uncommon				> 1000 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, Sp	DP, Sp	
Ranunculus (c) (CHR 472008; Garvie Range)		Data Deficient	Yes	Yes	250–20000 mature individuals		Stable: ±10%	Medium	Low	DPS, DPT, NS, NStr, RE, RR, Sp, St		
Ranunculus aff. *reflexus* (CHR 394270; Mt Peel)		Data Deficient	Yes			< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NS, NStr, Sp		

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural state; NStr = Natural Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan

Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Regionally Non-Resident Native (1)

Taxa whose natural presence in Otago is either discontinuous (Migrant) or sporadic or temporary (Vagrant) or which have succeeded in recently (since 1950) establishing a resident breeding population (Coloniser).

Regional Coloniser (1)

Criteria for Regional Coloniser:

Taxa that otherwise trigger 'Threatened' categories because of small population size, but have arrived without direct or indirect help from humans and have been successfully reproducing in the wild since 1950.

Table 3.5: Regional Coloniser indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
REGIONAL COLONISER (1)													
TAXONOMICALLY DETERMINATE (1)													
Disphyma clavellatum (Haw.) Chinnock		Coloniser										SO	

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural state; NStr = Natural Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure? Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Regionally Not Threatened (614)

Resident native taxa that have large, stable populations.

Table 3.6: Regionally Not Threatened indigenous vascular plant taxa in Otago

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY NOT THREATENED (613)					
TAXONOMICALLY DETERMINATE (611)					
Abrotanella caespitosa Petrie ex Kirk		Not Threatened	TL		TL = H, L, S?: Mount Kyeburn / St. Mary Ecological District. Accession numbers: H W?; L AK 10466; WELT SP057804
Abrotanella inconspicua Hook.f.		Not Threatened	TL		TL = H, ISL, TF: Mount Alta. Accession numbers: H K? ISL WELT SP057814; TF CHR 402986
Acaena anserinifolia (J.R.Forst. & G.Forst.) J.B.Armstr.	bidibidi	Not Threatened			
Acaena fissistipula Bitter	bidibidi	Not Threatened	TL		TL = H: Tapuae-o-Uenuku | Hector Mountains. Accession number: H TURIC?
Acaena juvenca B.H.Macmill.	bidibidi	Not Threatened	TL		TL = H, I: above Karoro Creek, south of Willsher Bay Reserve / Tahakopa Ecological District. Accession numbers: H CHR 316173 A, CHR 316173 B; I CHR 554414; WELT SP078439/A, WELT SP078439/B, AK 176854
Acaena novae-zelandiae Kirk	red bidibid	Not Threatened		SO	
Acaena profundeincisa (Bitter) B.H.Macmill.	bidibidi	Not Threatened			
Acaena saccaticupula Bitter	bidibidi	Not Threatened			
Aciphylla aurea W.R.B.Oliv.	golden speargrass	Not Threatened	TL		TL = H, I (possible): Swampy Hill, Ōtepoti Dunedin. Accession numbers: H WELT SP005373/A, WELT SP005373/B; I (possible) WELT SP013760
Aciphylla crenulata J.B.Armstr.		Not Threatened		DP	
Aciphylla glaucescens W.R.B.Oliv.	speargrass	Not Threatened	TL	DP	TL = H, I: Swampy Hill, Ōtepoti Dunedin. Accession numbers: H WELT SP005401/A, I WELT SP005401/B, WELT SP005401/C, WELT SP005401/D
Acrothamnus colensoi (Hook.f.) Quinn		Not Threatened			
Adenochilus gracilis Hook.f.	orchid	Not Threatened			
Adiantum cunninghamii Hook.	maidenhair fern	Not Threatened			
Agrostis muelleriana Vickery		Not Threatened		SO	
Agrostis personata Edgar		Not Threatened			
Anaphalioides bellidioides (G.Forst.) Glenny	Hell's bells	Not Threatened			
Androstoma empetrifolium Hook.f.	bog mingimingi	Not Threatened			
Anisotome aromatica Hook.f.	aromatic aniseed	Not Threatened	TL		TL = H, H?: Flagstaff HIll, Ōtepoti Dunedin / upper basin of Wilkin River / Tapuae-o-Uenuku | Hector Mountains. Accession numbers: H CHR 75688, W?; H? CHR 76104

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Anisotome flexuosa J.W.Dawson		Not Threatened	TL		TL = H: From upper basins of the Wilkin River above the forks. Accession numbers: H CHR 76104
Anisotome haastii (F.Muell.) Cockayne & Laing	Haast's carrot	Not Threatened			
Anisotome imbricata (Hook.f.) Cockayne var. imbricata		Not Threatened	TL		TL = H: Otago, dry debris on the alps of the lake district. Accession number: H G-G-263084/1
Anisotome imbricata var. *prostrata* J.W.Dawson		Not Threatened			
Anthosachne solandri (Steud.) Barkworth & S.W.L.Jacobs	native wheatgrass	Not Threatened	TL	DP	
Apium prostratum subsp. *prostratum* var. *filiforme* (A.Rich.) Kirk	New Zealand celery	Not Threatened		SO	
Apodasmia similis (Edgar) B.G.Briggs & L.A.S.Johnson	jointed wire rush	Not Threatened			
Aporostylis bifolia (Hook.f.) Rupp & Hatch	odd-leaved orchid	Not Threatened	TL		TL = H: Otago. Accession number: H K?
Aristotelia fruticosa Hook.f.	mountain wineberry	Not Threatened	TL		TL = H, S: Flagstaff Hill, near Ōtepoti Dunedin / Dunedin Ecological District. Accession numbers: H CHR 75704; S AK 22919, AK 22917, AK 22914, AK 22916, AK 22915, AK 22920, AK 22918
Aristotelia serrata (J.R.Forst. & G.Forst.) W.R.B.Oliv.	wineberry	Not Threatened			
Arthropodium candidum Raoul	small renga lily	Not Threatened			
Asplenium appendiculatum (Labill.) C.Presl subsp. *appendiculatum*	ground spleenwort	Not Threatened		SO	
Asplenium flabellifolium Cav.	butterfly fern	Not Threatened		SO	
Asplenium flaccidum G.Forst.	drooping spleenwort	Not Threatened		SO	
Asplenium gracillimum Colenso	hen & chicken fern	Not Threatened		SO	
Asplenium hookerianum Colenso	Hooker's spleenwort	Not Threatened			
Asplenium lyallii (Hook.f.) T.Moore	Lyall's spleenwort	Not Threatened			
Asplenium richardii (Hook.f.) Hook.f.	Richard's spleenwort	Not Threatened			
Astelia fragrans Colenso	bush lily	Not Threatened			
Astelia nervosa Hook.f.	mountain astelia	Not Threatened			
Astelia nivicola Cockayne ex Cheeseman var. *nivicola*		Not Threatened			
Austroblechnum banksii (Hook.f.) Gasper et V.A.O.Dittrich	shore hard fern	Not Threatened			Previous Name and Authority: *Blechnum blechnoides* (Bory) Keyserl.
Austroblechnum colensoi (Hook.f.) Gasper et V.A.O.Dittrich	Colenso's hard fern	Not Threatened			Previous Name and Authority: *Blechnum colensoi* (Hook.f.) N.A.Wakef.
Austroblechnum lanceolatum (R.Br.) Gasper et V.A.O.Dittrich	lance fern	Not Threatened		SO	Previous Name and Authority: *Blechnum chambersii* Tindale
Austroblechnum penna-marina subsp. *alpina* (R.Br.) A.R.Field	little hard fern	Not Threatened		SO	Previous Name and Authority: *Blechnum penna-marina* subsp. *alpina* T.C.Chambers & P.A.Farrant
Austroderia richardii (Endl.) N.P.Barker & H.P.Linder	toetoe	Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Austrolycopodium fastigiatum (R.Br.) Holub		Not Threatened	TL	SO	TL = T?: Otago. Accession number: LD 1406084 Previous Name and Authority: *Lycopodium fastigiatum* R.Br.
Azolla rubra R.Br.	Pacific azolla	Not Threatened		SO	
Azorella haastii subsp. *cyanopetala* (Domin) G.M.Plunkett & A.N.Nicolas		Not Threatened			
Azorella hookeri Drude		Not Threatened			
Brachyglottis bellidioides (Hook.f.) B.Nord. var. *bellidioides*		Not Threatened			
Brachyglottis bellidioides var. *orbiculata* (G.Simpson & J.S.Thomson) B.Nord.		Not Threatened	TL		TL = H: Garvie Mountains. Accession number: H CHR?
Brachyglottis buchananii (J.B.Armstr.) B.Nord.		Not Threatened	TL		TL = H, S: Mount Cargill, near Ōtepoti Dunedin, upper forest margins / Dunedin Ecological District. Accession numbers: H CHR 29513; S AK 35247
Brachyglottis haastii (Hook.f.) B.Nord.		Not Threatened			
Brachyglottis revoluta (Kirk) B.Nord.		Not Threatened			
Brachyscome radicata Hook.f.	button daisy	Not Threatened	TL		TL = H: Cape Wanbrow, Ōamaru, Ōamaru Ecological District. Accession number: H AK 9389
Brachyscome sinclairii Hook.f.	daisy	Not Threatened			
Bulbinella angustifolia (Cockayne & Laing) L.B.Moore	onion	Not Threatened			
Caladenia chlorostyla D.L.Jones, Molloy & M.A.Clem.	finger orchid	Not Threatened			
Caladenia lyallii Hook.f.	cap orchid	Not Threatened	TL	SO?	TL = H: Otago. Accession number: H K?
Callitriche petriei R.Mason subsp. *petriei*	Petrie's starwort	Not Threatened			
Caltha obtusa Cheeseman	white caltha	Not Threatened	TL		TL = S, S?: St. Bathans and Dunstan Mountains. Accession numbers: S WELT SP025743, S? AK 4363, WELT SP025745
Calystegia soldanella (L.) R.Br.	shore bindweed	Not Threatened		SO	
Calystegia tuguriorum (G.Forst.) R.Br. ex Hook.f.	climbing convolvulus	Not Threatened		SO	
Cardamine corymbosa Hook.f.	cress	Not Threatened			
Cardamine forsteri Govaerts	cress	Not Threatened			
Cardamine heleniae Heenan	cress	Data Deficient	TL		TL = H: Centre Road, Otago Peninsula. Accession number: H CHR 616824
Carex acicularis Boott	sedge	Not Threatened	TL		
Carex banksiana K.A.Ford	fine-leaved bastard grass	Not Threatened			
Carex breviculmis R.Br.	grassland sedge	Not Threatened		SO	
Carex comans Berggr.	sedge	Not Threatened			
Carex coriacea Hamlin	cutty grass	Not Threatened			
Carex corynoidea K.A.Ford		Not Threatened			
Carex crispa K.A.Ford	hook sedge	Not Threatened			
Carex diandra Schrank	sedge	Not Threatened		SO	
Carex dissita Sol. ex Boott	forest sedge	Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Carex drucei (Hamlin) K.A.Ford	Druce's hook sedge	Not Threatened			
Carex echinata Murray	star sedge	Not Threatened		SO	
Carex edura K.A.Ford	hook sedge	Not Threatened	TL		TL = ISL, T?: Eweburn Creek, Naseby / Maniototo Ecological District. Accession numbers: ISL AK 2339; T? WELT SP001388
Carex egmontiana (Hamlin) K.A.Ford	hook sedge	Not Threatened			
Carex flagellifera Colenso	Glen Murray tussock	Not Threatened			
Carex flaviformis Nelmes	yellow sedge	Not Threatened			
Carex forsteri Wahlenb.	Forster's sedge	Not Threatened			
Carex gaudichaudiana Kunth	Gaudichaud's sedge	Not Threatened		SO	
Carex geminata Schkuhr	cutty grass	Not Threatened			
Carex horizontalis (Colenso) K.A.Ford	hook sedge	Not Threatened	TL		TL = S: Otago. Accession number: S CHR 294827
Carex imbecilla K.A.Ford	delicate hook sedge	Not Threatened			
Carex inversa R.Br.	creeping lawn sedge	Not Threatened		SO	
Carex lectissima K.A.Ford	fine-leaved hook sedge	Not Threatened			
Carex megalepis K.A.Ford	Caver's beard	Not Threatened			
Carex minor (Kük.) K.A.Ford	hook sedge	Not Threatened	TL		TL = T?: Rongahere, Tuapeka County. Accession numbers: H? WELT SP003134/A, WELT SP003134/B
Carex penalpina K.A.Ford	hook sedge	Not Threatened	TL		TL = T?: Maungatua. Accession number: T? WELT SP001696
Carex petriei Cheeseman	Petrie's sedge	Not Threatened			
Carex pumila Thunb.	sand sedge	Not Threatened		SO	
Carex punicea K.A.Ford	frost flat hook sedge	Not Threatened			
Carex pyrenaica var. *cephalotes* (F.Muell.) Kük.	mountain sedge	Not Threatened			
Carex secta Boott	pūrei	Not Threatened			
Carex sinclairii Boott	Sinclair's sedge	Not Threatened			
Carex solandri Boott	forest sedge	Not Threatened			
Carex testacea Sol. ex Boott	speckled sedge	Not Threatened			
Carex uncinata L.f.	hook sedge	Not Threatened		SO	
Carex virgata Sol. ex Boott	swamp sedge	Not Threatened			
Carex wakatipu Petrie	sedge	Not Threatened	TL		TL = S, S?: Ben Lomond, Lake Whakatipu / Shotover Ecological District. Accession numbers: S AK 2659, WELT SP011894; S? WELT SP011895
Carex zotovii (Hamlin) K.A.Ford	Zotov's hook sedge	Not Threatened			
Carmichaelia arborea (G.Forst.) Druce		Not Threatened			
Carpha alpina R.Br.	sedge	Not Threatened			
Carpodetus serratus J.R.Forst. & G.Forst.	putaputaweta	Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Celmisia alpina (Kirk) Cheeseman	mountain daisy	Not Threatened			
Celmisia angustifolia Cockayne	strap-leaved daisy	Not Threatened			
Celmisia armstrongii Petrie	Armstrong's mountain daisy	Not Threatened			
Celmisia densiflora Hook.f.	mountain daisy	Not Threatened			
Celmisia durietzii Cockayne & Allan	du Rietz's mountain daisy	Not Threatened			
Celmisia glandulosa Hook.f. var. *glandulosa*	bog mountain daisy	Not Threatened			
Celmisia glandulosa var. *longiscapa* Cockayne	bog mountain daisy	Not Threatened			
Celmisia gracilenta Hook.f.	common mountain daisy	Not Threatened			
Celmisia haastii Hook.f. var. *haastii*	Haast's mountain daisy	Not Threatened	TL		TL = L: Otago Lake District, alpine. Accession numbers: L K882081
Celmisia hectorii Hook.f.	Hector's daisy	Not Threatened	TL		TL = H: Mount Brewster, Otago-Westland boundary / north-east Otago. Accession number: H K882078
Celmisia laricifolia Hook.f.	needle-leaved mountain daisy	Not Threatened			
Celmisia lyallii Hook.f.	false spaniard	Not Threatened	TL		TL = H: Mount Alta. Accession number: H K?
Celmisia petriei Cheeseman	Petrie's mountain daisy	Not Threatened			
Celmisia ramulosa Hook.f. var. *ramulosa*	mountain daisy	Not Threatened			
Celmisia semicordata Petrie subsp. *semicordata*	large mountain daisy	Not Threatened			
Celmisia semicordata subsp. *stricta* (Cockayne) Given	large mountain daisy	Not Threatened			
Celmisia sessiliflora Hook.f.	white cushion mountain daisy	Not Threatened			
Celmisia verbascifolia Hook.f. subsp. *verbascifolia*	daisy	Not Threatened			
Celmisia vespertina Given	daisy	Not Threatened		DP	
Celmisia viscosa Hook.f.	sticky mountain daisy	Not Threatened			
Celmisia walkeri Kirk	Walker's mountain daisy	Not Threatened	TL		TL = H, I, ISL (possible): mountains above Lake Harris, Otago-Southland boundary / Dividing range above Lake Harris. Accession numbers: H WELT SP003287; I CHR 288140; ISL (possible) WELT SP004548, WELT SP045260
Centella uniflora (Colenso) Nannf.	centella	Not Threatened		SO	
Centrolepis ciliata (Hook.f.) Druce	centrolepis	Not Threatened			
Chaerophyllum colensoi (Hook.f.) K.F.Chung var. colensoi	mountain myrrh	Not Threatened			
Chaerophyllum ramosum (Hook.f.) K.F.Chung	apiaceae	Not Threatened	TL		TL = H, S or ISN: Otago, river flats in the Lakes District / Lake Wānaka District. Accession numbers: H K?; S or ISN AK 6371
Chiloglottis cornuta Hook.f.	bird orchid	Not Threatened		SO	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Chionochloa conspicua (G.Forst.) Zotov subsp. *conspicua*	broad-leaved tussock	Not Threatened			
Chionochloa crassiuscula subsp. *torta* Connor	curly snow tussock	Not Threatened	TL		TL = H: Lake Harris, Routeburn, left Branch. Accession numbers: H CHR 9613
Chionochloa macra Zotov	slim snow tussock	Not Threatened			
Chionochloa oreophila (Petrie) Zotov	mountain snow tussock	Not Threatened			
Chionochloa pallens subsp. *cadens* Connor	mid-ribbed snow tussock	Not Threatened			
Chionochloa rigida subsp. *amara* Connor	narrow-leaved snow tussock	Not Threatened			
Chionochloa rubra subsp. *cuprea* Connor	copper tussock	Not Threatened	TL		TL = H: Pigroot, 16 miles from Ranfurly. Accession number: H CHR 132481
Clematis foetida Raoul	clematis	Not Threatened			
Clematis marata J.B.Armstr.	clematis	Not Threatened			
Clematis paniculata J.F.Gmel.	white clematis	Not Threatened			
Colobanthus acicularis Hook.f.		Not Threatened			
Colobanthus affinis (Hook.) Hook.f.	colobanthus	Not Threatened		SO	
Colobanthus buchananii Kirk	pin cushion	Not Threatened	TL		TL = H, L, S: Manuherikia Valley / interior of Otago. Accession numbers: H W?; L WELT SP050895; S AK 4090
Colobanthus canaliculatus Kirk	colobanthus	Not Threatened	TL		TL = H, T?: Central Otago / interior of Otago. Accession numbers: H W? T? WELT SP050876
Convolvulus waitaha (Sykes) Heenan, Molloy & de Lange	grass convolvulus	Not Threatened			
Coprosma areolata Cheeseman	thin-leaved coprosma	Not Threatened	TL		TL = S: vicinity of Ōtepoti Dunedin / Dunedin Ecological District. Accession numbers: S AK 211646, AK 211647, AK 8785
Coprosma atropurpurea (Cockayne & Allan) L.B.Moore	coprosma	Not Threatened			
Coprosma cheesemanii W.R.B.Oliv.	coprosma	Not Threatened			
Coprosma ciliata Hook.f.	coprosma	Not Threatened			
Coprosma colensoi Hook.f.		Not Threatened			
Coprosma crassifolia Colenso	thick leaved coprosma	Not Threatened	TL		TL = T?: Otago. Accession number: T? WELT SP048862
Coprosma crenulata W.R.B.Oliv.	coprosma	Not Threatened			
Coprosma cuneata Hook.f.	coprosma	Not Threatened	TL		TL = H, L, S?, T?: Whisky Gully, near Tapanui. Accession numbers: H W? L WELT SP048878/A, WELT SP048878/B, WELT SP048878/C; T? WELT SP048873/A, WELT SP048873/B; S? WELT SP048879
Coprosma decurva Heads	coprosma	Not Threatened	TL		TL = H, I: Mount Cargill, Ōtepoti Dunedin, by Bethune's Gully Track / Dunedin Ecological District. Accession numbers: H AK 231764; I CHR 489340, NSW 413944; OTA 048469, WELT SP080001
Coprosma depressa Colenso ex Hook.f.	coprosma	Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Coprosma dumosa (Cheeseman) G.T.Jane	coprosma	Not Threatened			
Coprosma foetidissima J.R.Forst. & G.Forst.	stinkwood	Not Threatened			
*Coprosma foweraker*i D.A.Norton & de Lange	Foweraker's coprosma	Not Threatened			
Coprosma linariifolia Hook.f.	yellow wood	Not Threatened			
Coprosma lucida J.R.Forst. & G.Forst.	shining karamu	Not Threatened			
Coprosma niphophila Orchard	creeping coprosma	Not Threatened		SO	
Coprosma perpusilla Colenso subsp. *perpusilla*	coprosma	Not Threatened		SO	
Coprosma petriei Cheeseman	turfy coprosma	Not Threatened	TL		TL = S: Cromwell / Maniototo Plains / Mount St. Bathans / Maniototo Ecological District / Central Otago Ecological Region / St. Bathans Ecological District. Accession numbers: S AK 9124, AK 9128
Coprosma propinqua var. *propinqua* A.Cunn.	mingimingi	Not Threatened			
Coprosma pseudociliata G.T.Jane	coprosma	Not Threatened			
Coprosma pseudocuneata W.R.B.Oliv. ex Garn.-Jones & Elder		Not Threatened			
Coprosma rhamnoides A.Cunn.	coprosma	Not Threatened			
Coprosma rigida Cheeseman		Not Threatened			
Coprosma rotundifolia A.Cunn.	round leaved coprosma	Not Threatened			
Coprosma rubra Petrie	coprosma	Not Threatened	TL		TL = H, L, S?, T?: Leith Valley, Ōtepoti Dunedin / vicinity of Ōtepoti Dunedin / Dunedin Ecological District. Accession numbers: H W?; L WELT SP048848/A, WELT SP048848/B, WELT SP048848/C, WELT SP048848/D, WELT SP048848/E, S? AK 8928, AK 8929, AK 8930, AK 8922, AK 211963, AK 8924, AK 8923, AK 8926, AK 8925, AK 8921, AK 8927
Coprosma rugosa Cheeseman	coprosma	Not Threatened	TL		TL = S: Otago. Accession numbers: S AK 8968, AK 8969, AK 8970, AK 8971
Coprosma serrulata Hook.f. ex Buchanan	coprosma	Not Threatened			
Cordyline australis (G.Forst.) Endl.	cabbage tree	Not Threatened			
Coriaria arborea R.Linds. var. arborea	tutu	Not Threatened			
Coriaria plumosa W.R.B.Oliv.	feathery tutu	Not Threatened	TL		
Coriaria sarmentosa G.Forst.		Not Threatened			
Corokia cotoneaster Raoul	korokio	Not Threatened			
Corybas hatchii Lehnebach	spider orchid	Not Threatened			
Corybas iridescens Irwin & Molloy		Not Threatened			
Corybas macranthus (Hook.f.) Rchb.f.	spider orchid	Not Threatened			
Corybas oblongus (Hook.f.) Rchb.f.		Not Threatened			
Corybas orbiculatus (Colenso) L.B.Moore		Not Threatened			
Corybas trilobus (Hook.f.) Rchb.f.		Not Threatened			
Cotula australis (Spreng.) Hook.f.		Not Threatened		SO	
Cotula coronopifolia L.		Not Threatened		SO	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Cranfillia deltoides (Colenso) de Lange et Parris	mountain hard fern	Not Threatened		SO	
Cranfillia fluviatilis (R.Br.) Gasper et V.A.O.Dittrich	creek fern	Not Threatened		SO	Previous Name and Authority: *Blechnum fluviatile* (R.Br.) Lowe ex Salomon
Craspedia lanata (Hook.f.) Allan var. lanata		Not Threatened			
Crassula sieberiana (Schult. & Schult.f.) Druce		Not Threatened		SO	
Crassula sinclairii (Hook.f.) A.P.Druce & Given		Not Threatened	TL		TL = S, T?: Otago, Waipahī and Lake Waihola / Gore Ecological Region and District. Accession numbers: S AK 4552; T? WELT SP050141, WELT SP050143, WELT SP050165, WELT SP050175/A, WELT SP050175/B, WELT SP050176
Cyathea colensoi (Hook.f.) Domin	mountain tree fern	Not Threatened			
Cyathea dealbata (G.Forst.) Sw.		Not Threatened			
Cyathea smithii Hook.f.		Not Threatened			
Dacrycarpus dacrydioides (A.Rich.) de Laub.	kahikatea	Not Threatened			
Dacrydium cupressinum Lamb.	rimu	Not Threatened			
Dendrobium cunninghamii Lindl.		Not Threatened			
Deschampsia tenella Petrie		Not Threatened	TL		TL = L; uncertain type material: Catlins River, Clutha County, on coast. Accession numbers: L WELT SP069304/A; uncertain type material WELT SP069304/B
Dianella nigra Colenso		Not Threatened			
Dichondra brevifolia Buchanan		Not Threatened	TL		TL = H, T (possible), T?: "Popotunoa, Otago, pastures in swampy places mixed with *D. repens*". Accession numbers: H OM?I T (possible) WELT SP032646, T? WELT SP070293
Dichondra repens J.R.Forst. & G.Forst.	Mercury bay weed	Not Threatened		SO	
Dicksonia fibrosa Colenso		Not Threatened			
Dicksonia squarrosa (G.Forst.) Swartz		Not Threatened			
Diphasium scariosum (G.Forst.) Rothm.		Not Threatened		SO	Previous Name and Authority: *Lycopodium scariosum* G.Forst.
Discaria toumatou Raoul	matagouri	Declining			
Disphyma australe (W.T.Aiton) N.E.Br. subsp. australe	horokaka	Not Threatened			
Dolichoglottis lyallii (Hook.f.) B.Nord.		Not Threatened		DP	
Donatia novae-zelandiae Hook.f.		Not Threatened		SO	
Dracophyllum kirkii Berggr.		Not Threatened			
Dracophyllum longifolium (J.R.Forst. & G.Forst.) R.Br. var. *longifolium*	inanga	Not Threatened			
Dracophyllum muscoides Hook.f.		Not Threatened	TL		TL = H, S or IS: Mount Alta / Wānaka Ecological District. Accession numbers: H K?; I or ISN AK 7046
Dracophyllum pronum W.R.B.Oliv.		Not Threatened			
Dracophyllum rosmarinifolium (G.Forst.) R.Br.		Not Threatened			
Drosera arcturi Hook.		Not Threatened		SO	

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Drosera spatulata Labill.		Not Threatened		SO	
Drosera stenopetala Hook.f.		Not Threatened			
Earina autumnalis (G.Forst.) Hook.f.		Not Threatened			
Earina mucronata Lindl.		Not Threatened			
Echinopogon ovatus (G.Forst.) P.Beauv.		Not Threatened		SO	
Elaeocarpus hookerianus Raoul	pokaka	Not Threatened			
Elatine gratioloides A.Cunn.		Not Threatened		SO	
Eleocharis acuta R.Br.		Not Threatened		SO	
Eleocharis gracilis R.Br.		Not Threatened		SO	
Eleocharis pusilla R.Br.		Not Threatened		SO	
Empodisma minus (Hook.f.) L.A.S.Johnson & D.F.Cutler	wire rush	Not Threatened		SO	
Epilobium alsinoides A.Cunn.		Not Threatened			
Epilobium atriplicifolium A.Cunn.		Not Threatened			
Epilobium billardiereanum DC.		Not Threatened		SO	
Epilobium brunnescens (Cockayne) P.H.Raven & Engelhorn subsp. *brunnescens*		Not Threatened			
Epilobium brunnescens subsp. *minutiflorum* (Cockayne) P.H.Raven & Engelhorn		Not Threatened			
Epilobium chlorifolium Hausskn.		Not Threatened			
Epilobium cinereum A.Rich.		Not Threatened		SO	
Epilobium crassum Hook.f.		Not Threatened		DP	
Epilobium glabellum G.Forst.		Not Threatened			
Epilobium macropus Hook.		Not Threatened			
Epilobium melanocaulon Hook.		Not Threatened			
Epilobium nerteroides A.Cunn.		Not Threatened			
Epilobium nummulariifolium A.Cunn.		Not Threatened			
Epilobium pedunculare A.Cunn.		Not Threatened			
Epilobium pernitens Cockayne & Allan		Not Threatened			
Epilobium pubens A.Rich.		Not Threatened			
Epilobium pycnostachyum Hausskn.		Not Threatened			
Epilobium rotundifolium G.Forst.		Not Threatened			
Epilobium tasmanicum Hausskn.		Not Threatened		SO	
Euchiton audax (D.G.Drury) Holub	creeping cudweed	Not Threatened			
Euchiton lateralis (C.J.Webb) Breitw. & J.M.Ward		Not Threatened			
Euchiton limosus (D.G.Drury) Holub		Not Threatened			
Euchiton ruahinicus (D.G.Drury) Breitw. & J.M.Ward		Not Threatened			
Euchiton sphaericus (Willd.) Holub		Not Threatened		SO	
Euphrasia australis Petrie		Not Threatened			
Euphrasia revoluta Hook.f.		Not Threatened			
Euphrasia zelandica Wettst.		Not Threatened			
Festuca novae-zelandiae (Hack.) Cockayne		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Ficinia nodosa (Rottb.) Goetgh., Muasya & D.A.Simpson	wiwi	Not Threatened	TL	SO	
Forstera sedifolia G.Forst.		Not Threatened			
Forstera tenella Hook.f.		Not Threatened			
Fuchsia excorticata (J.R.Forst. & G.Forst.) L.f.	tree fuchsia	Not Threatened			
Fuchsia perscandens Cockayne & Allan		Not Threatened			
Fuscospora cliffortioides (Hook.f.) Heenan & Smissen	mountain beech	Not Threatened			
Fuscospora fusca (Hook.f.) Heenan & Smissen	red beech	Not Threatened			
Gaimardia setacea Hook.f.		Not Threatened		SO	
Galium perpusillum (Hook.f.) Allan		Not Threatened			
Galium propinquum A.Cunn.		Not Threatened		SO	
Galium trilobum Colenso	native bedstraw	Not Threatened			
Gastrodia cunninghamii Hook.f.		Not Threatened			
Gastrodia molloyi Lehnebach & J.R.Rolfe		Not Threatened			
Gaultheria antipoda G.Forst.		Not Threatened			
Gaultheria crassa Allan		Not Threatened	TL		TL = H: Flagstaff Hill, west of Ōtepoti Dunedin. Accession number: H CHR 93594
Gaultheria depressa Hook.f. var. *depressa*		Data Deficient		SO	
Gaultheria depressa var. *novae-zelandiae* D.A.Franklin		Not Threatened			
Gaultheria macrostigma (Colenso) D.J.Middleton		Not Threatened			
Gaultheria parvula D.J.Middleton		Not Threatened			
Gentianella bellidifolia (Hook.f.) Holub		Not Threatened			
Gentianella corymbifera (Kirk) Holub subsp. *corymbifera*		Not Threatened			
Gentianella corymbifera subsp. *gracilis* Glenny		Not Threatened			
Gentianella grisebachii (Hook.f.) T.N.Ho		Not Threatened	TL		TL = L, ISL: Lake Harris, Routeburn, Lake Whakatipu. Accession numbers: L WELT SP004710; ISL WELT SP079965
Gentianella montana (G.Forst.) Holub subsp. *montana* var. *montana*		Not Threatened	TL		TL = L, ISL: Lake Harris, Routeburn, west of Lake Whakatipu. Accession numbers: L WELT SP004723/A; ISL WELT SP004723/B
Geranium brevicaule Hook.f.		Not Threatened		SO	
Geum cockaynei (F.Bolle) Molloy & C.J.Webb		Not Threatened			
Geum leiospermum Petrie		Not Threatened	TL		TL = H, L, ISL: Mount Cardrona / upper Waipori, northeast from Lawrence. Accession numbers: H W?; L WELT SP030386/A; ISL WELT SP030386/B
Geum uniflorum Buchanan		Not Threatened			
Gingidia decipiens (Hook.f.) J.W.Dawson		Not Threatened			
Gleichenia alpina R.Br.	alpine tangle fern	Not Threatened		SO	
Glossostigma diandrum (L.) Kuntze		Not Threatened	TL		TL = H, PT, T?: Lake Waihola, below high tide level, east of Otago. Accession numbers: H W?; T? CHR 293989; PT CHR 119292

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Glossostigma elatinoides Benth. ex Hook.f.		Not Threatened		SO	
Gonocarpus aggregatus (Buchanan) Orchard		Not Threatened	TL		TL = L, ISL: Lower part of Hunter River, Lake Hāwea / Lakes Ecological Region. Accession numbers: L WELT SP0407084/A, WELT SP040784/B; ISL AK 5939, ISL AK 209568, WELT SP006882, WELT SP040817, WELT SP040822
Gonocarpus micranthus subsp. *micranthus* Thunb.		Not Threatened		SO	
Gonocarpus montanus (Hook.f.) Orchard		Not Threatened			
Goodenia radicans (Cav.) Pers.	remuremu	Not Threatened			Previous Name and Authority: *Selliera radicans* Cav.
Griselinia littoralis Raoul	kāpuka	Not Threatened			
Gunnera monoica Raoul		Not Threatened	TL		TL = T?: Otago. Accession number: T? WELT SP025332
Gunnera prorepens Hook.f.		Not Threatened			
Haastia sinclairii var. *fulvida* Allan		Not Threatened			
Halocarpus bidwillii (Kirk) Quinn		Not Threatened		DP	
Halocarpus biformis (Hook.) Quinn	pink pine	Not Threatened		DP	
Haloragis erecta (Banks ex Murray) Oken subsp. erecta		Not Threatened			
Hectorella caespitosa Hook.f.		Not Threatened	TL		TL = H: Otago Lake District, 4000–6000 ft. Accession numbers: H K?
Helichrysum filicaule Hook.f.		Not Threatened			
Helichrysum lanceolatum (Buchanan) Kirk		Not Threatened			
Helichrysum simpsonii Kottaim. subsp. *simpsonii*		Not Threatened	TL		TL = H, lost?. I, S? T?: Bold Peak, at 1400 m, Lake Whakatipu / Berwick, Taeri plain. Accession numbers: H CHR 76018; CHR 154063 Previous Name and Authority: *Helichrysum intermedium* G.Simpson
Herpolirion novae-zelandiae Hook.f.		Not Threatened		SO	
Hierochloe novae-zelandiae Gand.		Not Threatened	TL		TL = H: Ōtepoti Dunedin. Accession number: H LY?
Hierochloe recurvata (Hack.) Zotov		Not Threatened			
Hierochloe redolens (Vahl) Roem. & Schult.		Not Threatened		SO	
Histiopteris incisa (Thunb.) J.Sm.		Not Threatened		SO	
Hoheria angustifolia Raoul		Not Threatened			
Hoheria glabrata Sprague & Summerh.		Not Threatened			
Hoheria lyallii Hook.f.		Not Threatened			
Huperzia australiana (Herter) Holub		Not Threatened		SO	
Hydrocotyle elongata A.Cunn.		Not Threatened			
Hydrocotyle heteromeria A.Rich.		Not Threatened			
Hydrocotyle hydrophila Petrie		Not Threatened	TL		TL = H, L, ISL?: Wickliffe Bay, between the Pyramids, Otago Peninsula / Dunedin Ecological District. Accession numbers: H W?; L WELT SP068306; ISL? AK 6239
Hydrocotyle microphylla A.Cunn.		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Hydrocotyle moschata G.Forst. var. *moschata*		Not Threatened			
Hydrocotyle novae-zeelandiae DC. var. *novae-zeelandiae*		Not Threatened			
Hydrocotyle novae-zeelandiae var. *montana* Kirk		Not Threatened			
Hydrocotyle sulcata C.J.Webb & P.N.Johnson		Not Threatened			
Hymenophyllum aff. *rarum* (AK 330262; New Zealand)		Not Threatened			
Hymenophyllum bivalve (G.Forst.) Sw.	two-valved filmy fern	Not Threatened		SO	
Hymenophyllum demissum (G.Forst.) Sw.	filmy fern	Not Threatened			
Hymenophyllum dilatatum (G.Forst.) Sw.		Not Threatened			
Hymenophyllum flabellatum Labill.		Not Threatened		SO	
Hymenophyllum flexuosum A.Cunn.		Not Threatened			
Hymenophyllum frankliniae Colenso		Not Threatened			
Hymenophyllum malingii (Hook.) Mett.		Not Threatened			
Hymenophyllum multifidum (G.Forst.) Sw.	sharp-toothed filmy fern	Not Threatened		SO	
Hymenophyllum peltatum (Poir.) Desv.		Not Threatened		SO	
Hymenophyllum pulcherrimum Colenso		Not Threatened			
Hymenophyllum revolutum Colenso		Not Threatened			
Hymenophyllum sanguinolentum (G.Forst.) Sw.		Not Threatened		TO	
Hymenophyllum scabrum A.Rich.		Not Threatened			
Hymenophyllum villosum Colenso		Not Threatened			
Hypericum pusillum Choisy		Not Threatened		SO	
Hypolepis ambigua (A.Rich.) Brownsey & Chinnock		Not Threatened			
Hypolepis millefolium Hook.		Not Threatened			
Hypolepis rufobarbata (Colenso) N.A.Wakef.		Not Threatened		EF	
Ileostylus micranthus (Hook.f.) Tiegh.		Not Threatened		TO	
Isoetes alpina Kirk		Not Threatened			
Isolepis aucklandica Hook.f.		Not Threatened		SO	
Isolepis caligenis (V.J.Cook) Soják		Not Threatened		DP	
Isolepis cernua (Vahl) Roem. & Schult. var. cernua		Not Threatened		SO	
Isolepis habra (Edgar) Soják		Not Threatened		SO	
Juncus antarcticus Hook.f.		Not Threatened		SO	
Juncus edgariae L.A.S.Johnson & K.L.Wilson		Not Threatened			
Juncus novae-zelandiae Hook.f.		Not Threatened			
Juncus pallidus R.Br.		Not Threatened		SO	
Juncus planifolius R.Br.		Not Threatened		SO	
Juncus sarophorus L.A.S.Johnson		Not Threatened		SO	
Kelleria dieffenbachii (Hook.) Endl.		Not Threatened			
Kelleria laxa (Cheeseman) Heads		Not Threatened			
Kelleria villosa var. villosa Berggr.		Not Threatened			
Koeleria cheesemanii (Hack.) Petrie		Not Threatened			
Koeleria novozelandica Domin		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Korthalsella lindsayi (Oliv.) Engl.		Not Threatened	TL		TL = H: East Taiari/Taieri Bush. Accession number: H K?
Kunzea robusta de Lange & Toelken	rawirinui	Nationally Vulnerable	De	DP, De	De = impacts of myrtle risk is unknown
Kunzea serotina de Lange & Toelken	mākahikātoa	Nationally Vulnerable	De	DP, De	De = impacts of myrtle risk is unknown
Lachnagrostis lyallii (Hook.f.) Zotov		Not Threatened			
Lachnagrostis pilosa (Buchanan) Edgar subsp. pilosa		Not Threatened			
Lagenophora cuneata Petrie		Not Threatened	TL		TL = H, L, I, ISL: Flagstaff Hill, near Ōtepoti Dunedin. Accession numbers: H W?; L WELT SP044165; I CHR 333540; ISL AK 9346
Lagenophora petiolata Hook.f.		Not Threatened	TL		TL = I, S, S?: Catlins River / Tahakopa Ecological District. Accession numbers: I WELT SP044167; S AK 9350; S? AK 30646
Lagenophora pumila (G.Forst.) Cheeseman		Not Threatened			
Lagenophora strangulata Colenso		Not Threatened			
Lastreopsis hispida (Sw.) Tindale		Not Threatened		SO	
Lecanopteris pustulata (G.Forst.) Perrie & Brownsey subsp. *pustulata*		Not Threatened		SO	Previous Name and Authority: *Microsorum pustulatum* (G.Forst.) Copel. subsp. *pustulatum*
Lemna minor L.	duckweed	Not Threatened		SO	
Lepidium desvauxii Thell.	bushy peppercress	Not Threatened		SO	
Lepidosperma australe (A.Rich.) Hook.f.		Not Threatened			
Lepidothamnus laxifolius (Hook.f.) Quinn	pygmy pine	Not Threatened			
Leptecophylla juniperina (J.R.Forst. & G.Forst.) C.M.Weiller subsp. *juniperina*		Not Threatened		SO	
Leptinella dioica Hook.f.		Not Threatened			
Leptinella pectinata subsp. *villosa* (G.Simpson) D.G.Lloyd & C.J.Webb		Not Threatened	TL		TL = L: Mount Roy, Lake Wānaka. Accession numbers: L CHR 76029
Leptinella pectinata subsp. *willcoxii* (Cheeseman) D.G.Lloyd & C.J.Webb		Not Threatened	TL		TL = H, I, L, ISL: near Mount Earnslaw / Upper Route Burn Valley / Dart Ecological District. Accession numbers: H A?, CHR 75701; I CHR 155497; L AK 24966; ISL AK 209500
Leptinella squalida subsp. *mediana* (D.G.Lloyd) D.G.Lloyd & C.J.Webb		Not Threatened			
Leptolepia novae-zelandiae (Colenso) Mett. ex Diels		Not Threatened			
Leptopteris hymenophylloides (A.Rich.) C.Presl		Not Threatened			
Leptopteris superba (Colenso) C.Presl		Not Threatened			
Leptospermum scoparium J.R.Forst. & G.Forst. var. *scoparium*	mānuka	Declining	De	DP, De	De = impacts of myrtle risk is unknown
Leptostigma setulosum (Hook.f.) Fosberg		Not Threatened			
Leucogenes grandiceps (Hook.f.) Beauverd		Not Threatened			
Leucopogon fraseri A.Cunn.		Not Threatened		SO	
Libertia ixioides (G.Forst.) Spreng.		Not Threatened			
Libocedrus bidwillii Hook.f.		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Lilaeopsis novae-zelandiae (Gand.) A.W.Hill		Not Threatened	TL	SO	TL = H: Tomahawk Lagoon, Ōtepoti Dunedin Accession number: H Gandoger?
Limosella australis R.Br.		Not Threatened		SO	Previous Name and Authority: *Limosella lineata* Gluck
Lobelia angulata G.Forst.		Not Threatened			
Lomaria discolor (G.Forst.) Willd.	crown fern	Not Threatened			Previous Name and Authority: *Blechnum discolor* (G.Forst.) Keyserl.
Lophozonia menziesii (Hook.f.) Heenan & Smissen	silver beech	Not Threatened			
Luzula banksiana var. *migrata* (Buchenau) Edgar	wood-rush	Not Threatened			
Luzula crinita var. *petrieana* (Buchenau) Edgar	wood-rush	Not Threatened			
Luzula pumila Hook.f.	wood-rush	Not Threatened	TL		TL = H, I, L, ISL, T?, uncertain: Otago Lake District, alpine / Mount Cardrona / Rock and Pillar Range / Wānaka Ecological District. Accession numbers: H AK 105078; I CHR 491678; L WELT SP012356; T? CHR 491679; ISL WELT SP012355; uncertain WELT SP012354
Luzula rufa Edgar var. *rufa*	wood-rush	Not Threatened			
Luzula traversii (Buchenau) Cheeseman var. *traversii*	wood-rush	Not Threatened			
Luzuriaga parviflora (Hook.f.) Kunth		Not Threatened		SO	
Marsippospermum gracile (Hook.f.) Buchenau		Not Threatened			
Mazus radicans (Hook.f.) Cheeseman		Not Threatened			
Melicope simplex A.Cunn.	poataniwha	Not Threatened			
Melicytus alpinus (Kirk) Garn.-Jones		Not Threatened			
Melicytus lanceolatus Hook.f.		Not Threatened	TL		TL = H, S: Flagstaff Hill, Ōtepoti Dunedin / Dunedin Ecological District. Accession numbers: H CHR 75719 (var. *latior* G.Simpson & J.S.Thomson); S AK 100240
Melicytus ramiflorus J.R.Forst. & G.Forst. subsp. *ramiflorus*	mahoe	Not Threatened			
Metrosideros diffusa (G.Forst.) Sm.	white rata	Nationally Vulnerable	De	DP, De	De = impacts of myrtle risk is unknown
Metrosideros umbellata Cav.	southern rata	Nationally Vulnerable	De	DP, De	De = impacts of myrtle risk is unknown
Microlaena avenacea (Raoul) Hook.f.	bush rice grass	Not Threatened		SO	
Microseris scapigera (Sol. ex A.Cunn.) Sch.Bip.	catsear	Not Threatened		DP	
Microtis oligantha L.B.Moore		Not Threatened			
Microtis unifolia (G.Forst.) Rchb.f.		Not Threatened		S?O	
Montia fontana L. subsp. *fontana*		Not Threatened		SO	
Montia sessiliflora (G.Simpson) Heenan		Not Threatened	TL		TL = L: Cardrona River. Accession number: L CHR 60027
Montitega dealbata (R.Br.) C.M.Weiller		Not Threatened		SO	
Muehlenbeckia australis (G.Forst.) Meisn.	muehlenbeckia vine	Not Threatened		SO	
Muehlenbeckia axillaris (Hook.f.) Endl.		Not Threatened		SO	
Muehlenbeckia complexa (A.Cunn.) Meisn. var. *complexa*		Not Threatened		SO	
Myoporum laetum G.Forst.	ngaio	Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Myosotis australis R.Br. subsp. *australis*		Not Threatened		SO	Previous name and authority: *Myosotis australis* R.Br.
Myosotis forsteri Lehm.		Not Threatened			
Myriophyllum propinquum A.Cunn.		Not Threatened		SO	
Myriophyllum triphyllum Orchard		Not Threatened			
Myrsine australis (A.Rich.) Allan	mapou	Not Threatened			
Myrsine divaricata A.Cunn.	weeping mapou	Not Threatened			
Myrsine nummularia (Hook.f.) Hook.f.		Not Threatened			
Neomyrtus pedunculata (Hook.f.) Allan	rōhutu	Nationally Critical	De	DP	De = impacts of myrtle risk is unknown
Nertera ciliata Kirk		Not Threatened			
Nertera depressa Banks & Sol. ex Gaertn.		Not Threatened		SO	
Nertera villosa B.H.Macmill. & R.Mason		Not Threatened	TL		TL = H: Long Flat, Hunter Valley, Otago. Accession number: H CHR 113477
Notogrammitis angustifolia (Jacq.) Parris		Not Threatened			
Notogrammitis angustifolia subsp. *nothofageti* (Parris) Parris		Not Threatened		SO	
Notogrammitis billardierei (Willd.) Parris		Not Threatened		SO	
Notogrammitis crassior (Kirk) Parris		Not Threatened		SO	
Notogrammitis heterophylla (Labill.) Parris		Not Threatened		SO	
Notogrammitis patagonica (C.Chr.) Parris		Not Threatened		SO	
Olearia arborescens (G.Forst.) Cockayne & Laing		Not Threatened			
Olearia avicenniifolia (Raoul) Hook.f.		Not Threatened			
Olearia ilicifolia Hook.f.		Not Threatened			
Olearia moschata Hook.f.		Not Threatened			
Olearia nummulariifolia (Hook.f.) Hook.f.		Not Threatened			
Olearia odorata Petrie		Not Threatened	TL		TL = H, S: Maniototo Plain, Otago / Maniototo to Lake Hāwea / Between Roxburgh and Speargrass Flat, Clutha Valley / North of Roxburgh, Clutha Valley / Cromwell / Upper Clutha basin. Accession numbers: S WELT SP023630, WELT SP032636, WELT SP032640, WELT SP057388; WELT SP057339; WELT SP057340
Ophioglossum coriaceum A.Cunn.		Not Threatened			
Oreobolus impar Edgar	comb sedge	Not Threatened			
Oreobolus pectinatus Hook.f.	comb sedge	Not Threatened			
Oreobolus strictus Berggr.	comb sedge	Not Threatened			
Ourisia caespitosa Hook.f.		Not Threatened			
Ourisia glandulosa Hook.f.		Not Threatened	TL		TL = H: Otago Lake District, alpine. Accession number: H K?
Ourisia macrocarpa Hook.f.		Not Threatened			
Ourisia sessilifolia Hook.f. subsp. *sessilifolia*		Not Threatened	TL		TL = H: Mount Brewster, on the West Coast–Otago boundary. Accession number: H K?
Oxalis exilis A.Cunn.		Not Threatened		SO	
Oxalis magellanica G.Forst.		Not Threatened		SO	
Paesia scaberula (A.Rich.) Kuhn		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Parablechnum minus (R.Br.) Gasper et Salino	swamp kiokio	Not Threatened		SO	Previous Name and Authority: *Blechnum minus* (R.Br.) Ettingsh.
Parablechnum montanum (T.C. Chambers et P.A.Farrant) Gasper et Salino	mountain kiokio	Not Threatened			Previous Name and Authority: *Blechnum montanum* T.C.Chambers & P.A.Farrant
Parablechnum novae-zelandiae (T.C.Chambers et P.A.Farrant) Gasper et Salino	common hard fern	Not Threatened			Previous Name and Authority: *Blechnum novae-zelandiae* T.C.Chambers & P.A.Farrant
Parablechnum procerum (G.Forst.) C.Presl	small kiokio	Not Threatened			Previous Name and Authority: *Blechnum procerum* (G.Forst.) Sw.
Parapolystichum glabellum (A.Cunn.) Labiak, Sundue & R.C.Moran		Not Threatened			
Parsonsia capsularis (G.Forst.) R.Br. var. *capsularis*	New Zealand jasmine	Not Threatened			
Parsonsia heterophylla A.Cunn.		Not Threatened			
Pelargonium inodorum Willd.		Not Threatened		DP, EF, SO	
Pellaea rotundifolia (G.Forst.) Hook.	button fern	Not Threatened		TO	
Pennantia corymbosa J.R.Forst. & G.Forst.	kaikomako	Not Threatened			
Pentachondra pumila (J.R.Forst. & G.Forst.) R.Br.		Not Threatened		SO	
Pentapogon aucklandica (Hook.f.) de Lange & L.M.H.Schmid		Not Threatened			
Pentapogon avenoides (Hook.f.) P.M.Peterson, Romasch. & Soreng		Not Threatened			Previous Name and Authority: *Deyeuxia avenoides* (Hook.f.) Buchanan
Pentapogon crinita (L.f.) P.M.Peterson, Romasch. & Soreng		Not Threatened		EF, SO	Previous Name and Authority: *Dichelachne crinita* (L.f.) Hook.f.
Phlegmariurus varius (R.Br.) A.R.Field & Bostock		Not Threatened		SO	
Phormium cookianum Le Jol. subsp. cookianum	mountain flax	Not Threatened			
Phormium tenax J.R.Forst. & G.Forst.	flax	Not Threatened		SO	
Phyllachne colensoi (Hook.f.) Berggr.		Not Threatened		SO	
Phyllocladus alpinus Hook.f.		Not Threatened			
Pimelea oreophila C.J.Burrows subsp. *oreophila*		Not Threatened			
Pimelea oreophila subsp. *lepta* C.J.Burrows		Not Threatened	TL		TL = H: Taiari/Taieri Ridge, east Otago. Accession number: H OTA 041293
Pittosporum colensoi Hook.f.		Not Threatened			
Pittosporum eugenioides A.Cunn.	lemonwood	Not Threatened			
Pittosporum tenuifolium Sol. ex Gaertn.	kohuhu	Not Threatened			
Plagianthus divaricatus J.R.Forst. & G.Forst.		Not Threatened			
Plagianthus regius (Poit.) Hochr. subsp. *regius*	lowland ribbonwood	Not Threatened			
Plantago lanigera Hook.f.		Not Threatened	TL		TL = H, ISL, T?: St. Mary Ecological District / Otago Lake District, alpine / Mount Kyeburn / Maniototo. Accession number: H AK 8666, K000340079?; ISL WELT SP002306; T? WELT SP002301, WELT SP002306
Plantago novae-zelandiae L.B.Moore		Not Threatened	TL		TL = T?: Mount Kyeburn. Accession number: T? WELT SP002320
Plantago raoulii Decne.		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Plantago triandra Berggr.		Not Threatened			
Plantago unibracteata Rahn		Not Threatened	TL		TL = T?: Mount Kyeburn. Accession numbers: T? WELT SP002984, WELT SP002300
Pakau pennigera (G. Forst.) S.E. Fawc. et A.R. Sm.		Not Threatened		TO	Previous Name and Authority: *Pneumatopteris pennigera* (G.Forst.) Holttum
Poa breviglumis Hook.f.		Not Threatened			
Poa buchananii Zotov		Not Threatened			
Poa cita Edgar	silver tussock	Not Threatened	TL		TL = ISL: Otago. Accession number: ISL AK 1876
Poa colensoi Hook.f.		Not Threatened			
Poa hesperia Edgar		Not Threatened			
Poa imbecilla Spreng.		Not Threatened	TL		TL = I, L, I or ISL: Manuherikia Plain, "Vincent Co. & Blacks, same station" / Blacks, Ophir, Manuherikia plain. Accession numbers: I WELT SP067003/B; L WELT SP067003/A; I or ISL WELT SP06990
Poa kirkii Buchanan		Not Threatened			
Poa matthewsii Petrie		Not Threatened	TL		TL = L, ISL: Catlins River, Otago, sea level / Waipahī, S. Otago, on banks of river. Accession numbers: L WELT SP066983, WELT SP066929; ISL CHR 6768
Poa novae-zelandiae Hack.		Not Threatened			
Poa sublimis Edgar		Not Threatened			
Poa subvestita (Hack.) Edgar		Not Threatened			
Podocarpus laetus Hooibr. ex Endl.	Hall's totara	Not Threatened			
Podocarpus nivalis Hook.		Not Threatened			
Podocarpus totara var. *totara* G.Benn. ex D.Don	tōtara	Not Threatened			
Polystichum cystostegium (Hook.) J.B.Armstr.		Not Threatened			
Polystichum neozelandicum Fée	shield fern	Not Threatened			Previous Name and Authority: *Polystichum neozelandicum* Fée subsp. *neozelandicum*
Polystichum neozelandicum subsp. *zerophyllum* (Colenso) Perrie	shield fern	Not Threatened			
Polystichum vestitum (G.Forst.) C.Presl	prickly shield fern	Not Threatened			
Potamogeton cheesemanii A.Benn.	red pondweed	Not Threatened		SO	
Potentilla anserinoides Raoul		Not Threatened		DP	
Prasophyllum colensoi Hook.f.	leek orchid	Not Threatened			
Pectinopitys ferruginea (G.Benn. ex D.Don) C.N.Page	miro	Not Threatened			Previous Name and Authority: *Prumnopitys ferruginea* (D.Don) de Laub.
Pseudodiphasium volubile (G.Forst.) Holub		Not Threatened		SO?	Previous and Name Authority: *Lycopodium volubile* G.Forst.
Pseudopanax arboreus (Murray) Philipson	Five finger	Not Threatened	NR		Indigenous and naturalised populations
Pseudopanax colensoi (Hook.f.) Philipson var. *colensoi*		Not Threatened			
Pseudopanax colensoi var. *ternatus* Wardle		Not Threatened			
Pseudopanax crassifolius (Sol. ex A.Cunn.) K.Koch	lancewood	Not Threatened			
Pseudopanax linearis (Hook.f.) K.Koch		Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Pseudowintera colorata (Raoul) Dandy	horopito	Not Threatened			
Pteridium esculentum (G.Forst.) Cockayne		Not Threatened		SO	
Pterophylla racemosa (L.f.) Pillon & H.C.Hopkins	kāmahi	Not Threatened			
Pterostylis areolata Petrie		Not Threatened			
Pterostylis australis Hook.f.		Not Threatened			
Pterostylis banksii A.Cunn.	greenhood orchid	Not Threatened			
Pterostylis graminea Hook.f.		Not Threatened			
Pterostylis montana Hatch		Not Threatened			
Pterostylis venosa Colenso		Not Threatened			
Pyrrosia eleagnifolia (Bory) Hovenkamp		Not Threatened			
Ranunculus acaulis Banks & Sol. ex DC.		Not Threatened		SO	
Ranunculus amphitrichus Colenso	waoriki	Not Threatened		SO	
Ranunculus cheesemanii Kirk		Not Threatened			
Ranunculus crithmifolius Hook.f.		Not Threatened			
Ranunculus foliosus Kirk		Not Threatened	TL		TL = L: Otago. Accession number: L WELT SP000332
Ranunculus glabrifolius Hook.		Not Threatened		SO	
Ranunculus gracilipes Hook.f.		Not Threatened	TL		TL = N, S: Maungatua (Hill) / Mount Maungatua, Taiari/Taieri Country. Accession numbers: N CHR 334052; S WELT SP000366, WELT SP000367
Ranunculus multiscapus Hook.f.		Not Threatened			
Ranunculus reflexus Garn.-Jones		Not Threatened	TL		TL = T? or S?, T?: Routeburn, Valley of the Dart (Dart Valley). Accession numbers: T? WELT SP000358; T? or S? WELT SP000359, WELT SP000358
Ranunculus sericophyllus Hook.f.		Not Threatened	TL		TL = H, N, lost: snow holes on Mount Brewster and Hopkins River / Bold Peak. Accession numbers: H K? lost?; N CHR 76532
Raoulia buchananii Kirk		Not Threatened	TL		TL = S, lost: Mount Alta / Wānaka Ecological District. Accession numbers: S AK 10095, lost?
Raoulia glabra Hook.f.		Not Threatened			
Raoulia grandiflora Hook.f.		Not Threatened			
Raoulia hectorii Hook.f. var. *hectorii*		Not Threatened	TL		TL = H, T (possible): Otago Lake District "subalpine" / Old Man Range. Accession number: H K?; T (possible): WELT SP046434
Raoulia subsericea Hook.f.		Not Threatened			
Raoulia tenuicaulis Hook.f.		Not Threatened			
Raukaua anomalus (Hook.) A.D.Mitch., Frodin & Heads		Not Threatened			
Raukaua edgerleyi (Hook.f.) Seem.		Not Threatened		DP	
Raukaua simplex (G.Forst.) A.D.Mitch., Frodin & Heads		Not Threatened			
Ripogonum scandens J.R.Forst. & G.Forst.	supplejack	Not Threatened			
Rorippa palustris (L.) Besser		Not Threatened		SO	
Rubus australis G.Forst.	bush lawyer	Not Threatened			
Rubus cissoides A.Cunn.	bush lawyer	Not Threatened			
Rubus schmidelioides A.Cunn. var. *schmidelioides*	bush lawyer	Not Threatened			

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Rubus schmidelioides var. *subpauperatus* (Cockayne) Allan	bush lawyer	Not Threatened			
Rubus squarrosus Fritsch	leafless lawyer	Not Threatened			
Rumohra adiantiformis (G.Forst.) Ching		Not Threatened		SO	
Ruppia polycarpa R.Mason		Not Threatened		SO	
Rytidosperma australe (Petrie) Connor & Edgar		Not Threatened	TL	SO	TL = H, I, TF: Mount Ida Range / Maniototo County / Macraes. Accession numbers: H WELT SP040330; I CHR 20141, WELT SP039845; TF CHR 4091
Rytidosperma clavatum (Zotov) Connor & Edgar		Not Threatened			
Rytidosperma corinum Connor & Edgar		Not Threatened			
Rytidosperma gracile (Hook.f.) Connor & Edgar		Not Threatened		SO	
Rytidosperma nigricans (Petrie) Connor & Edgar		Not Threatened			
Rytidosperma setifolium (Hook.f.) Connor & Edgar		Not Threatened			
Rytidosperma unarede (Raoul) Connor & Edgar		Not Threatened			
Samolus repens var. *repens* (J.R.Forst. & G.Forst.) Pers.		Not Threatened		SO	
Sarcocornia quinqueflora subsp. *quinqueflora* (Bunge ex Ung.-Sternb.) A.J.Scott		Not Threatened		SO	
Schefflera digitata J.R.Forst. & G.Forst.	patē	Not Threatened			
Schoenoplectus pungens (Vahl) Palla		Not Threatened		SO	
Schoenus concinnus (Hook.f.) Hook.f.		Not Threatened			
Schoenus pauciflorus (Hook.f.) Hook.f.		Not Threatened			
Scleranthus uniflorus P.A.Will.		Not Threatened			
Senecio glomeratus Poir. subsp. *glomeratus*		Not Threatened		SO	
Senecio minimus Poir.	fireweed	Not Threatened		SO	
Senecio quadridentatus Labill.	cotton fireweed	Not Threatened		SO	
Senecio wairauensis Belcher	mountain fireweed	Not Threatened			
Solanum laciniatum Aiton	porporo	Not Threatened		SO	
Sophora microphylla Aiton	kōwhai	Not Threatened			
Spergularia tasmanica (Kindb.) L.G.Adams	New Zealand sea spurrey	Not Threatened		SO	
Stellaria gracilenta Hook.f.	Slender chickweed	Not Threatened			
Stellaria parviflora Hook.f.	New Zealand chickweed	Not Threatened		SO	
Stellaria roughii Hook.f.	Scree chickweed	Not Threatened			
Sticherus cunninghamii (Heward ex Hook.) Ching	umbrella fern	Not Threatened			
Streblus heterophyllus (Blume) Corner	small-leaved milk tree	Not Threatened			
Suaeda novae-zelandiae Allan		Not Threatened			
Taraxacum zealandicum Dahlst.	New Zealand dandelion	Not Threatened		SO	Previous Name and Authority: *Taraxacum magellanicum* Sch.Bip.
Tetragonia trigyna Banks et Sol. ex Hook.f.	native spinach	Not Threatened		SO	Previous Name and Authority: *Tetragonia implexicoma* (Miq.) Hook.f.

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Thelymitra cyanea (Lindl.) Benth.	swamp sun orchid	Not Threatened		SO	
Thelymitra hatchii L.B.Moore	Hatch's sun orchid	Not Threatened			
Thelymitra longifolia J.R.Forst. & G.Forst.	white sun orchid	Not Threatened			
Thelymitra nervosa Colenso	spotted sun orchid	Not Threatened			
Thelymitra pauciflora R.Br.	sun orchid	Not Threatened		SO	
Thelymitra pulchella Hook.f.	striped sun orchid	Not Threatened			
Tmesipteris elongata P.A.Dang.	fork fern	Not Threatened		SO	
Tmesipteris tannensis (Spreng.) Bernh.	fork fern	Not Threatened			
Trichomanes venosum R.Br.		Not Threatened		SO	
Triglochin striata Ruiz & Pav.	arrow grass	Not Threatened		SO	
Trisetum lepidum Edgar & A.P.Druce		Not Threatened			
Trisetum spicatum (L.) K.Richt.		Not Threatened		SO	
Trisetum tenellum (Petrie) A.W.Hill		Not Threatened			
Typha orientalis C.Presl		Not Threatened		SO	
Urtica ferox G.Forst.	tree nettle	Not Threatened			
Urtica sykesii Grosse-Veldmann & Weigend	scrub nettle	Not Threatened	TL	SO	TL = H: Waipori Falls, approx. 25 km south of Ōtepoti Dunedin. Accession numbers: H CHR 546587 A, CHR 546587 B
Utricularia dichotoma Labill.	Bladderwort	Not Threatened		SO	
Veronica buchananii Hook.f.		Not Threatened	TL		TL = H, S, ISL. T?: Otago Lake District, alpine / Waitaki Ecological Region / Wānaka Ecological District. Accession numbers: H K?; S AK 8146; ISL AK 8138; T? WELT SP005364
Veronica decora (Ashwin) Garn.-Jones		Not Threatened			
Veronica densifolia (F.Muell.) F.Muell.	hebejeebie	Not Threatened	TL		TL = H, L, ISL: Otago Lake District alpine / peaty ridges at Rough Peaks, Lake Whakatipu / Eyre Ecological District. Accession numbers: H K?; L CHR 70216, CHR 70216 P; ISL AK 107847
Veronica elliptica G.Forst.		Not Threatened		SO	
Veronica epacridea Hook.f.		Not Threatened			
Veronica hectorii Hook.f. subsp. *hectorii*		Not Threatened	TL		TL = H: Mount Alta. Accession number: H K?
Veronica lyallii Hook.f.		Not Threatened			
Veronica lycopodioides Hook.f.		Not Threatened			
Veronica odora Hook.f.		Not Threatened			
Veronica pauciramosa (Cockayne & Allan) Garn.-Jones		Not Threatened	TL		TL = L, ISL: upper Routeburn Valley, up to Lake Harris / Dart Ecological District. Accession numbers: L W?; ISL AK 107674
Veronica pulvinaris (Hook.f.) Cheeseman	plantaginaceae	Not Threatened			
Veronica salicifolia G.Forst.		Not Threatened		SO	

Continued on next page

Regionally Not Threatened

Name and Authority	Common Name	National Conservation Status	Regional Qualifiers	National Qualifiers	Notes
Veronica subalpina Cockayne		Not Threatened	TL		TL = H, CT, T?: subalpine scrub head of Estuary Burn, Lake Wānaka / Arawata Ecological District. Accession numbers: H CHR 33029; CT WELT SP017380/A, WELT SP017381; T? CHR 549641
Veronica thomsonii (Buchanan) Cheeseman	snow hebe	Not Threatened	TL		TL = L, L?: Mount Pisa, Otago / Mount Alta / Pisa Ecological District. Accession numbers: L AK 8335, WELT SP042922/A; L? AK 8335
Viola cunninghamii Hook.f.	mountain violet	Not Threatened		SO?	
Viola filicaulis Hook.f.	forest violet	Not Threatened			
Wahlenbergia rupestris G.Simpson	white harebell	Not Threatened	TL		TL = H, I: Alexandra, Central Otago. Accession numbers: H CHR 76430; I CHR 550042, CHR 550043
Wahlenbergia albomarginata subsp. *albomarginata* Hook.	New Zealand harebell	Not Threatened			
Waireia stenopetala (Hook.f.) D.L.Jones, M.A.Clem. & Molloy	yellow beaks	Not Threatened			
Wolffia australiana (Benth.) Hartog & Plas	water meal	Not Threatened			
Zotovia colensoi (Hook.f.) Edgar & Connor	grass	Not Threatened			
TAXONOMICALLY INDETERMINATE (2)					
Agrostis (a) (CHR 402485; Dunstan Range)		Not Threatened		DP	
Ozothamnus vauvilliersii Hombr. & Jacquinot ex Decne.	mountain tauhinu	Not Threatened			

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural State; NStr = National Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Assessed taxa not in the New Zealand Threat Classification System (14)

Taxa considered to be in the Otago region but have not been assessed in the New Zealand Threat Classification System for indigenous vascular plant taxa (de Lange et al. 2018). These taxa are mostly 'taxonomically indeterminate', i.e., used loosely to include both undescribed entities which still require formal taxonomic research to confirm their validity and provide them with a formal name and, occasionally, described species whose validity is in question.

Table 4: Assessed indigenous vascular plant taxa in Otago not in NZTCS

Name and Authority	Common Name	Regional Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
REGIONALLY DATA DEFICIENT (4)													
TAXONOMICALLY INDETERMINATE (4)													
Carex potens K.A Ford		Regionally Data Deficient									TL		TL = T?: Old Man Range. Accession numbers: T? WELT SP001701, WELT SP001703
Celmisia aff *graminifolia*		Regionally Data Deficient											
Craspedia sp. "Tautuku"		Regionally Data Deficient		Yes									
Veronica matthewsii		Regionally Data Deficient									TL		TL = L: Humboldt Mountains, Dart Ecological District. Accession number: L AK 7955
REGIONALLY CRITICAL (4)													
TAXONOMICALLY DETERMINATE (1)													
Myosotis venticola		Regionally Critical	A (3)	Yes		≤ 1 ha			Low	Low	DPR, DPS, DPT, NR, NS, NStr, Sp, TL		
TAXONOMICALLY INDETERMINATE (3)													
Apium "inland saline"		Regionally Critical	A (3)	Yes	Yes	≤ 1 ha			Low	Low	DPS, DPT, NStr, RE, RR, Sp		
Brachyscome "Taiari		Regionally Critical	A (3)	Yes	Yes	≤ 1 ha			Low	Low	DPR, DPS, DPT, NStr, OL, RE		

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Assessed taxa but not in NZTCS

Name and Authority	Common Name	Regional Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Qualifiers	Notes
Melicytus aff. *crassifolius* (b) (CHR 616706; Cape Saunders)		Regionally Critical	A (1)	Yes	Yes	≤ 250 mature individuals			High	Low	DPR, DPT, RR		
REGIONALLY ENDANGERED (1)													
TAXONOMICALLY INDETERMINATE (1)													
Stellaria cf *roughii* CHR 595279		Regionally Endangered	B (3)				≤ 10 ha	Stable: ±10%	Low	Low	DPR, DPS, DPT, RR, Sp		
REGIONALLY NATURALLY UNCOMMON (2)													
TAXONOMICALLY INDETERMINATE (2)													
Montia "String Bog"		Regionally Naturally Uncommon		Yes	Yes		< 100000 ha	Stable: ±10%	Low	Low	DPS, DPT, NStr, RE, RR, Sp		
Oxalis "Otago scree"		Regionally Naturally Uncommon		Yes			< 100000 ha	Stable: ±10%	Low	Low	NS		
REGIONALLY NOT THREATENED (2)													
TAXONOMICALLY INDETERMINATE (2)													
Anisotome flabellifolia Simpson		Regionally Not Threatened											TL = H: Flagstaff Hill, Ōtepoti Dunedin. Accession number: CHR 75688 Other known Name and Authority: *Anisotome aromatica* var. *flabellifolia* (G.Simpson) Allan
Geranium aff. *microphyllum*		Regionally Not Threatened		Yes			> 1000 ha	Stable: ±10%	Medium	Medium	DPS, DPT, NStr, PF, Sp		

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural State; NStr = Natural Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Type localities: H = Holotype, I = Isotype; S = Syntype; IS = Isosyntype; L = Lectoype; ISL = Isolectotype; N = Neotype; ISN = Isoneotype; TF = Type Fragment; NT = Not Typified; ? = uncertainty on locality type; T? = where type was mentioned but not described further. Abbreviations for Herbarium are: AD = State Herbarium of South Australia; AK = Auckland War Memorial Museum Herbarium; BD = DSIR Botany Division, now in CHR; CHR = Allan Herbarium; K = Royal Botanic Gardens Kew; LY = Claude Bernard University; MO = Missouri Botanical Garden; NSW = Royal Botanic Gardens, National Herbarium of New South Wales; OM = Otago Museum, now in either WELT or OTA; OTA = Otago Regional Herbarium; W = Wellington Dominion Museum, now in WELT; WELT = Museum of New Zealand Te Papa Tongarewa

Adventive indigenous vascular plant taxa from Aotearoa New Zealand reproducing in the wild in Otago.

Indigenous Aotearoa New Zealand taxa introduced to Otago that are wild and reproducing but are not considered native to the region

Table 5: Adventive indigenous vascular plant taxa from Aotearoa New Zealand that have been introduced to Otago

Name and Authority	Common Name	National Conservation Status	Notes
TAXONOMICALLY DETERMINATE			
Brachyglottis repanda J.R.Forst. & G.Forst.	rangiora	Not Threatened	In the South Island occurs in northwest Nelson to just south of Greymouth in the west, and near Kekerengu in the east. Naturalised on Banks Peninsula, Otago Peninsula, and on Stewart Island at Oban
Coprosma grandifolia Hook.f.	large-leaved coprosma	Not Threatened	Naturally occurs on the North to South Islands. In the South Island extending to Lake Ianthe in the west and the Marlborough Sounds in the east. Naturalised.populations are common round settled areas, particularly in eastern Otago
Coprosma repens Hook.f	taupata	Not Threatened	Occurs naturally in Three Kings, North and South Islands as far south as Greymouth in the west and Rarangi in the east but now extensively naturalised throughout the South Island, Stewart and Chatham Islands
Coprosma robusta Raoul	karamu	Not Threatened	Found in North and South Islands south to Banks Peninsula. Naturalised populations occur in Otago and Southland (typically around planting sites).
Hoheria sexstylosa Colenso	lacebark	Not Threatened	Naturally occurs probably as far south as Banks Peninsula but distinguishing between natural populations and those arising from planted individuals is difficult. Now common around settled areas in eastern Otago.
Metrosideros excelsa Sol. ex Gaertn.	pōhutukawa	Nationally Vulnerable	Naturally occurring north of Poverty Bay and north Taranaki, but can be now found as far south as Ōtepoti Dunedin where trees regularly produce wild seedlings
Olearia paniculata (J.R.Forst. & G.Forst.) Druce	akeake	Not Threatened	Occurs naturally on both the North and South Island from East Cape to south Canterbury. Widely planted in eastern Otago where occasional naturalised populations now occur.
Pseudopanax laetus (Kirk) Philipson		Declining	Occurs naturally in the northern half of the North Island but has naturalised around Ōtepoti Dunedin and elsewhere from introduced plants

Discussion

Regional threat assessments have been completed by regional councils in Aotearoa New Zealand, with the resulting regional threat lists being used as a tool to help maintain indigenous biodiversity. This report is the first regional assessment of the conservation status of indigenous vascular plant taxa in the Otago region. A total of 1242 indigenous vascular plant taxa were recorded in the Otago region from the national assessment (de Lange et al 2018). Of these indigenous vascular taxa, 115 were Regionally Data Deficient, 227 were Regionally Threatened, 275 were Regionally At Risk, and 614 Regionally Not Threatened. The panel also assessed 14 taxa not included in the national assessment of indigenous vascular plants. An additional 10 taxa were Regionally Extirpated (likely now extinct in the Otago region).

Regionally Extirpated indigenous vascular plant taxa

The number of regionally extirpated indigenous vascular plant taxa in Otago is 10 (Table 1). These include 9 regional extirpations and 1 national extinction. Of the 9 regional extirpations, five were in the Nationally Threatened categories (Nationally Critical = 3; Nationally Endangered = 1; Nationally Vulnerable = 1), two were At Risk (both Declining), and two were Not Threatened. A total of five taxa were at their historical – or indigenous – range, the inferred range of the taxon in pre-human times meet its natural limit in the region. For the nationally extinct taxon, *Stellaria elatinoides*, type gatherings and notes in the literature indicate that the species was in Otago (Heenan 2019). While *S. elatinoides* is currently classified in the national assessment and implied to be Globally Extinct, this taxon is not included in *Stellaria multiflora* subsp. *multiflora* which is widespread but uncommon in eastern and southern Australia (Heenan 2019).

Regionally Data Deficient indigenous vascular plant taxa

In the Otago region 115 indigenous vascular plant taxa were identified as Regionally Data Deficient (Table 2). These taxa are suspected to be threatened or, in some instances, possibly extinct in Otago but are not definitely known to belong to any category due to a lack of current information about their distribution and abundance (Townsend et al. 2008). The percentage of the total number of indigenous vascular plant taxa in Otago from the national assessment that were Regionally Data Deficient species was 9.5%.

Although the true status of Regionally Data Deficient taxa will span the entire range of available categories in the Otago region, like in national assessments (Townsend et al. 2008) and globally in the International Union for Conservation of Nature (IUCN Standards and Petition Committee, 2023), taxa in this list are mainly in this status because they are very seldom seen, so most are likely to end up being considered

threatened and some may already be extinct. In the national assessment the collection of sufficient demographic data to allow evaluation is considered a high priority for 'Data Deficient' taxa, as such data may confirm whether these taxa are 'Threatened' or 'At Risk' (Townsend et al. 2008).

Regionally Threatened indigenous vascular plant taxa

Two hundred and twenty-seven indigenous vascular plant taxa from the national assessment were assessed as Regionally Threatened (Table 3.5). The percentage of Regionally Threatened taxa was 18.3%. These taxa are grouped into the three categories: Regionally Critical with 93 taxa, Regionally Endangered with 68 taxa, and Regionally Vulnerable with 66 taxa. Generally, Regionally Threatened taxa were more severely threatened in Otago than they are in the national assessments.

Regionally At Risk indigenous vascular plant taxa

The number of Regionally At Risk indigenous vascular plant taxa in Otago from the national assessment was 275 (22.3%; Tables 3.4.1 and 3.4.2). The percentage of Regionally Declining was 4% and Regionally Naturally Uncommon was 16%. While taxa that qualify as Regionally At Risk do not meet the criteria for any of the Regionally Threatened categories, they are declining (though buffered by a large total population size and/or a slow decline rate), biologically scarce, recovering from a previously threatened status, or survive only in relictual (surviving remnant) populations (Townsend et al. 2008).

Regionally At Risk taxa are grouped into two categories only: Regionally Declining with 50 taxa, and Regionally Naturally Uncommon with 225 taxa. Compared to the national assessment for indigenous vascular plant taxa (de Lange et al. 2018), no Regionally Relict or Regionally Increasing were assessed.

Regionally Not Threatened indigenous vascular plant taxa

In Otago, 614 indigenous vascular plant taxa were identified that were Regionally Not Threatened (Table 3.6). Among these taxa, some indigenous Myrtacea taxa were designated as Regionally Not Threatened from higher threat assessments in de Lange et al. (2018), including mānuka *(Leptospermum scoparium* var. *scoparium),* mākahikātoa (*Kunzea serotina*), rawirinui (*K. robusta*), and rōhutu (*Neomyrtus pedunculata*). The national assessments were assessed in 2017 as more severely threatened due to the then recent arrival of myrtle rust (caused by *Austropuccinia psidii*) to Raoul Island (Kermadec Islands group) and northern Aotearoa New Zealand in April and May 2017, respectively, and a lack of knowledge how it would affect indigenous Myrtacea taxa. Although myrtle rust has now been found across the North Island and in the upper areas of the South Island (including occasionally in Christchurch), the risk posed to Myrtacea taxa in Otago was generally considered to be lower than has been assessed in northern locations. Note that recent assessments

for indigenous vascular plant taxa in Wellington and Tāmaki Makarau / Auckland also assessed some indigenous Myrtacea taxa with a reduced risk of extinction status than the earlier national assessment when the threat of myrtle rust had greater uncertainty (Crisp 2020; Simpkins et al. 2023; *cf.* de Lange et al. 2018). Moreover, modelling of climate suitability for myrtle rust (using different approaches and algorithms) in Aotearoa New Zealand appears to be lower in the south of the South Island than in the north of the South Island and in the North Island (e.g., Kriticos et al. 2008, 2013; Narouei-Khandan et al. 2020). Ongoing research and monitoring of the impacts of myrtle rust, including mostly from outside the Otago region, would provide valuable information for future region assessments on indigenous vascular plant taxa.

Regionally Non-resident indigenous vascular plant taxa

The only indigenous vascular plant taxa to Otago that was in the non-resident category was *Disphyma clavellatum* (Table 3.5). This taxon was considered to be a Regional Coloniser, like its national status (de Lange et al. 2018), because it established without direct or indirect help from humans and has been successfully reproducing in the wild since 1950, and otherwise would have triggered a 'Threatened' category due to its small population size.

Assessed indigenous vascular plant taxa not in the New Zealand Threat Classification System

Fourteen taxa were assessed to be legitimate taxon by the expert panel but were not included in the NZTCS (Table 4). Of these taxa, four were considered Regionally Deficient, three Regionally Critical, one Regionally Endangered, three Regionally Naturally Uncommon, and two Regionally Not Threatened.

Adventive indigenous vascular plant taxa

While several adventive indigenous vascular taxa are found in Otago, common examples are provided in Table 5. These indigenous Aotearoa New Zealand taxa are those introduced to the region that are wild and reproducing but were considered not to be native to Otago (see Table 5 for more details).

Select regional qualifiers for indigenous vascular plant taxa discussion

Otago was identified as a National Stronghold (i.e., containing > 20% of the national population) for 321 of Regionally Threatened and Regionally At Risk taxa. Of those taxa with National Strongholds in Otago, at least 36 are not found elsewhere, i.e., they are Regional Endemics (see Appendix 4 for Regionally Threatened and Regionally At Risk). Of these Regional Endemics there were more in the Regional Threatened category with 21 taxa (Regionally Critical = 14; Regionally Endangered = 6; Regionally Vulnerable = 1), than in the Regionally At Risk category with 16 taxa (Regionally Declining = 2; Regionally Naturally Uncommon = 14); at least one taxon was assessed as in the Regionally Data Deficient category. For the National Stronghold qualifier, the

number in the Regionally Threatened category was 130 taxa (Regionally Critical = 43, Regionally Endangered = 48, Regionally Vulnerable = 39), Regionally At Risk taxa had 186 taxa (Regionally Declining = 40, Regionally Naturally Uncommon = 146), and Regionally Data Deficient had two taxa.

Regionally Threatened and Regionally At Risk taxa in Otago included 215 taxa at their Natural Range limits in the north and south, not including Regional Endemics. Such information could potentially be used to identify sites that may require monitoring or management; for example, to understand or to mitigate the effects of human-induced climate change on these taxa. Of these taxa, 101 were Regionally Threatened with the remainder being Regionally At Risk. Note that for other Regional Categories (e.g., Regionally Data Deficient, Regionally Not Threatened) were not considered for Natural Range limits, at this stage.

The number of indigenous vascular plant taxa with the One Location qualifier in the Otago region is 35. When assessing the One Location qualifier for taxa, there were eight Regional Endemics, of which all these taxa were assessed as being Regionally Critical. The number of taxa with only One Location in Otago but also found outside the region was 26. Of the taxa with the One Location qualifier, 32 taxa were Regionally Threatened (Nationally Critical = 25, Nationally Endangered = 3, Nationally Vulnerable = 4) and three taxa were Regionally At Risk (Naturally Uncommon = 3).

In the Otago region the number of taxa identified with type localities was identified as 280 (Tables 1–4). This included 184 taxa with holotypes (or possible holotypes) and 54 taxa with isotypes (or possible isotypes). Although the number of type localities identified in the region was high, its likely more type specimens are from the region.

Summary

For the first time in this report, indigenous vascular plant taxa in Otago were identified and collated systematically by local experts. A consistent framework was then followed to assign the status and trends of the taxa in the region. Although efforts were taken to be as comprehensive as possible in this assessment on indigenous vascular plant taxa in the Otago region, it is acknowledged that some taxa may have been missed in this process. It is anticipated that future iterations of threat assessments for indigenous vascular plants in the Otago region may include additional taxa, and/or removal of others. Similar to the taxa list and the threat assessments, the qualifiers for all Regionally Threatened and At Risk taxa were assessed as comprehensively as possible, with care taken to consult the relevant literature – both grey and published – and experts, where appropriate.

The Department of Conservation – Te Papa Atawhai is tasked with managing indigenous taxa nationally under the Wildlife Act, but regional and district councils

have a statutory obligation to manage the habitats of Threatened taxa under the RMA. By understanding regional population sizes and having a knowledge of habitats of threatened taxa, their threats can be managed and their recovery supported. For example, this includes for informing Assessments of Environmental Effects conducted through RMA consenting processes; identification of ecologically significant areas as provided for in the proposed Otago Regional Policy Statement and National Policy Statement for Indigenous Biodiversity as they include criteria for include for taxa that are only found in the region (i.e., regional endemics), have distribution limits in the region, have type localities in the region, and/or regionally uncommon species; and for the prioritisation of conservation activities undertaken by regional councils, territorial authorities and unitary councils, such as monitoring, pest animal and plant control or eradication, and restoration programmes. Potential benefits to be gained from assessing the threat to indigenous taxa at a regional scale, as well as the national scale include:

- improved knowledge of the status of taxa across the landscape,
- direction for local government and community groups to prioritise conservation actions that can work in synergy with or provide additionality to the work of DOC,
- an improved ability to protect taxa through regulatory processes, and
- improved national conservation assessments of species through greater local input.

Acknowledgement

Thanks to Philippa Crisp and Roger Uys from Greater Wellington Regional Council and Sabine Melzer from Auckland Council for advice on the regional conservation status process, Pascale Michel from the Department of Conservation | Te Papa Atawhai (DOC) for advice on the national assessments and the regional conservation status process, Janice Lord and Aimee Pritchard for compiling a list of type localities and indigenous vascular plant taxa, John Steel for assisting Janice Lord and Aimee Pritchard on the list for indigenous vascular plant taxa, Peter Johnson for advice on plant taxa, Leon Perrie for advice on plant taxa and for providing information on type localities from the Museum of New Zealand | Te Papa Tongarewa, Aaron Wilton and Peter Heenan from Manaaki Whenua – Landcare Research for providing information on type localities from the Allan Herbarium, Auckland Museum War Memorial Museum | Tāmaki Paenga Hira for information on type localities, Jerry Cooper, Helen Greenep and Aaron Wilton for information and discussions on types localities from the Global Biodiversity Information Facility and the Atlas of Living Australia, Jane Gosden for advice on plant taxa particularly Celmisia, Kerry Ford for advice on plant taxa particularly some Carex taxa, Jesse Bythell for discussions about the New Zealand Plant Conservation Network website and indigenous vascular plant species lists, Pieter Pelser and Matthew Walters for discussions on plants and regional conservation statuses, and Zoe Lunniss for attending a day of the regional conservation assessment, Nathan Whitmore for the development of the dashboard for the locally-operated assessments that expediated the regional threat status and trends assessments for this large group of taxa, Ciaran Campbell and Tim Ware from the Otago Regional Council for editorial advice and discussion on regional threat assessments, and other Council staff that provided support for these assessments. Thanks also to the those who collected information on indigenous vascular plant taxa who posted this information on open access databases, and the right holders for the type locality information accessed through online databases: Manaaki Whenua – Landcare Research, United Herbaria of the University and ETH Zurich, Board of the Botanic Gardens and State Herbarium, Royal Botanic Gardens Board, Missouri Botanical Garden, and the Naturalis Biodiversity Center. Jeremy Rolfe, who was formerly at DOC, led the development of this systematic approach to assessing the regional conservation status for indigenous species.

References

Allan H.H. (1961). Flora of New Zealand, Volume 1, DSIR, Government Printer, Wellington

Belbin, L., Wallis, E., Hobern, D., Zerger, A. (2021). The Atlas of Living Australia: History, current state and future directions. Biodiversity Data Journal 9: e65023. DOI: https://doi.org/10.3897/BDJ.9.e65023

Bibby, C.J. (1997). Macraes Ecological District: Survey report for the Protected Natural Areas Programme. New Zealand Protected Natural Areas Programme. Department of Conservation, Dunedin. 158 pp.

Bloxham, M., Woolly, J., Dunn, N., Chaffe, A., Melzer, S. (2023). Conservation status of freshwater fishes in Tāmaki Makaurau/Auckland. Auckland Council Technical Report, TR2023/13. 36 p.

Breitwieser, I., Heenan, P.J., Nelson, W.A., Wilton, A.D. eds. (2023) Flora of New Zealand Online. Accessed at: www.nzflora.info

Breitwieser, I., Ford, K.A. (2022). Four new species of *Craspedia* (Compositae/Asteraceae, Gnaphalieae) from the South Island of New Zealand, all characterised by dark red-purple anthers. New Zealand Journal of Botany, 61(2–3): 131–157.

Brumley, C.F., Stirling, M.W., Manning, M.S. (1986). Old Man Ecological District: Survey report for the Protected Natural Areas Programme. New Zealand Protected Natural Areas Programme Series No 3. Department of Land and Survey, Wellington. 174 p.

Burrows, C.J. (2008). Genus *Pimelea* (Thymelaeaceae) in New Zealand 1. The taxonomic treatment of seven endemic, glabrous-leaved species. New Zealand Journal of Botany 46: 127–176.

Burrows, C.J. (2009). Genus *Pimelea* (Thymelaeaceae) in New Zealand 2. The endemic *Pimelea prostrata* and *Pimelea urvilliana* species complexes. New Zealand Journal of Botany 47: 163–229.

Burrows, C.J. (2011). Genus *Pimelea* (Thymelaeaceae) in New Zealand 4. The taxonomic treatment of ten endemic abaxially hairy-leaved species. New Zealand Journal of Botany 49(1): 41–106.

Carter, J. (1994). Waipori Ecological District: A survey report for the Protected Natural Area Programme. New Zealand Protected Natural Areas Programme Series No 24. Department of Conservation, Dunedin. 166 p.

Chang, W., Cheng, J., Allaire, J., Sievert, C., Schloerke, B., Xie, Y., Allen, J., McPherson, J., Dipert, A., Borges. B. (2021). shiny: Web Application Framework for R. R package version 1.7.1.

Cheng, J., Karambelkar, B., Xie, Y. (2022). leaflet: Create Interactive Web Maps with the JavaScript 'Leaflet' Library. R package version 2.1.1, https://CRAN.R-project.org/package=leaflet

Comrie, J. (1992). Dansey Ecological District: Survey report for the Protected Natural Area Programme. New Zealand Protected Natural Areas Programme Series No 23. Department of Conservation, Dunedin. 106 p.

Crisp, P. (2020). Conservation status of indigenous vascular plant species in the Wellington region. Greater Wellington Regional Council Publication No. GW/ESCI-G-20/20 Wellington. 39 p.

Crisp, P., Hitchmough, R., Newman, D., Adams, L., Lennon, O., Woolley, C., Hulme-Moir, A., Bell, T., Herbert, S., Spearpoint, O., Nelson, N. (2022a). Conservation status of reptile species in the Wellington region. Greater Wellington Regional Council, Publication No. GW/ESCI-G-23/03, Wellington. 23 p.

Crisp, P., O'Donnell, C., Pryde, M., Ryan, J., Spearpoint, O. (2023). Conservation status of bat species in the Wellington region. Greater Wellington Regional Council, Publication No. GW/ESCI-G-23/01, Wellington. 13 p.

Crisp, P., Robertson, H., McArthur, N., Cotter, S. (2024). Conservation status of bird in the Wellington region. Greater Wellington Regional Council, Publication No. GW/KI-G-23/21, Wellington. 50 p.

Crisp, P., Perrie, A., Morar, A., Royal, C. (2022b). Conservation status of indigenous freshwater fish in the Wellington region. Greater Wellington Regional Council Publication No. GW/ESCI-T-22/02, Wellington. 8 p.

de Lange, P.J., Blanchon, D.J. (2023). New combinations in *Helichrysum simpsonii* Kottaim. for the taxa described as *H. selago* var. *acutum Cheeseman* and *H. selago* var. *tumidum* Cheeseman (Asteraceae) from Aotearoa / New Zealand. Ukrainian Botanical Journal 80(4): 301–305.

de Lange, P.J., Heenan, P.B., Houliston, G.J., Rolfe, J.R., Mitchell, A.D. (2013). New *Lepidium* (Brassicaceae) from New Zealand. PhytoKeys 24: 1–147.

de Lange, P.J., Rolfe, J.R., Barkla, J.W., Courtney, S.P., Champion, P.D., Perrie, L.R., Beadel, S.M., Ford, K.A., Breitwieser,I., Schonberger, I., Hindmarsh-Walls, R., Heenan, P.B., Ladley, K. (2018). Conservation status of New Zealand indigenous vascular plants, 2017. New Zealand Threat Classification Series 22. Department of Conservation, Wellington. 82 p.

Dickinson, K.J.M. (1988). Umbrella Ecological District: Survey report for the Protected Natural Areas Programme. New Zealand Protected Natural Areas Programme Series No 7. Department of Conservation, Wellington. 179 p.

Dickinson, K.J.M. (1998). Nokomai Ecological District: Survey report for the Protected Natural Area Programme. New Zealand Protected Natural Areas Programme Series No 9. Department of Conservation, Wellington. 139 p.

Druce, T. (2006). Plant checklist for mountains of Inland Otago and Northern Southland. Druce list number: 292. Gridref: S.

Edgar, E., Connor. H.E. (2010). Flora of New Zealand Volume 5 (2nd edition), Manaaki Whenua Press, Lincoln.

Esri., i-cubed., USDA., USGS., AEX., GeoEye., Getmapping., Aerogrid., IGN., IGP., UPR., EGP., GIS User Community. (2023). Map tiles by Stamen Design, CC by 3.0.

Fagan, B., Pillai, D. (1992). Manorburn Ecological District: Survey report for the Protected Natural Areas Programme. New Zealand Protected Natural Areas Programme Series No 22. Department of Conservation, Wellington. 150 p.

Firke, S. (2021). janitor: simple tools for examining and cleaning dirty data. R package version 2.1.0, https://CRAN.R-project.org/package=janitor

GBIF.org (2023). GBIF Occurrence Download. DOI: https://doi.org/10.15468/dl.t67cvv

Grolemund G., Wickham H. (2011). Dates and times made easy with lubridate. Journal of Statistical Software 40(3): 1–25.

Grove, P. (1994). Hawkdun Ecological District: Survey report for the Protected Natural Area Programme. New Zealand Protected Natural Areas Programme Series No 25. Department of Conservation, Dunedin. 118 p.

Grove, P. (1994). Maniototo Ecological District: Survey report for the Protected Natural Areas Programme. New Zealand Protected Natural Areas Programme Series No 30 Department of Conservation, Dunedin. 96 p.

Heads, M. (1998). Biodiversity in the New Zealand divaricating tree daisies: *Olearia* sect. nov. (Compositae). Botanical Journal of the Linnean Society 127(3): 239–285.

Heads, M.J. (1990). A revision of the *Kelleria* and *Drapetes* (Thymelaeaceae). Australian Systematic Botany 3: 595–652.

Heenan, P.B. (2017). A taxonomic revision of *Cardamine* L. (Brassicaceae) in New Zealand. Phytotaxa 330(1): 001–154.

Heenan, P.B. (2019). Taxonomic notes on the New Zealand flora: the status of the extinct herb *Stellaria elatinoides* (Carophyllaceae) and recognition of *Stellaria multiflora* subsp. *multiflora* from New Zealand. New Zealand Journal of Botany 57: 309–315.

Hijmans, R. (2022). terra: Spatial Data Analysis. R package version 1.5-21, https://CRAN-R-project.org/package=terra

Iannone, R., Allaire, J., Borges, B. (2020). flexdashboard: R Markdown Format for Flexible Dashboards. R package version 0.5.2

IUCN Standards and Petitions Committee. (2022). *Guidelines for using the IUCN Red List Categories and Criteria*. *Prepared by the Standards and Petitions Committee. Downloadable from* https://www.iucnredlist.org/documents/RedListGuidelines.pdf vol. 15.

Jarvie, S., Davidson-Watts, I., Dennis, G., Gower, C., Pryde, M. (2023a). Regional conservation status of bat species in Otago. Otago Regional Council, Otago Threat Classification Series, 2023/2. 19 p.

Jarvie, S., Knox, C., Monks, J.M., Reardon, J., Campbell, C. (2023b). Regional conservation status of reptile species in Otago. Otago Regional Council, Otago Threat Classification Series, 2023/1. 24 p.

Jarvie, S. (2024). Regional conservation status of Otago's amphibians. Otago Regional Council, Otago Classification Series, 2024/4. 24 p.

Karambelkar, B., Schloerke, B. (2018). leaflet.extras: Extra functionality for 'leaflet' Package. R package version 1.0.0, https://CRAN.R-project.org/package=leaflet.extras

Kriticos D.J., Leriche, A. (2008). The current and future potential distribution of guava rust, *Puccinia psidii* in New Zealand. MAF Biosecurity New Zealand Technical Paper. Rotorua, New Zealand: Scion.

Kriticos, D.J., Morin, L., Leriche, A., Anderson, R.C., Caley, P. (2013). Combining a climatic niche model of an invasive fungus with its host species distributions to identify risks to natural assets: *Puccinia psidii* sensu lato in Australia. *PLoS ONE* 8: e64479.

Macmillan, B.H. (1991). *Acaena rorida* and *Acaena tesca* (Rosaceae) — two new species from New Zealand. New Zealand Journal of Botany 29: 131–138.

Melzer, S., Hitchmough, R., van Winkel, D., Wedding, C., Chapman, S., Rixon, M., Moreno, V., J. Germano, J. (2022a). Conservation status of amphibian species in Tāmaki Makaurau / Auckland. Auckland Council Technical Report, TR2022/4. 16 p.

Melzer, S., Hitchmough, R., van Winkel, D., Wedding, C., Chapman, S., Rixon, M. (2022b). Conservation status of reptile species in Tāmaki Makaurau / Auckland. Auckland Council Technical Report, TR2022/3. 20 p.

Meudt, H.M. (2008). Taxonomic revision of Australasian snow hebes (*Veronica*, Plantaginaceae). Australian Systematic Botany 21: 387–421.

Meudt, H.M., Prebble, J.M. (2018). Species limits and taxonomic revision of the bracteate-prostrate group of southern hemisphere forget-me-nots (*Myosotis*, Boraginaceae), including description of three new species endemic to New Zealand. Australian Systematic Botany 31: 48–105.

Meudt, H.M., Thorsen, M.J., Prebble, J.M. (2020). Taxonomic revision of the *Myosotis australis* group (Boraginaceae) native to Australia, New Zealand and New Guinea. Australian Systematic Botany 33: 477–524.

Michel, P. (2021). Amendment to the New Zealand Threat Classification System 2008: revised categories 2021. Department of Conservation, Wellington. 5 p.

Moore, L.B., Edgar, E. (1976). Flora of New Zealand Volume 2, DSIR, Government Printer, Wellington.

Narouei-Khandan, H.A., Worner, S.P., Vijanen, S.L.H., van Bruggen, A.H.C., Jones, E.E. (2020). Projecting the suitability of global and local habitats for myrtle rust (*Austropuccinia psidii*) using model consensus. Plant Pathology 69: 17–27.

OpenStreetMap contributors. (2017). Planet dump retrieved from https://planet.osm.org. https://www.openstreetmap.org

Pebesma, E. (2018). Simple features for R: Standardized support for spatial vector data. The R Journal 10(1): 439–446.

Posit Team (2023). RStudio: Integrated Development Environment for R. Posit Software, PBC, Boston, MA, USA.

Prebble J.M., Symonds, V.V., Tate J.A., Meudt, H.M. (2022) Taxonomic revision of the southern hemisphere pygmy forget-me-not group (*Myosotis*; Boraginaceae) based on morphological, population genetic and climate-edaphic niche modelling data. Australian Systematic Botany 35, 63-94.

R Core Team. (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Rolfe, J., Makan, T. Tait, A. (2021). Supplement to the New Zealand Threat Classification System manual 2008: new qualifiers and amendments to qualifier definitions, 2021. Department of Conservation, Wellington. 7 p.

Saldivia, P. (2023). Nomenclature and typifications in *Celmisia* (Asteraceae: Astereae): The New Zealand endemic subgenera *Caespitosae*, *Glandulosae*, and *Lignosae*. Phytotaxa 591(1): 31–45.

Sievert, C. (2020). Interactive web-based data visualisation with R, plotly, and shiny. Chapman and Hall/CRC, Florida.

Simpkins, E., Woolly, J., de Lange, P., Kilgour, C., Cameron, E., Melzer, S. (2023). Conservation status of vascular plant species in Tāmaki Makaurau/Auckland. Auckland Council Technical Report, TR2022/19. 17 p.

Thorsen, M.J., de Lange, P.J. (2016). *Carex applanata* (Cyperaceae), a new species from southern New Zealand. New Zealand Journal of Botany, 54 (3): 335–343.

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M., Molloy, J., Norton, D.A. (2008). New Zealand Threat Classification System manual. Department of Conservation, Wellington. 35 p.

Turland, N. J., Wiersema, J. H., Barrie, F. R., Greuter, W., Hawksworth, D. L., Herendeen, P. S., Knapp, S., Kusber, W.-H., Li, D.-Z., Marhold, K., May, T. W., McNeill, J., Monro, A. M., Prado, J., Price, M. J. & Smith, G. F. (eds.) (2018). International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) adopted by the Nineteenth International Botanical Congress Shenzhen, China, July 2017. Regnum Vegetabile 159. Glashütten: Koeltz Botanical Books. DOI: https://doi.org/10.12705/Code.2018

Ward, C.M., Bruce, D.L., Rance, B.D., Roozen, D.A., Grove, P. (1994). Lindis, Pisa and Dunstan Ecological Districts: Survey report for the Protected Natural Areas Programme. New Zealand Protected Natural Areas Programme. Department of Conservation, Dunedin. 236 p.

Wickham, H. (2016). *ggplot2*: Elegant Graphics for Data Analysis. Springer-Verlag New York. ISBN 978-3-319-24277-4

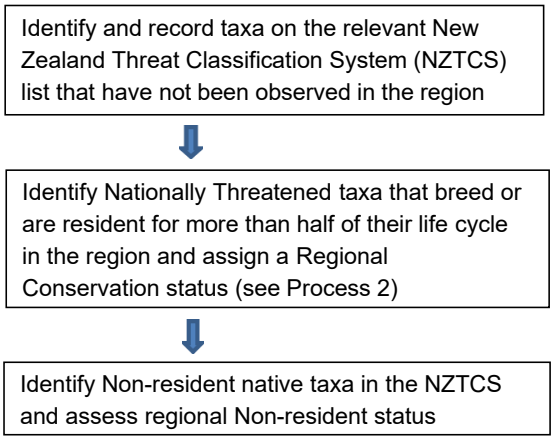
Wickham, H., Averick, A., Byran, J., Chang, W., D'Agostino McGowan, L., Francois, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Lin Pedersen, T., Miller, E., Milton Bache, S., Muller, K., Ooms, J., Robinson, D., Paige Seidel, D., Spinu, V., Takahashi, K, Vaughan, D., Wilke, C., Woo, K., Yutani, M. (2019). Welcome to the *tidyverse*. Journal of Open Source Software 4(43): 1686.

Wickham, J., Bryan, J. (2022). readxl: Read Excel Files. R package version 1.4.0, https://CRAN.R-project.org/package-readxl

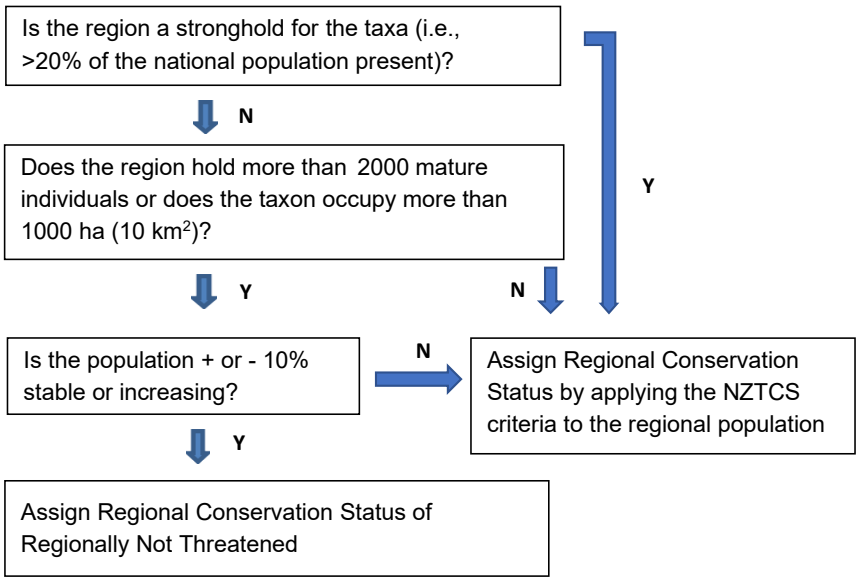
Woolly, J.B., Paris, B., Borkin, K., Davidson-Watts, I., Clarke, D., Davies, F., Burton, C., Melzer, S. (2023). Conservation status of bat species in Tāmaki Makaurau / Auckland. Auckland Council Technical Report, TR2023/4. 18 p.

Appendix 1: Process for determining the regional threat status of taxa

Process 1: Determination of regional threat status



Process 2: Determination of strongholds and Regionally Not Threatened species



Appendix 2: List of Regional Qualifiers for Regional Conservation Threat Assessments

Code	Qualifier	Description
FR	Former Resident	Breeding population (existed for more than 50 years) extirpated from region but continues to arrive as a regional vagrant or migrant. FR and RN are mutually exclusive.
HR	Historical Range	The inferred range (extending in any direction) of the taxon in pre-human times meets its natural limit in the region.
IN	Introduced Native	Introduced to the region, though not known to have previously occurred in it.
NS	National Stronghold	More than 20% of the national population breeding or resident for more than half their life cycle in the region.
NR	Natural Range	The known range (extending in any direction) of the taxon meets it natural limit in the region.
RE	Regional Endemic	Known to breed only in the region.
RN	Restored Native	Reintroduced to the region after having previously gone extinct there.
TL	Type Locality	The type locality of the taxon is within the region. Ignore if the taxon is or has ever been regionally extinct

Appendix 3: List of National Qualifiers from the New Zealand Threat Classification System (Townsend et al. 2008; Michel 2021; Rolfe et al. 2021)

Code	Qualifier	Qualifier Type	Description
DPR	Data Poor: Recognition	Assessment Process Qualifier	Confidence in the assessment is low because of difficulties determining the identity of taxon in the field and/or in the laboratory. Taxa that are DPR will often be DPS and DPT. In such cases, the taxon is most likely to be Data Deficient.
DPS	Data Poor: Size	Assessment Process Qualifier	Confidence in the assessment is low because of a lack of data on population size.
DPT	Data Poor: Trend	Assessment Process Qualifier	Confidence in the assessment is low because of a lack of data on population trend.
DE	Designated	Assessment Process Qualifier	A taxon that the Expert Panel has assigned to what they consider to be the most appropriate status without full application of the criteria. For example, a commercial fish that is being fished down to Biomass Maximum Sustainable yield (BMSy) may meet criteria for 'Declining', however, it could be designated as 'Not Threatened' if the Expert Panel believes that this better describes the taxon's risk of extinction.
IE	Island Endemic	Biological Attribute Qualifier	A taxon whose naturally distribution is restricted to one island archipelago (e.g., Auckland Islands) and is not part of the North or South Islands or Steward Island/Rakiura. This qualifier is equivalent to the 'Natural' Population State value in the database.
NS	Natural State	Biological Attribute Qualifier	A taxon that has a stable or increasing population that is presumed to be in a natural condition, i.e., has not experienced historical human-induced decline.
RR	Range Restricted	Biological Attribute Qualifier	A taxon naturally confined to specific substrates, habitats or geographic areas of less than 100 km^2 (100,000 ha), this is assessed by taking into account the area of occupied habitat of all sub-populations (and summing the areas of habitat if there is more than one sub-population), e.g., Chatham Island forget-me-not (*Myosotidium hortensia*) and Auckland Island snipe (*Coenocorypha aucklandica aucklandica*). This qualifier can apply to any 'Threatened' or 'At Risk' taxon. It is redundant if a taxon is confined to 'One Location' (OL)
Sp	Biologically Sparse	Biological Attribute Qualifier	The taxon naturally occurs within typically small and widely scattered subpopulations. This qualifier can apply to any 'Threatened' or 'At Risk' taxon.
NO	Naturalized Overseas	Population State Qualifier	A New Zealand endemic taxon that has been introduced by human agency to another country (deliberately or accidentally) and has naturalised there, e.g., *Olearia traversiourum* in the Republic of Ireland.

Continued on next page

List of National Qualifiers from the New Zealand Threat Classification System

Code	Qualifier	Qualifier Type	Description
OL	One Location	Population State Qualifier	Found at one location in New Zealand (geographically or ecologically distinct area) of less than 100,000 ha (1000 km2), in which a single event (e.g., a predator irruption) could easily affect all individuals of the taxon, e.g., L'Esperance Rock groundsel (*Senecio esperensis*) and Open Bay leech (*Hirudobdella antipodum*). 'OL' can apply to all 'Threatened', 'At Risk', 'Non-resident Native' – Coloniser and Non-resident Native – Migrant taxa, regardless of whether their restricted distribution in New Zealand is natural or human-induced. Resident native taxa with restricted distributions but where it is unlikely that all sub-populations would be threatened by a single event (e.g., because water channels within an archipelago are larger than known terrestrial predator swimming distances) should be qualified as 'Range Restricted' (RR).
SO	Secure Overseas	Population State Qualifier	The taxon is secure in the parts of its natural range outside New Zealand
SO?	Secure Overseas?	Population State Qualifier	It is uncertain whether a taxon of the same that is secure in the parts of its natural range outside New Zealand is conspecific with the New Zealand taxon.
S?O	Secure? Overseas	Population State Qualifier	It is uncertain whether the taxon is secure in the parts of its natural range outside New Zealand.
TO	Threatened Overseas	Population State Qualifier	The taxon is threatened in the parts of its natural range outside New Zealand.
T?O	Threatened Overseas?	Population State Qualifier	It is uncertain whether a taxon of the same name that is threatened in the parts of its natural range outside New Zealand is conspecific with the New Zealand taxon.
T?O	Threatened? Overseas	Population State Qualifier	It is uncertain whether the taxon is threatened in the parts of its natural range outside New Zealand.

Continued on next page

List of National Qualifiers from the New Zealand Threat Classification System

Code	Qualifier	Qualifier Type	Description
CI	Climate Impact	Pressure Management Qualifier	The taxon is adversely affected by long-term climate trends and/or extreme climatic events. The following questions provide a guide to using the CI Qualifier: Is the taxon adversely affected by long-term changes in the climate, such as an increase in average temperature or sea-level rise? If NO = no Qualifier but needs monitoring and periodic re-evaluation because projected changes to the average climate and sea-level rise may adversely impact the taxon (including via changes to the distribution and prevalence of pests, weeds and predators) in the future. If YES = CI Qualifier Is the taxon adversely affected by extreme climate events, such as a drought, storm or heatwave? If No = no Qualifier but needs monitoring and periodic re-evaluation because projected changes to the climate are likely to increase the frequency and/or severity of these events in the future. If YES = CI Qualifier Use of the Climate Impact Qualifier would indicate the need for more in-depth research, ongoing monitoring of climate impacts, and potentially a climate change adaptation plan for the taxon
CD	Conservation Dependent	Pressure Management Qualifier	The taxon is likely to move to a worse conservation status if current management ceases. The term ‘management’ can include indirect actions that benefit taxa, such as island biosecurity. Management can make a taxon CD only if cessation of the management would result in a worse conservation status. The influence of the benefits of management on the total population must be considered before using CD. The benefit of managing a single subpopulation may not be adequate to trigger CD, but may trigger Partial Decline (PD). Taxa qualified CD may also be PD because of the benefits of management.
CR	Conservation Research Needed	Pressure Management Qualifier	Causes of decline and/or solutions for recovery are poorly understood and research is required.

Continued on next page

List of National Qualifiers from the New Zealand Threat Classification System

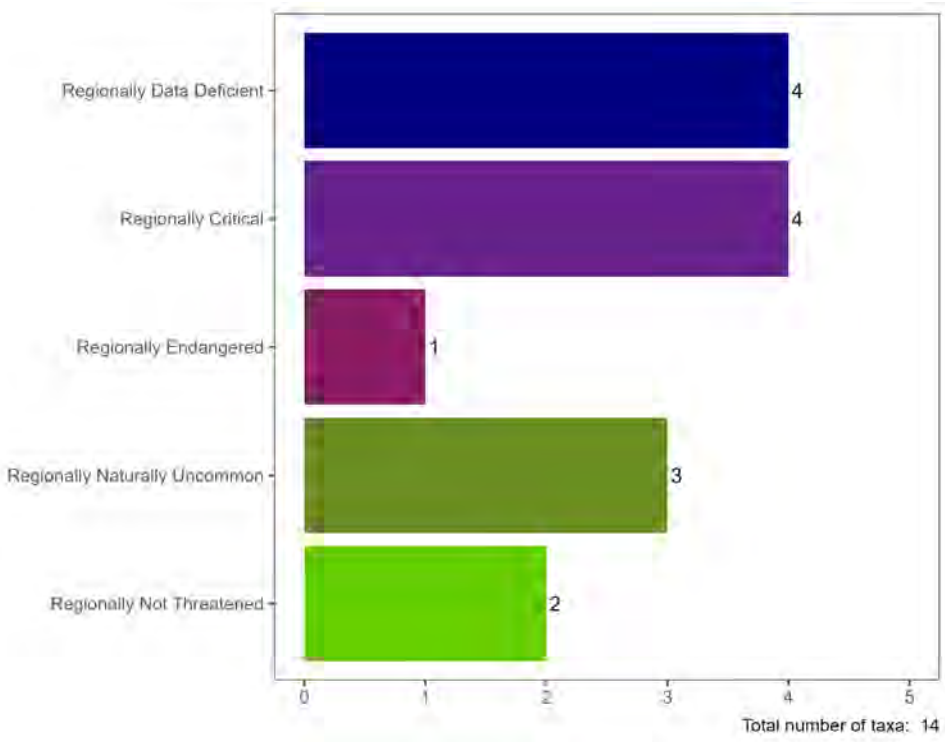
Code	Qualifier	Qualifier Type	Description
EW	Extinct In The Wild	Pressure Management Qualifier	The taxon is known only in captivity or cultivation or has been reintroduced to the wild but is not self-sustaining. Assessment of a reintroduced population should be considered only when it is self-sustaining. A population is deemed to be self-sustaining when the following two criteria have been fulfilled: it is expanding or has reached a stable state through natural replenishment and at least half the breeding adults are products of the natural replenishment, and it has been at least 10 years since reintroduction
EF	Extreme Fluctuations	Pressure Management Qualifier	The taxon experiences extreme unnatural population fluctuations, or natural fluctuations overlaying human-induced declines, that increase the threat of extinction. When ranking taxa with extreme fluctuations, the lowest estimate of mature individuals should be used for determining population size, as a precautionary measure.
INC	Increasing	Pressure Management Qualifier	There is an ongoing or forecast increase of > 10% in the total population, taken over the next 10 years or three generations, whichever is longer. This qualifier is redundant for taxa ranked as ‘Recovering’.
PD	Partial Decline	Pressure Management Qualifier	The taxon is declining over most of its range, but with one or more secure populations (such as on offshore islands). Partial decline taxa (e.g., North Island kākā *Nestor meridionalis septentrionalis* and Pacific gecko *Dactylocnemis pacificus*) are declining towards a small stable population, for which the Relict qualifier may be appropriate.
PF	Population Fragmentation	Pressure Management Qualifier	Gene flow between subpopulations is hampered as a direct or indirect result of human activity. Naturally disjunct populations are not considered to be 'fragmented'.
PE	Possibly/Presumed Extinct	Pressure Management Qualifier	A taxon that has not been observed for more than 50 years but for which there is little or no evidence to support declaring it extinct. This qualifier might apply to several Data Deficient and Nationally Critical taxa.
RF	Recruitment Failure	Pressure Management Qualifier	The age structure of the current population is such that a catastrophic decline is likely in the future. Failure to produce new progeny or failure of progeny to reach maturity can be masked by apparently healthy populations of mature specimens.

Continued on next page

List of National Qualifiers from the New Zealand Threat Classification System

Code	Qualifier	Qualifier Type	Description
Rel	Relict	Pressure Management Qualifier	The taxon has declined since human arrival to less than 10% of its former range but its population has stabilised. The range of a relictual taxon takes into account the area currently occupied as a ratio of its former extent. Reintroduced and self-sustaining populations within or outside the former known range of a taxon should be considered when determining whether a taxon is relictual. This definition is modified from the definition of the At Risk – Relict category in the NZTCS manual (Townsend et al. 2008). The main difference is that trend is not included in the qualifier definition. This enables the qualifier to be applied to any taxon that has experienced severe range contraction, regardless of whether that contraction continues or has been arrested. This qualifier complements the 'Naturally Uncommon (NU)' qualifier which can be applied to taxa whose abundance has declined but which continue to occupy a substantial part of their natural range.

Appendix 4. Regional conservation status for 14 indigenous vascular plants in the Otago region not assessed in the national assessment (de Lange et al. 2018). See Figure 1 for the threat statuses of the 1242 indigenous vascular plants in Otago also assessed national nationally (de Lange et al. 2018)



Appendix 5: Indigenous vascular plants found only in Otago

This table shows regional endemics that were considered Regionally Threatened or Regionally At Risk

Name and Authority	Common Name	Regional Conservation Status	National Conservation Status	Distributional Notes
Abrotanella patearoa Heads		Regionally Naturally Uncommon	Naturally Uncommon	Eastern and Central Otago: Rock and Pillar Range, Lammerlaw Top, Umbrella Mountains, Garvie Mountain
Acaena aff. *rorida* (OTA 59561; Pool Burn)	bidibidi	Regionally Critical	Nationally Critical	Maniototo and Macraes
Acaena tesca B.H.Macmill.	bidibidi	Regionally Naturally Uncommon	Not Threatened	Central and Southern Otago
Anisotome (b) (CHR 511716); "Otago bog")		Regionally Naturally Uncommon	Naturally Uncommon	Pisa Range
Anthosachne aprica (Á.Löve & Connor) C.Yen & J.L.Yang	blue wheat grass	Regionally Vulnerable	Naturally Uncommon	Central Otago
Apium “inland saline”		Regionally Critical		Central Otago
Brachyscome “Taiari		Regionally Critical		Central Otago
Brachyscome humilis G.Simpson & J.S.Thomson	daisy	Regionally Naturally Uncommon	Naturally Uncommon	Rock and Pillar Range and Lammerlaw/Lammermoor Ranges
Cardamine sciaphila Heenan	cress	Regionally Critical	Nationally Critical	Central Otago - the highest parts of the Dunstan Mountains and Pisa Range
Carex applanata Thorsen & de Lange		Regionally Endangered	Naturally Uncommon	Central Otago, including the Old Woman, Old Man, Umbrella, Garvie, Pisa and The Remarkables Range
Carmichaelia compacta Petrie	Cromwell broom	Regionally Declining	Naturally Uncommon	Central Otago, centred on the Kawarau and Cromwell Gorges and immediate surrounding area, also near Alexandra, Omakau, and Cromwell
Celmisia haastii var. *tomentosa* G.Simpson & J.S.Thomson	daisy	Regionally Naturally Uncommon	Naturally Uncommon	Rock and Pillar Range

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regional endemic continued

Name and Authority	Common Name	Regional Conservation Status	National Conservation Status	Distributional Notes
Celmisia lindsayi Hook.f.	Lindsay's Daisy	Regionally Naturally Uncommon	Naturally Uncommon	Coast from Clutha River to Chaslands Mistake
Craspedia (y) (CHR 516260; Cape Saunders)		Regionally Critical	Nationally Critical	Otago Peninsula
Craspedia argentea Breitw. & K.A.Ford, sp. nov.		Regionally Critical	Nationally Critical	One location in the Upper Clutha Catchment, Central Otago
Festuca matthewsii subsp. *pisamontis* Connor		Regionally Naturally Uncommon	Naturally Uncommon	Central Otago: Dunstan, Pisa, and Kopuwai | Old Man Range
Gingidia grisea Heenan		Regionally Declining	Naturally Uncommon	North-eastern Otago, from near the Millhouse (Herbert) south to Mt Watkin/Hikaroroa (Waikouaiti), east to Macraes Flat and then west to Shag and Moeraki Points.
Helichrysum simpsonii subsp. tumidum (Cheeseman) de Lange & Blanchon		Regionally Vulnerable	Nationally Vulnerable	Otago Peninsula
Kelleria villosa var. *barbata* Heads		Regionally Naturally Uncommon	Naturally Uncommon	Rock and Pillar Range
Lepidium crassum Heenan & de Lange	thick-leaved scurvy grass	Regionally Endangered	Nationally Endangered	Once found in the Waitaki Valley, an inland location, to coastal locations from Oamaru to North Head, Waikawa Harbour in the south Catlins. Now most common on Otago Peninsula, but occurs in small populations from near Kakanui, North Otago to The Nuggets, South Otago
Lepidium kirkii Petrie	salt-pan cress	Regionally Critical	Nationally Critical	Formerly widespread on saline/sodic soils from the Ida Valley and Maniototo plans south to Alexandra in the Manuherikia Valley, but now only known only Central Otago
Leptinella aff. *pectinata* (a) (CHR 580894; Nevis)		Regionally Critical	Nationally Critical	One location in Nevis Valley

Continued on next page

Regional endemic continued

Name and Authority	Common Name	Regional Conservation Status	National Conservation Status	Distributional Notes
Luzula traversii var. *tenuis* Edgar	wood-rush	Regionally Endangered	Naturally Uncommon	Central Otago
Melicytus aff. *crassifolius* (b) (CHR 616706; Cape Saunders)		Regionally Critical		Otago Peninsula
Montia “String Bog”		Regionally Naturally Uncommon		The Remarkables
Myosotis albosericea Hook.f.		Regionally Critical	Nationally Critical	One location on the southern Dunstan Range, Central Otago
Myosotis bryonoma Meudt, Prebble & Thorsen	forget-me-not	Regionally Naturally Uncommon	Naturally Uncommon	High-elevation bogs and wet places in mountain ranges of Otago
Myosotis glabrescens L.B.Moore	Forget-me-not	Regionally Critical	Data Deficient	Hector Mountains and Harris Mountains
Myosotis goyenii subsp. *goyenii* Petrie		Regionally Endangered	Naturally Uncommon	Central Otago
Myosotis hikuwai Meudt et al. 2022.		Regionally Critical	Nationally Critical	One location on outwash gravel terraces, near Wānaka
Myosotis oreophila Petrie		Regionally Critical	Nationally Critical	Central Otago
Myosotis umbrosa Meudt, Prebble & Thorsen		Regionally Critical	Nationally Critical	Rock and Pillar and Lammerlaw Ranges
Pimelea sericeovillosa subsp. *alta* C.J.Burrows		Regionally Naturally Uncommon	Naturally Uncommon	Pisa Range
Poa pygmaea Buchanan		Regionally Naturally Uncommon	Naturally Uncommon	Pisa Range and Mount St Bathans

Continued on next page

Regional conservation status of indigenous vascular plants in Otago

Regional endemic continued

Name and Authority	Common Name	Regional Conservation Status	National Conservation Status	Distributional Notes
Ranunculus (c) (CHR 472008; Garvie Range)		Regionally Naturally Uncommon	Data Deficient	Garvie Range
Solenogyne christensenii (Petrie) de Lange, Jian Wang ter & Barkla, comb. nov.		Regionally Critical	Nationally Critical	One location in the upper Clutha Valley. Believed extinct from the Hanmer Plains, Canterbury.

Regional Conservation Status of Otago's Amphibians

Scott Jarvie

April 2024

Otago Threat Classification Series 4

Otago Regional Council

orc.govt.nz

Regional Conservation Status of Otago's Amphibians

April 2024 – Otago Threat Classification Series 4

Scott Jarvie
Otago Regional Council, Ōtepoti Dunedin

Otago Regional Council
Otago Threat Classification Series 4
ISSN 2816-0983 (web PDF)
ISBN 978-1-7385867-3-8 (web PDF)

Otago Threat Classification Series is a scientific monograph series presenting publications related to regional threats assessments of groups of taxa in the Otago region. Most will be lists providing regional threat assessments of members of a plant or animal group (e.g., bats, indigenous vascular plants, fungi, reptiles), and leverages off national assessments for the New Zealand Threat Classification System within the regional context.

Recommended citation
Jarvie, S. (2024). Regional conservation status of Otago's amphibians. Otago Regional Council, Otago Threat Classification Series, 2024/4

Cover and frontispiece image credits
brown tree frog, *Litoria ewingii*, Regionally Introduced and Naturalised. Photograph by Samuel Purdie

southern tree frog, *Ranoidea raniformis*, Regionally Introduced and Naturalised. Photograph by Samuel Purdie

Executive Summary

This report provides the first assessment of the regional conservation status of amphibians in Otago. Standardised methodology was followed to assess the regional threat status of amphibian taxa in the Otago region. Two amphibian taxa were assessed as Regionally Introduced and Naturalised (brown tree frog, *Litoria ewingii*, and southern tree frog, *Ranoidea raniformis*). An additional taxon was identified as Regionally Extirpated (Markham's frog, *Leiopelma markhami*).

Table of Contents

Introduction

Threat classifications play an important role in monitoring biodiversity and informing conservation actions. The New Zealand Threat Classification System (NZTCS) is a tool used to assign a threat status to candidate taxa (species, subspecies, varieties, and forma) in Aotearoa New Zealand (Townsend et al. 2008). The classification system was developed to apply equally to terrestrial, freshwater, and marine biota (flora and fauna). The NZTCS scores taxa at the national scale against criteria based on an understanding of population state, size, and trend, while considering population status, impact of threats, recovery potential, and taxonomic certainty. The Department of Conservation | Te Papa Atawhai (DOC) administers the NZTCS in Aotearoa New Zealand, with national assessments used to inform conservation action, target resources, and monitor biodiversity trends and conservation effectiveness.

While DOC is tasked with managing indigenous taxa nationally, regional and district councils have statutory obligations to maintain indigenous biodiversity under the Resource Management Act 1991 (RMA), including to manage the habitats of threatened taxa. The regional threat status of taxa is particularly important in the context of the RMA and in conservation planning. A key requirement of managing the habitats occupied by taxa is to understand regional population sizes and distributions, and to monitor trends and management effectiveness.

This report is the first regional conservation status assessment for amphibians in the Otago region. Regional threat assessments have been completed following a standardised methodology by Otago Regional Council for three taxonomic groups (bats, Jarvie et al. 2023a; reptiles, Jarvie et al. 2023b; indigenous vascular plants, Jarvie et al. 2024), Greater Wellington Regional Council for five taxonomic groups (birds, Crisp et al. 2024; indigenous freshwater fish, Crisp et al. 2022; indigenous vascular plants, Crisp 2020; reptiles, Crisp et al. 2023b; bats, Crisp et al. 2023b) and Auckland Council for five taxonomic groups (amphibians, Melzer et al. 2022a; reptiles, Melzer et al. 2022b; indigenous vascular plants, Simpkins et al. 2023; bats, Woolly et al. 2023; freshwater fish, Bloxham et al. 2023) as of April 2024. Regional threat assessments also provide a stronger foundation for assessing the threat status of taxa nationally. The methodology for the regional threat assessments leverages off national threat assessments as determined using the NZTCS (Townsend et al. 2008, Rolfe et al. 2021, Michel 2021), with thresholds for area of occupancy or species numbers adjusted for the land area in the region (Appendix 1). National strongholds and additional regional qualifiers are also considered (Appendix 2).

Methods

The regional threat status of amphibians was assessed in April 2024. This assessment covers all amphibian taxa in the region, following standardised methodology for regional threat assessments as shown in Appendix 1, the list of regional qualifiers in Appendix 2, and the list of national qualifiers in Appendix 3. The national threat assessments and national qualifiers were from Burns et al. (2018). All the taxa in this regional assessment were classified following Burns et al. (2018) as: 'taxonomically determinate', i.e., legitimately, and effectively published and generally accepted by relevant experts as distinct; and 'taxonomically indeterminate', i.e., used loosely to include both undescribed entities which still require formal taxonomic research to confirm their validity and provide them with a formal name and, occasionally, described species whose taxonomic validity is in question.

Following the standardised methodology, amphibian taxa recognised in the NZTCS list (Burns et al. 2018) but not known to occur in Otago were first removed from consideration. The next step was to identify Nationally Threatened and At-Risk taxa that are present in the region. If more than 20% of the national population of native taxa are breeding or resident for more than half their life cycle in the region, they were assigned a National Stronghold status and the NZTCS criteria applied. In this exercise, the regional conservation status must not be of a lower threat status than the national status.

Regional thresholds were set at more than 2000 mature individuals present or occupancy of more than 1000 hectares. If taxa did not meet the threshold, they were assigned a regional threat status by applying the NZTCS criteria. If taxa meet the threshold and the population trend was ±10% stable or increasing, they were assigned the status Regionally Not Threatened. For Nationally Not Threatened and Non-Resident taxa, the regional population threshold was applied. If the population was not stable to increasing or decreasing by more than 10%, the NZTCS criteria were used to determine the regional threat status. Population trend criteria are applied based on current knowledge, representing trends over the next 10 years or 3 generations, whichever is longer.

Regional conservation assessments for amphibian taxa were completed in a locally operated dashboard using R v. 4.2.2 (R Core Team 2022) via the RStudio platform (Posit Team 2023). The main packages used for the dashboard were 'shiny' (Chang et al. 2021) and 'flexdashboard' (Iannone et al. 2020). Other packages used in the dashboard, data wrangling, included 'tidyverse' (Wickham et al. 2019), 'readxl' (Wickham and Bryan 2022), 'sf' (Pebesma 2018), 'lubridate' (Grolemund and Wickham 2011), 'leaflet' (Cheng et al. 2022), 'leaflet.extras' (Karambelkar and Schloerke 2018), 'plotly' (Sievert 2020), 'janitor' (Firke 2020), 'ggplot2' (Wickham

2016), and 'terra' (Hijmans 2022). The map layers used to view records in the dashboard were OpenStreetMap (OpenStreetMap Contributors 2017) and Esri World Imagery (Esri 2023).

Results

Two extant amphibian species were identified in Otago as Regionally Introduced and Naturalised (brown tree frog, *Litoria ewingii*, and southern bell frog, *Ranoidea raniformis*: the National Assessment for both from the NZTCS are Introduced and Naturalised; Figure 1, Tables 1). An additional species was identified as having been in Otago during the Holocene but is now Regionally Extirpated (Markham's frog, *Leiopelma markhami*: the National Assessment from the NZTCS is Extinct; Figure 1, Tables 1).

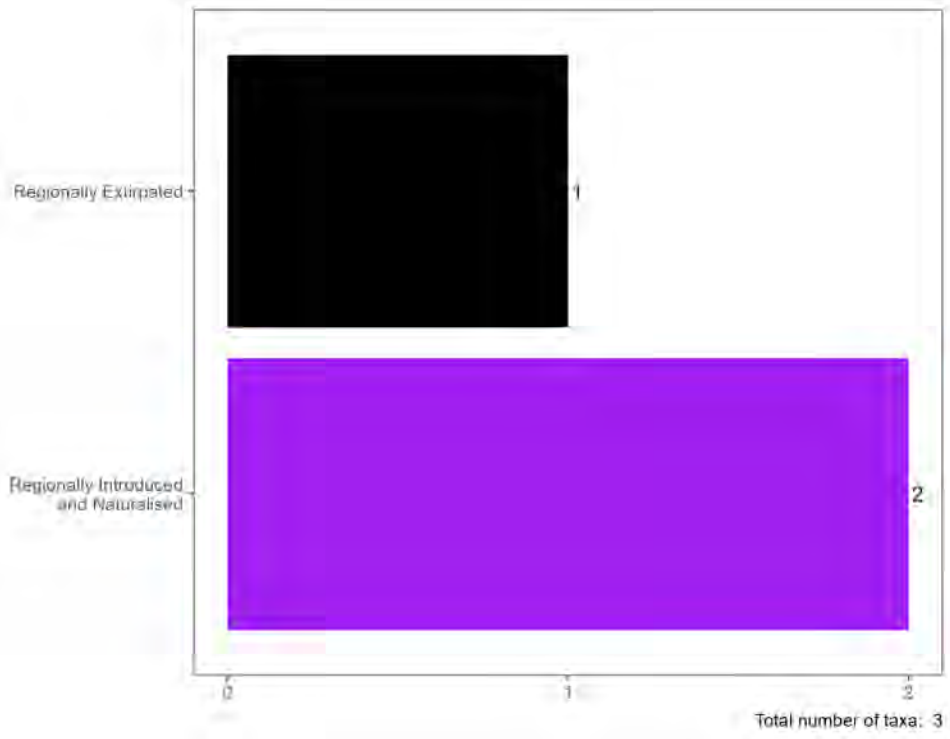


Figure 1: Regional conservation status of Otago's amphibians

Table 1: Regional conservation status of Otago's amphibians

Name and Authority	Common Name	Regional Conservation Status	Regional Criteria	National Stronghold	Regional Endemic	Regional Population	Regional Area	Regional Trend	Regional Confidence Population	Regional Confidence Trend	Regional Qualifiers	National Conservation Status	National Qualifiers
REGIONALLY EXTIRPATED (1)													
TAXONOMICALLY DETERMINATE (1)													
Leiopelma markhami Worthy, 1987	Markham's frog	Regionally Extirpated										Extinct	
REGIONALLY INTRODUCED AND NATURALISED (2)													
TAXONOMICALLY DETERMINATE (2)													
Litoria ewingii Duméril & Bibron (1841)	brown tree frog											Introduced and Naturalised	
Ranoidea raniformis (Keferstein, 1867)	southern bell frog											Introduced and Naturalised	

Regional and national qualifiers: CD = Conservation Dependent; DPR = Data Poor Recognition; DPS = Data Poor Size; DPT = Data Poor Trend; De = Designated; EF = Extreme Fluctuations; NR = Natural Range Limit; NS = Natural State; NStr = Natural Stronghold; OL = One Location; PD = Partial Decline; RR = Range Restricted; SO = Secure Overseas; SO? = Secure Oversea?; S?O = Secure?Overseas; TO = Threatened Overseas' TO? = Threatened Overseas?; T?O = Threatened? Overseas; CI = Climate Impact; CRN = Conservation Research Needed; EW = Extinct in the Wild; INC = Increasing; PF = Population Fragmentation' PE = Possibly/Presumed Extinct; RE = Regional Endemic; Rel = Relict; RF = Recruitment Failure; Sp = Biologically Sparse

Discussion

Regional threat assessments have already been completed by regional councils in Aotearoa New Zealand (Bloxham et al. 2024; Crisp 2020, Crisp et al. 2022, 2023a, 2023b, 2024; Jarvie et al. 2023a, 2023b, 2024a, 2024b; Melzer et al. 2022a, 2022b; Simpkins et al. 2023). This report is the first regional assessment of the conservation status of amphibian species in the Otago region. Two amphibian species are currently present in the Otago region, both of which are Regionally Introduced and Naturalised. An additional taxon was identified as Regionally Extirpated; this taxon has, in fact, has gone extinct.

The extinct amphibian taxon Markham's frog, *Leiopelma markhami*, is known from Mt Nicholas Station, near Lake Whakatipu (Easton 2018). The age of this specimen is dated as 1,413 calendar years before present (where present is 2016; L. Easton. pers. comm. April 9, 2024). This specimen was radiocarbon dated from other material collected from the same-time averaged layer within the fossil deposits due to the small size of the frog fossils (Easton 2018). Although this radiocarbon date illustrates that an endemic frog taxon was present during the Holocene in Otago, they likely disappeared following the arrival of humans to Aotearoa New Zealand due to the introduction of mammalian predators and habitat loss (Worthy 1987, Easton 2018).

Two extant amphibian species found in Otago are Regionally Introduced and Naturalised. Both these frog species were deliberately introduced to Aotearoa New Zealand from Australia. The southern bell frog (*Ranoidea raniformis*) was initially introduced to Aotearoa by the Canterbury Acclimatisation Society, in 1867, with the species now widespread across much of the country except for Stewart Island/Rakiura and some offshore islands. The brown tree frog (*Litoria ewingii*) was initially introduced to Greymouth, in 1875, and is now currently distributed throughout much of Aotearoa New Zealand, including Rakiura and Chatham Island/Rēkohu.

Conservation translocations of native frogs/pepeketua (*Leiopelma* sp.) have so far not occurred in Otago, but this taxonomic group has been included in restoration plans, including for Orokonui Ecosanctuary – Te Korowai o Mihiwaka, near Ōtepoti Dunedin (Orokonui Ecosanctuary 2019). The translocation of native frog populations to extend the range of taxon in the wild is a preferred conservation option by the Department of Conservation – Te Papa Atawhai to aid the recovery of frog populations (Bishop et al. 2013). Although native frog habitat is thought to exist within the Orokonui Ecosanctuary (Easton et al. 2016), any translocation into the reserve would be as a surrogate for a species that might have been present in the region. Conservation translocation guidelines place great emphasis on feasibility and

risk analysis as essential components of any conservation translocation (IUCN/SSC 2013). A critical aspect in planning for conservation translocations of native frogs to Otago would be the selection of suitable release sites that match the biotic and abiotic needs of the focal species under future climate scenarios (IUCN/SSC 2013).

Acknowledgement

Thanks to Philippa Crisp and Roger Uys from Greater Wellington Regional Council and Sabine Melzer from Auckland Council for advice on the regional conservation status process, Pascale Michel from the Department of Conservation | Te Papa Atawhai (DOC) for advice on the national assessments and the regional conservation status process, Luke Easton from DOC for advice on the extinct frog taxon in Otago, Nic Rawlence from Te Tari Mātai Kararehe | Department of Zoology, Ōtākou Whakaihu Waka | University of Otago, Nathan Whitmore from Reproducible for the development of the dashboard for the locally-operated regional assessments, Samuel Purdie from Southern Lakes Sanctuary for providing the cover and frontispiece images of extant amphibian taxon in Otago as well as for advice, Ciaran Campbell and Tim Ware from the Otago Regional Council for editorial advice and discussion on regional threat assessments, and other Council staff that provided support for these assessments.

References

Bishop, P.J., Daglish, L.A., Haigh, A.J.M., Marshall, L.J., Tocher, M.D., McKenzie, K.L. 2013. Native frog (*Leiopelma* spp.) recovery plan, 2013–2018. Department of Conservation Science and Technical Threatened Species Recovery Plan 63, Wellington. 39 p.

Bloxham, M., Woolly, J., Dunn, N., Chaffe, A., Melzer, S. (2023). Conservation status of freshwater fishes in Tāmaki Makaurau/Auckland. Auckland Council Technical Report, TR2023/13. 36 p.

Burns, R.J., Bell, B.D., Haigh, A., Bishop, P., Easton, L., Wren, S., Germano, J., Hitchmough, R.A., Rolfe, J.R., Makan, T. (2018). Conservation status of New Zealand amphibians, 2017. New Zealand Threat Classification Series 25. Department of Conservation, Wellington. 7 p.

Chang, W., Cheng, J., Allaire, J., Sievert, C., Schloerke, B., Xie, Y., Allen, J., McPherson, J., Dipert, A., Borges. B. (2021). shiny: Web Application Framework for R. R package version 1.7.1.

Cheng, J., Karambelkar, B., Xie, Y. (2022). leaflet: Create Interactive Web Maps with the JavaScript 'Leaflet' Library. R package version 2.1.1, https://CRAN.R-project.org/package=leaflet

Crisp, P. (2020). Conservation status of indigenous vascular plant species in the Wellington region. Greater Wellington Regional Council Publication No. GW/ESCI-G-20/20 Wellington. 39 p.

Crisp, P., Hitchmough, R., Newman, D., Adams, L., Lennon, O., Woolley, C., Hulme-Moir, A., Bell, T., Herbert, S., Spearpoint, O., Nelson, N. (2022a). Conservation status of reptile species in the Wellington region. Greater Wellington Regional Council, Publication No. GW/ESCI-G-23/03, Wellington. 23 p.

Crisp, P., O'Donnell, C., Pryde, M., Ryan, J., Spearpoint, O. (2023). Conservation status of bat species in the Wellington region. Greater Wellington Regional Council, Publication No. GW/ESCI-G-23/01, Wellington. 13 p.

Crisp, P., Robertson, H., McArthur, N., Cotter, S. (2024). Conservation status of bird in the Wellington region. Greater Wellington Regional Council, Publication No. GW/KI-G-23/21, Wellington. 50 p.

Crisp, P., Perrie, A., Morar, A., Royal, C. (2022b). Conservation status of indigenous freshwater fish in the Wellington region. Greater Wellington Regional Council Publication No. GW/ESCI-T-22/02, Wellington. 8 p.

Easton, L.J. (2018). Taxonomy and genetic management of New Zealand's Leiopelma frogs. Unpublished PhD thesis, University of Otago, Dunedin, New Zealand. 181 p.

Easton, L.J., Dickinson, K.J.M., Whigham, P.A., Bishop, P.J. (2016). Habitat suitability and requirements for a threatened New Zealand amphibian. The Journal of Wildlife Management, 80: 916–923.

Esri., i-cubed., USDA., USGS., AEX., GeoEye., Getmapping., Aerogrid., IGN., IGP., UPR., EGP., GIS User Community. (2023). Map tiles by Stamen Design, CC by 3.0.

Firke, S. (2021). janitor: simple tools for examining and cleaning dirty data. R package version 2.1.0, https://CRAN.R-project.org/package=janitor

Grolemund G., Wickham H. (2011). Dates and times made easy with lubridate. Journal of Statistical Software 40(3): 1–25.

Hijmans, R. (2022). terra: Spatial Data Analysis. R package version 1.5-21, https://CRAN-R-project.org/package=terra

Iannone, R., Allaire, J., Borges, B. (2020). flexdashboard: R Markdown Format for Flexible Dashboards. R package version 0.5.2

IUCN/SSC. (2013). Guidelines for reintroductions and other conservation translocations. IUCN, Gland, Switzerland. 34 p.

Jarvie, S., Davidson-Watts, I., Dennis, G., Gower, C., Pryde, M. (2023a). Regional conservation status of bat species in Otago. Otago Regional Council, Otago Threat Classification Series, 2023/2. 19 p.

Jarvie, S., Knox, C., Monks, J.M., Reardon, J., Campbell, C. (2023b). Regional conservation status of reptile species in Otago. Otago Regional Council, Otago Threat Classification Series, 2023/1. 24 p.

Jarvie, S., Barkla, J., Rance, B., Rogers, G., Ewans, R., Thorsen, M. (2024). Regional conservation status of indigenous vascular plants in Otago. Otago Regional Council, Otago Threat Classification Series, 2024/3. 138 p.

Karambelkar, B., Schloerke, B. (2018). leaflet.extras: Extra functionality for 'leaflet' Package. R package version 1.0.0, https://CRAN.R-project.org/package=leaflet.extras

Melzer, S., Hitchmough, R., van Winkel, D., Wedding, C., Chapman, S., Rixon, M., Moreno, V., J. Germano, J. (2022a). Conservation status of amphibian species in Tāmaki Makaurau / Auckland. Auckland Council Technical Report, TR2022/4. 16 p.

Melzer, S., Hitchmough, R., van Winkel, D., Wedding, C., Chapman, S., Rixon, M. (2022b). Conservation status of reptile species in Tāmaki Makaurau / Auckland. Auckland Council Technical Report, TR2022/3. 20 p.

Michel, P. (2021). Amendment to the New Zealand Threat Classification System 2008: revised categories 2021. Department of Conservation, Wellington. 5 p.

OpenStreetMap contributors. (2017). Planet dump retrieved from https://planet.osm.org. https://www.openstreetmap.org

Orokonui Ecosanctuary (2019). Orokonui Ecosanctuary Restoration Plan. Unpublished report, Dunedin. 51 p.

Worthy, T.H. (1987). Palaeoecological information concerning members of the frog genus *Leiopelma*: Leiopelmatidae in New Zealand. Journal of the Royal Society of New Zealand. 17: 409–420.

Pebesma, E. (2018). Simple features for R: Standardized support for spatial vector data. The R Journal 10(1): 439–446.

Posit Team (2023). RStudio: Integrated Development Environment for R. Posit Software, PBC, Boston, MA, USA.

R Core Team. (2022). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Rolfe, J., Makan, T. Tait, A. (2021). Supplement to the New Zealand Threat Classification System manual 2008: new qualifiers and amendments to qualifier definitions, 2021. Department of Conservation, Wellington. 7 p.

Sievert, C. (2020). Interactive web-based data visualisation with R, plotly, and shiny. Chapman and Hall/CRC, Florida.

Simpkins, E., Woolly, J., de Lange, P., Kilgour, C., Cameron, E., Melzer, S. (2023). Conservation status of vascular plant species in Tāmaki Makaurau/Auckland. Auckland Council Technical Report, TR2022/19. 17 p.

Townsend, A.J., de Lange, P.J., Duffy, C.A.J., Miskelly, C.M., Molloy, J., Norton, D.A. (2008). New Zealand Threat Classification System manual. Department of Conservation, Wellington. 35 p.

Wickham, H. (2016). *ggplot2: Elegant Graphics for Data Analysis.* Springer-Verlag New York. ISBN 978-3-319-24277-4

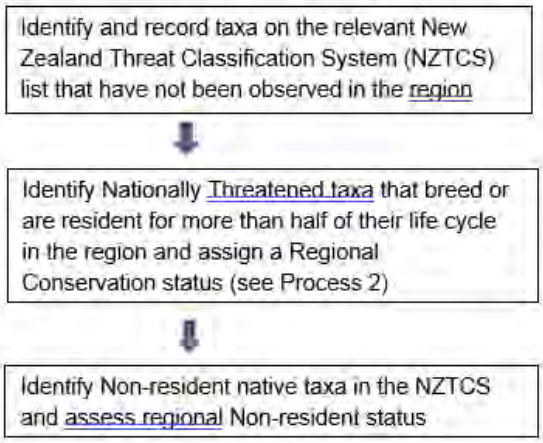
Wickham, H., Averick, A., Byran, J., Chang, W., D'Agostino McGowan, L., Francois, R., Grolemund, G., Hayes, A., Henry, L., Hester, J., Kuhn, M., Lin Pedersen, T., Miller, E., Milton Bache, S., Muller, K., Ooms, J., Robinson, D., Paige Seidel, D., Spinu, V., Takahashi, K, Vaughan, D., Wilke, C., Woo, K., Yutani, M. (2019). Welcome to the *tidyverse*. Journal of Open Source Software 4(43): 1686.

Wickham, J., Bryan, J. (2022). readxl: Read Excel Files. R package version 1.4.0, https://CRAN.R-project.org/package-readxl

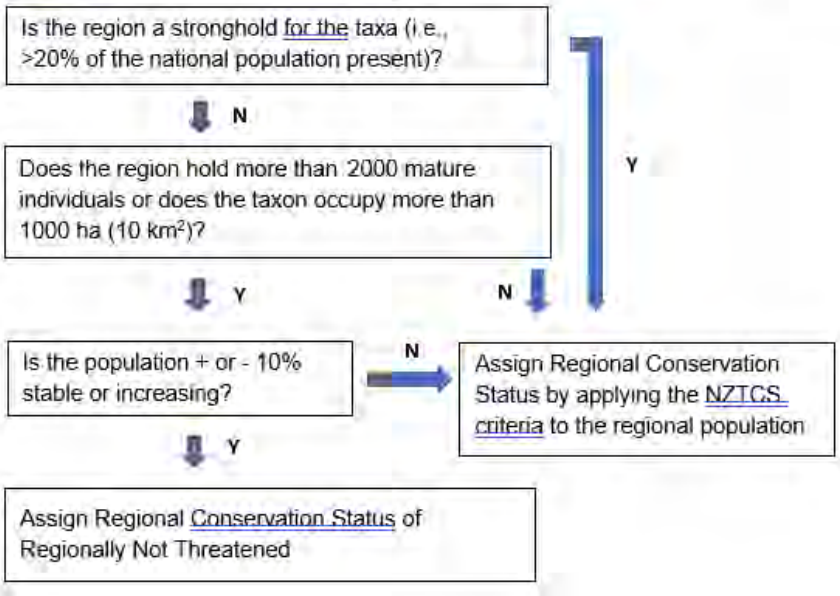
Woolly, J.B., Paris, B., Borkin, K., Davidson-Watts, I., Clarke, D., Davies, F., Burton, C., Melzer, S. (2023). Conservation status of bat species in Tāmaki Makaurau/Auckland. Auckland Council Technical Report, TR2023/4. 18 p.

Appendix 1: Process for determining the regional threat status of taxa

Process 1: Determination of regional threat status



Process 2: Determination of strongholds and Regionally Not Threatened species



Appendix 2: List of Regional Qualifiers for Regional Conservation Threat Assessments

Code	Qualifier	Description
FR	Former Resident	Breeding population (existed for more than 50 years) extirpated from region but continues to arrive as a regional vagrant or migrant. FR and RN are mutually exclusive.
HR	Historical Range	The inferred range (extending in any direction) of the taxon in pre-human times meets its natural limit in the region.
IN	Introduced Native	Introduced to the region, though not known to have previously occurred in it.
NS	National Stronghold	More than 20% of the national population breeding or resident for more than half their life cycle in the region.
NR	Natural Range	The known range (extending in any direction) of the taxon meets it natural limit in the region.
RE	Regional Endemic	Known to breed only in the region.
RN	Restored Native	Reintroduced to the region after having previously gone extinct there.
TL	Type Locality	The type locality of the taxon is within the region. Ignore if the taxon is or has ever been regionally extinct

Appendix 3: List of National Qualifiers from the New Zealand Threat Classification System (Townsend et al. 2008; Michel 2021; Rolfe et al. 2021)

Code	Qualifier	Qualifier Type	Description
DPR	Data Poor: Recognition	Assessment Process Qualifier	Confidence in the assessment is low because of difficulties determining the identity of taxon in the field and/or in the laboratory. Taxa that are DPR will often be DPS and DPT. In such cases, the taxon is most likely to be Data Deficient.
DPS	Data Poor: Size	Assessment Process Qualifier	Confidence in the assessment is low because of a lack of data on population size.
DPT	Data Poor: Trend	Assessment Process Qualifier	Confidence in the assessment is low because of a lack of data on population trend.
DE	Designated	Assessment Process Qualifier	A taxon that the Expert Panel has assigned to what they consider to be the most appropriate status without full application of the criteria. For example, a commercial fish that is being fished down to Biomass Maximum Sustainable yield (BMSy) may meet criteria for 'Declining', however, it could be designated as 'Not Threatened' if the Expert Panel believes that this better describes the taxon's risk of extinction.
IE	Island Endemic	Biological Attribute Qualifier	A taxon whose naturally distribution is restricted to one island archipelago (e.g., Auckland Islands) and is not part of the North or South Islands or Steward Island/Rakiura. This qualifier is equivalent to the 'Natural' Population State value in the database.
NS	Natural State	Biological Attribute Qualifier	A taxon that has a stable or increasing population that is presumed to be in a natural condition, i.e., has not experienced historical human-induced decline.
RR	Range Restricted	Biological Attribute Qualifier	A taxon naturally confined to specific substrates, habitats, or geographic areas of less than 100 km^2 (100,000 ha), this is assessed by taking into account the area of occupied habitat of all sub-populations (and summing the areas of habitat if there is more than one sub-population), e.g., Chatham Island forget-me-not (*Myosotidium hortensia*) and Auckland Island snipe (*Coenocorypha aucklandica aucklandica*). This qualifier can apply to any 'Threatened' or 'At Risk' taxon. It is redundant if a taxon is confined to 'One Location' (OL)
Sp	Biologically Sparse	Biological Attribute Qualifier	The taxon naturally occurs within typically small and widely scattered subpopulations. This qualifier can apply to any 'Threatened' or 'At Risk' taxon.
NO	Naturalized Overseas	Population State Qualifier	A New Zealand endemic taxon that has been introduced by human agency to another country (deliberately or accidentally) and has naturalised there, e.g., *Olearia traversiourum* in the Republic of Ireland.

Continued on next page

List of National Qualifiers from the New Zealand Threat Classification System

Code	Qualifier	Qualifier Type	Description
OL	One Location	Population State Qualifier	Found at one location in New Zealand (geographically or ecologically distinct area) of less than 100,000 ha (1000 km2), in which a single event (e.g., a predator irruption) could easily affect all individuals of the taxon, e.g., L'Esperance Rock groundsel (*Senecio esperensis*) and Open Bay leech (*Hirudobdella antipodum*). 'OL' can apply to all 'Threatened', 'At Risk', 'Non-resident Native' – Coloniser and Non-resident Native – Migrant taxa, regardless of whether their restricted distribution in New Zealand is natural or human-induced. Resident native taxa with restricted distributions but where it is unlikely that all sub-populations would be threatened by a single event (e.g., because water channels within an archipelago are larger than known terrestrial predator swimming distances) should be qualified as 'Range Restricted' (RR).
SO	Secure Overseas	Population State Qualifier	The taxon is secure in the parts of its natural range outside New Zealand
SO?	Secure Overseas?	Population State Qualifier	It is uncertain whether a taxon of the same that is secure in the parts of its natural range outside New Zealand is conspecific with the New Zealand taxon.
S?O	Secure? Overseas	Population State Qualifier	It is uncertain whether the taxon is secure in the parts of its natural range outside New Zealand.
TO	Threatened Overseas	Population State Qualifier	The taxon is threatened in the parts of its natural range outside New Zealand.
T?O	Threatened Overseas?	Population State Qualifier	It is uncertain whether a taxon of the same name that is threatened in the parts of its natural range outside New Zealand is conspecific with the New Zealand taxon.
T?O	Threatened? Overseas	Population State Qualifier	It is uncertain whether the taxon is threatened in the parts of its natural range outside New Zealand.
CI	Climate Impact	Pressure Management Qualifier	The taxon is adversely affected by long-term climate trends and/or extreme climatic events. The following questions provide a guide to using the CI Qualifier: Is the taxon adversely affected by long-term changes in the climate, such as an increase in average temperature or sea-level rise? If NO = no Qualifier but needs monitoring and periodic re-evaluation because projected changes to the average climate and sea-level rise may adversely impact the taxon (including via changes to the distribution and prevalence of pests, weeds, and predators) in the future. If YES = CI Qualifier Is the taxon adversely affected by extreme climate events, such as a drought, storm, or heatwave? If No = no Qualifier but needs monitoring and periodic re-evaluation because projected changes to the climate are likely to increase the frequency and/or severity of these events in the future. If YES = CI Qualifier Use of the Climate Impact Qualifier would indicate the need for more in-depth research, ongoing monitoring of climate impacts, and potentially a climate change adaptation plan for the taxon

Continued on next page

List of National Qualifiers from the New Zealand Threat Classification System

Code	Qualifier	Qualifier Type	Description
CD	Conservation Dependent	Pressure Management Qualifier	The taxon is likely to move to a worse conservation status if current management ceases. The term 'management' can include indirect actions that benefit taxa, such as island biosecurity. Management can make a taxon CD only if cessation of the management would result in a worse conservation status. The influence of the benefits of management on the total population must be considered before using CD. The benefit of managing a single subpopulation may not be adequate to trigger CD, but may trigger Partial Decline (PD). Taxa qualified CD may also be PD because of the benefits of management.
CR	Conservation Research Needed	Pressure Management Qualifier	Causes of decline and/or solutions for recovery are poorly understood and research is required.
EW	Extinct In The Wild	Pressure Management Qualifier	The taxon is known only in captivity or cultivation or has been reintroduced to the wild but is not self-sustaining. Assessment of a reintroduced population should be considered only when it is self-sustaining. A population is deemed to be self-sustaining when the following two criteria have been fulfilled: it is expanding or has reached a stable state through natural replenishment and at least half the breeding adults are products of the natural replenishment, and it has been at least 10 years since reintroduction
EF	Extreme Fluctuations	Pressure Management Qualifier	The taxon experiences extreme unnatural population fluctuations, or natural fluctuations overlaying human-induced declines, that increase the threat of extinction. When ranking taxa with extreme fluctuations, the lowest estimate of mature individuals should be used for determining population size, as a precautionary measure.
INC	Increasing	Pressure Management Qualifier	There is an ongoing or forecast increase of > 10% in the total population, taken over the next 10 years or three generations, whichever is longer. This qualifier is redundant for taxa ranked as 'Recovering'.
PD	Partial Decline	Pressure Management Qualifier	The taxon is declining over most of its range, but with one or more secure populations (such as on offshore islands). Partial decline taxa (e.g., North Island kākā *Nestor meridionalis septentrionalis* and Pacific gecko *Dactylocnemis pacificus*) are declining towards a small stable population, for which the Relict qualifier may be appropriate.
PF	Population Fragmentation	Pressure Management Qualifier	Gene flow between subpopulations is hampered as a direct or indirect result of human activity. Naturally disjunct populations are not considered to be 'fragmented'.

Continued on next page

List of National Qualifiers from the New Zealand Threat Classification System

Code	Qualifier	Qualifier Type	Description
PE	Possibly/Presumed Extinct	Pressure Management Qualifier	A taxon that has not been observed for more than 50 years but for which there is little or no evidence to support declaring it extinct. This qualifier might apply to several Data Deficient and Nationally Critical taxa.
RF	Recruitment Failure	Pressure Management Qualifier	The age structure of the current population is such that a catastrophic decline is likely in the future. Failure to produce new progeny or failure of progeny to reach maturity can be masked by apparently healthy populations of mature specimens.
Rel	Relict	Pressure Management Qualifier	The taxon has declined since human arrival to less than 10% of its former range but its population has stabilised. The range of a relictual taxon takes into account the area currently occupied as a ratio of its former extent. Reintroduced and self-sustaining populations within or outside the former known range of a taxon should be considered when determining whether a taxon is relictual. This definition is modified from the definition of the At Risk – Relict category in the NZTCS manual (Townsend et al. 2008). The main difference is that trend is not included in the qualifier definition. This enables the qualifier to be applied to any taxon that has experienced severe range contraction, regardless of whether that contraction continues or has been arrested. This qualifier complements the 'Naturally Uncommon (NU)' qualifier which can be applied to taxa whose abundance has declined but which continue to occupy a substantial part of their natural range.

9.4. Land & Soil Monitoring Update

Prepared for: Environmental Science and Policy Committee

Report No. SPS2404

Activity: Environmental - Biodiversity

Author: Erik Button, Scientist – Land and Soil

Endorsed by: Anita Dawe, General Manager Policy and Science

Date: 27th June 2024

PURPOSE

[1] This report provides an annual update on the Land and Soil work programme.

EXECUTIVE SUMMARY

[2] Progress has continued to revitalise the ORC's land and soil programme. The soil health monitoring programme has expanded further with additional soil biology indicators added.

[3] Data suggests soil health is generally good but there are emerging issues of compaction, depletion of organic reserves and nutrient imbalance. Soil biology indicators across different land uses highlight differences in the diversity and abundance of soil invertebrates.

[4] The expansion of S-Map (soil maps) will reach 36% coverage in Otago by 2025 which will include 98% of our most productive soils (LUC classes 1-3). Significant updates of the land information available on the ORC website have been made including downloadable soil order factsheets. The Otago irrigation map was updated in 2023, and the land use map will be updated again this year.

RECOMMENDATION

That the Committee:

*1) **Notes** this report.*

BACKGROUND

[5] The ORC's land and soil programme was revitalised in 2021 and has focussed on developing key maps and datasets relating to land use, soil health and quality, and technical information for a range of different audiences. These resources are being utilised both across the ORC and in the community for a wide range of applications including nutrient modelling, economics, policy development, catchment management, and farm scale mitigations.

LAND USE AND IRRIGATION MAPPING

[6] An update of the 2022 Otago Land Use map has been contracted and will be available later this year to improve the accuracy of land use classifications and extents.

[7] The 2021 Otago Irrigated Area Map was updated in 2023[1]. The mapping used aerial imagery to identify irrigated areas during the dry 2022-2023 summer. The total mapped irrigated area in Otago increased by 6% to 129,752 ha, with pivot irrigation making up 37% of that area (Table 1). This increase can partially be attributed to mapping improvements and does not solely reflect a physical increase in irrigated area over that time. The update highlights the change in irrigation that has and is occurring, with a shift towards pivot irrigation. The irrigation feature spatial data can be accessed publicly through the Freshwater Farm Plan Layers in Otago Maps.

Table 1. Mapped areas of irrigation types and changes between these in the mapping from 2021 and 2023 for the Otago region[1].

Irrigation type	**2023 area** (ha)	**2021 area** (ha)	**Difference** (ha)	**Difference** (%)	**Estimated error** (ha)	**Proportion of total** (%)
Borderdyke	9,456	11,040	-1,584	-14	473	7
Drip/micro	5,683	4,109	+1,574	+38	284	4
Gun	3,049	3,637	-588	-16	213	2
K-line/Long lateral	25,609	26,812	-1,203	-4	1,537	20
Lateral	136	136	0	0	3	0
Linear boom	131	315	-184	-59	7	0
Pivot	48,350	41,736	+6,614	+16	967	37
Rotorainer	3,203	3,660	-457	-12	160	2
Solid-set	723	689	+34	+5	36	1
Wild flooding	8,074	9,196	-1,122	-12	646	6
Unknown[2]	25,338	21,358	+3,980	+19	2,534	20
Total	**129,752**	**122,688**	**7,064**	**+6**	**6,859**	**100**

SOIL HEALTH MONITORING

Background

[1] Aqualinc, 2023. Otago irrigated area spatial dataset: 2023 update. Memorandum prepared for Otago Regional Council.

[2] The 'Unknown' irrigation type is due to lower resolution satellite imagery that was available at the time of analysis not making irrigation type identification possible. This land is more likely to be assigned an irrigation type classification in the next update with the availability of higher resolution imagery.

[8] Healthy soil is crucial for agricultural production, flood mitigation, carbon storage, supporting biodiversity, filtering, and storing nutrients, water, and gases[3]. Healthy soils are also resilient to a wide range of natural and human pressures such as climate and land use change. The soil health monitoring programme is designed to monitor long term trends in indicators that gauge the physical state, fertility, depletion, and contamination of the soil. Sites are resampled after 3-5 years with the intent to reveal any trends over time, which is especially important with pressures of climate and land use change. Programme data is anonymised and contributes to national datasets and publications about the state of New Zealand's soil.[4]

Framework

[9] Under the RMA, regional authorities are required to monitor, and report on the health of soils[5]. Specific requirements are monitoring and reporting on the "life supporting capacity of soil" and the capacity of current practices to meet the "foreseeable needs of future generations". These requirements are met through the State of the Environment (SOE) soil health monitoring programme which is guided by the national Land Monitoring Forum and carried out consistently across regional authorities.

Network expansion

[10] The soil monitoring programme in Otago is still in its infancy having been started in 2021 (Figure 1). In 2023 an additional 15 sites were added, bringing the total to 37 across Otago.

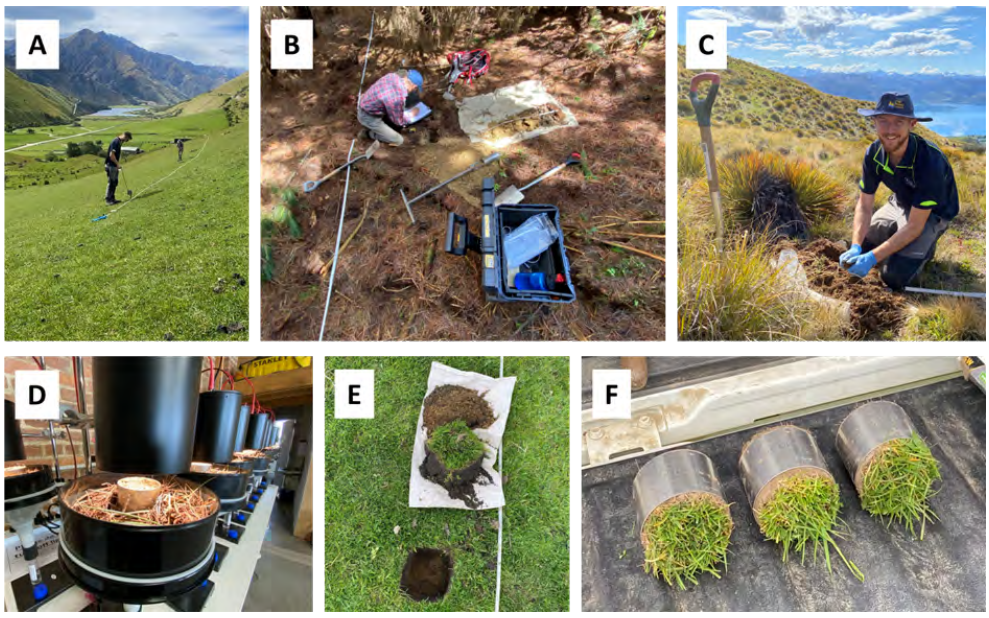


Figure 1. Pictures from the soil monitoring programme. A) collecting soil plug samples for chemical analysis along a 50 m transect; B) classification of the soil at a forestry site; C) collecting soil invertebrates for assessing soil biological health on a high-country

[3] Ministry of Primary Industries. 2015. Future Requirements for Soil Management in New Zealand. National Land Resource Centre, Palmerston North.

[4] Ministry for the Environment & Stats NZ (2024). New Zealand's Environmental Reporting Series: Our land 2024. Available from www.environment.govt.nz and www.stats.govt.nz.

[5] Section 30(1) (c) and (ca) and 35(2) (a) of the Resource Management Act (1991).

station; D) Funnels used to extract soil mesoinvertebrates from collected soil cores; E) one of three 20x20x20 cm soil cubes that are searched for 10 mins each for collecting macroinvertebrates; F) intact soil cores collected for physical soil analyses.

[11] A screening exercise was undertaken to ensure monitoring sites captured the variability of land use, soil type and climate in Otago. The sites added in 2023 include high-country dry stock, plantation forestry, market gardening, and orchards, improving the representation of land uses, soil orders and areas in Otago (Figure 2). The programme as it stands is useful as an indication of the current state of soils but will become more insightful when sites are resampled, quantifying any changes to soil over time.

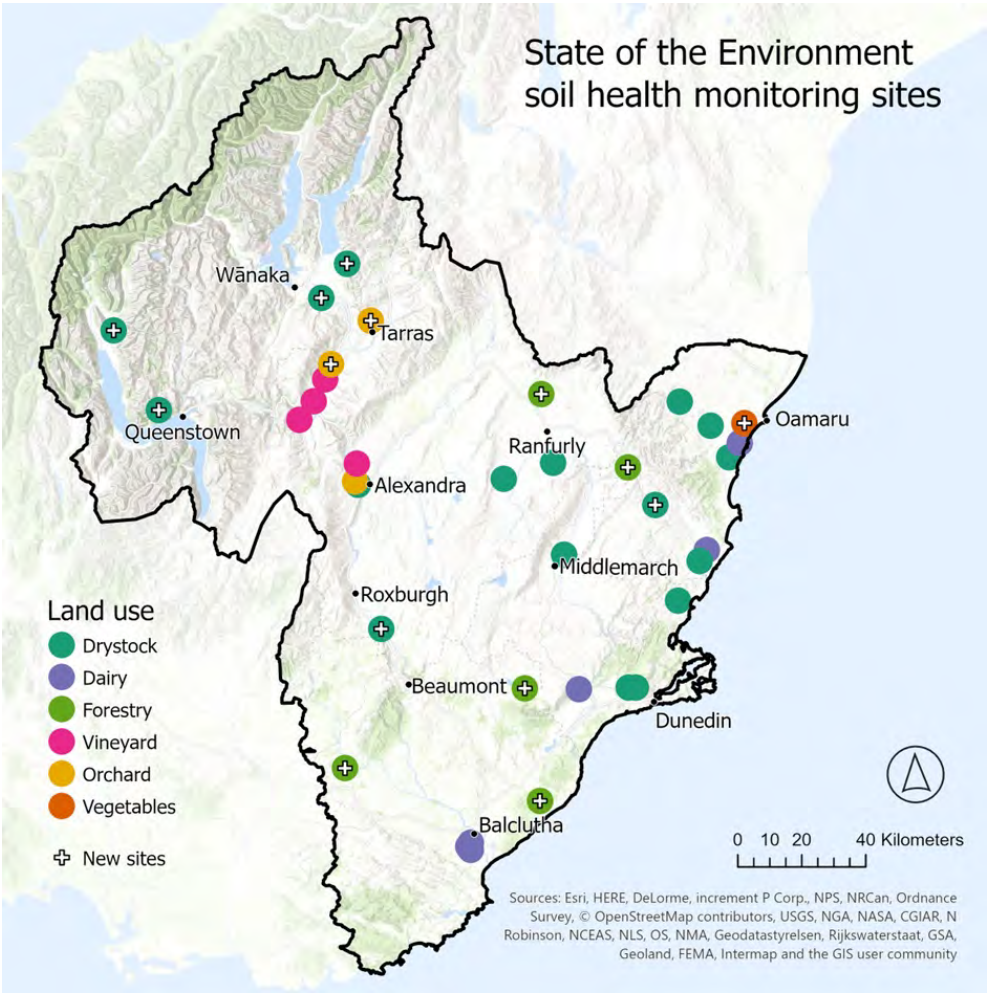


Figure 2. Map of the current soil health monitoring sites and their land uses. New sites are denoted by the plus symbols and were sampled in late 2023.

[12] Land uses and soil orders not captured or poorly represented in the programme will be targeted in 2024, including conservation land, arable farming, and market gardening. A Department of Conservation permit has been granted for establishment of sites in a

range of native forest and tussock conservation areas in Otago that will be important additions to the network by representing a natural or reference state.

[13] The Land Monitoring Forum has developed a set of soil health indicators that vary across different land uses. Overall, the results collected so far suggest that soil health in Otago is in a good position with few exceedances of the critical limits (Figure 3). Graphs of numerical measurements are shown in Appendix 1.

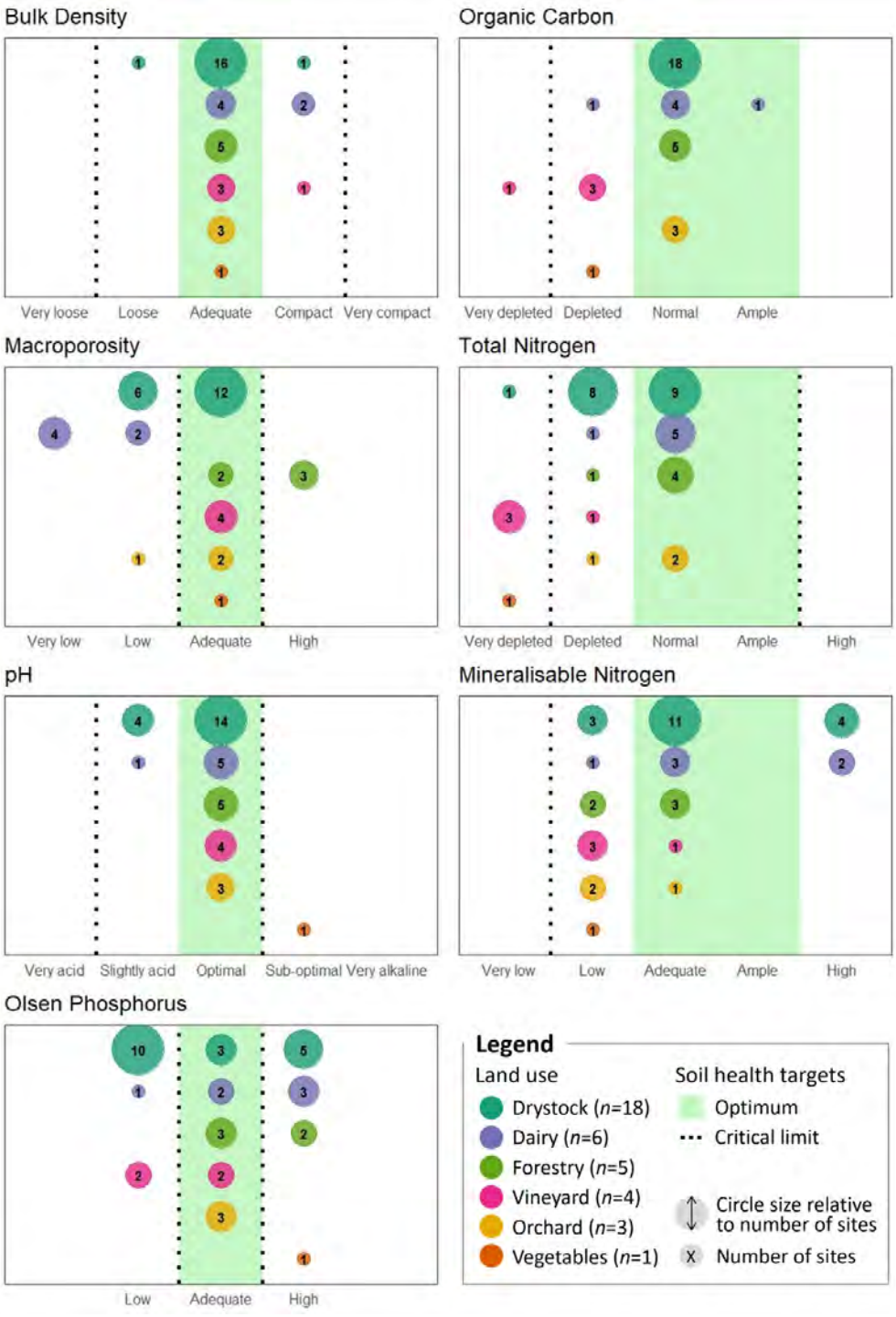


Figure 3. The proportion of sites in each land use that meet soil health targets. Targets were developed by a panel of soil scientists and are relative to soil order and/or land use[6]. A recently awarded Ministry for the Environment funded project will review and revise these targets. Numeric values are shown in Appendix 1.

[14] Some trends in soil properties can be attributed to land use effects. For example, low macroporosity together with high bulk densities suggest compaction of the soil by either stock or machinery which can limit plant productivity and increase flooding susceptibility. The state of soil organic reserves (carbon and nitrogen) indicates some depletion across most land uses, which suggests a loss of soil organic matter from management practices that alter the conditions for the soil life that both build up and break down soil organic matter. Elevated phosphorus levels (Olsen P) can reflect excess application of phosphorus fertilizer and are also associated with increased risks to water quality. Measured concentrations of potentially toxic elements (arsenic, cadmium, chromium, copper, lead, nickel, and zinc) were variable but mostly in line with predicted background concentrations and all below human health protection guidelines.

[15] Programme results are fed back to individual landowners in a standardised 'Soil Health Report', which are automatically generated via code for consistency and efficiency. An example report is included in Appendix 2.

Soil biological health

[16] A recent study estimated that soil is home to 59% of all life[7]. Biology is increasingly being recognised as central to the healthy functioning of soil and research of how to measure it has grown over the last 50 years. There has been extensive research on soil biological indicators appropriate for different locations (Australia, Europe, and Canada). In New Zealand, earthworms are considered good indicators for pasture systems and are part of the Visual Soil Assessment tool[8] for landowners to test the health of their soil. However, this indicator is not useful in other land uses where worms are not naturally found. Bacteria have been found to be sensitive to change and good predictors of soil health in New Zealand but are more challenging to measure. Despite this growing body of research, soil biology is not included in the standard parameters of the national SOE soil health monitoring programme, which focuses on more static soil physical and chemical properties. This means little is known about the life in the soil of different land uses in New Zealand or how it might be affected by land management over time.

[17] To address this gap, in 2023 three different soil biology measurements were added to the soil monitoring programme in Otago. These methods target organisms of different sizes that range in their complexity (Table 2). The purpose of measuring soil biology was to 1) understand the status of soil biology in Otago; 2) compare methods of different complexities to see which has most value and promise for future use; and 3) feedback this information to the regional sector to contribute to the development of national soil biological health measurement. There has also been significant landowner interest in

[6] National Environmental Monitoring Standard, 2022. Soil Quality and Trace Elements. Sampling, Measuring, and Managing Soil Quality and Trace Element Data. Version 1.0.0.

[7] Anthony, M.A., Bender, S.F. and van der Heijden, M.G., 2023. Enumerating soil biodiversity. *Proceedings of the National Academy of Sciences*, 120(33), p.e2304663120.

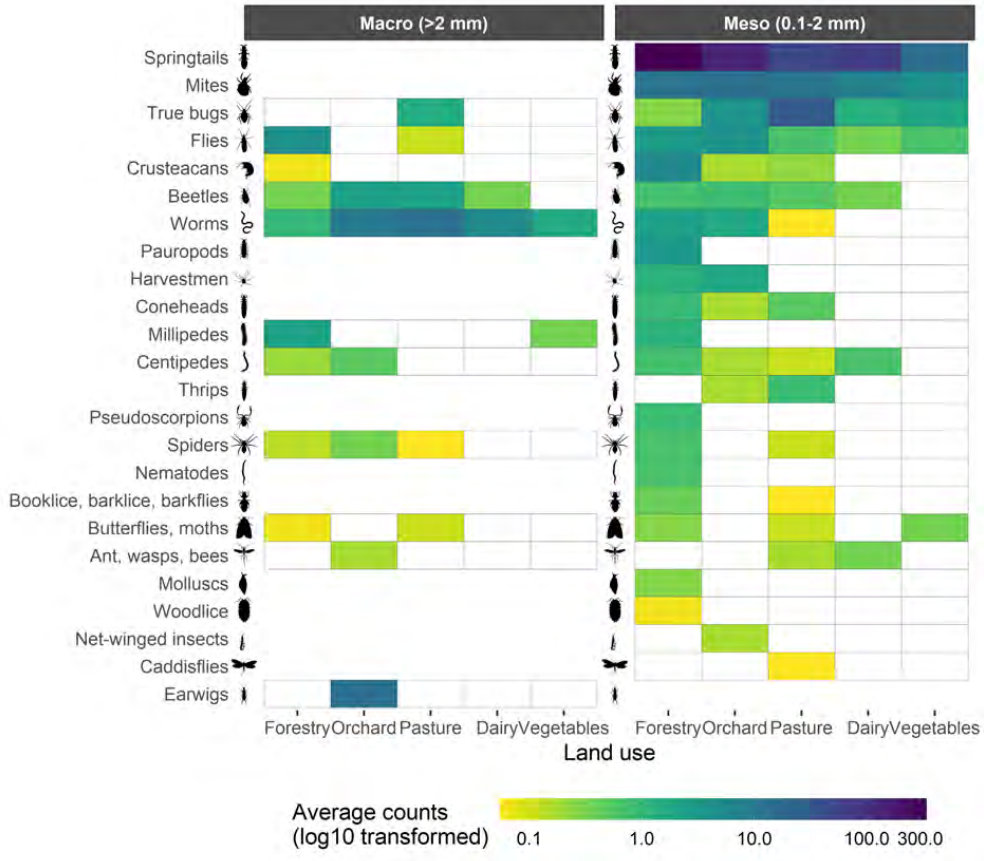
[8] Shepherd, T.G.; Ross, C.W.; Basher, L.R.; Saggar, S. 2000: Visual soil assessment, Volume 2. Soil management guidelines for cropping and pastoral grazing on flat to rolling country. horizons.mw & Landcare Research, Palmerston North. 44p.

the soil biology and the results from individual sites will be reported back to landowners.

Table 2. A general comparison of three different methods included as part of the 2023 soil health monitoring programme expansion. The DNA extraction collaboration with Otago University will be co-funded by an EnviroLink Advice grant to assist in the bioinformatic processing and interpretation of the data (results are not yet available).

Method name	Macro	Meso	DNA
Collection	Hand-searching	Extraction	Extraction
Analysis	Identification	Identification	DNA sequencing
Soil life targeted	Macroinvertebrates (>2 mm)	Mesoinvertebrates (0.1-2 mm)	All invertebrates, bacteria, fungi
Time requirements	Low	Medium	High
Data volume	Low to medium	Medium to high	Very high
Relative cost	Very low	Medium	High
Collaborators	-	Massey University	Otago University

[18] Routine soil biology assessment as part of monitoring programmes is still an emerging field with little guidance about interpreting data relevant to land use and soil type. The results to date demonstrate that the number and abundance of soil invertebrate groups varied significantly both by invertebrate size and land use (Figure 4). This is important for choosing appropriate organisms for soil health benchmarking between land uses and methods. In general, the results highlight that increasing land use intensity (e.g., more cultivation, higher fertilizer use) decreases both the abundance and diversity of soil invertebrate groups present. However, this is based on a limited number of sites and more data will allow for greater confidence in interpretation.



[19] **Figure 4.** The presence and average counts of soil invertebrate groups across land uses from collection methods that target different sizes of invertebrates (Hand searching - 'Macro' and Extraction - 'Meso'). The total number of sites was 15 (Forestry = 5, Orchard = 2, Pasture = 6, Dairy = 1, Vegetables = 1).

[20] Certain soil invertebrate groups have been used as soil health indicators, such as predatory mites (indicative of a complex food chain and sensitive to changes) and others are recognised agricultural pests (threat to production and suggestive of an imbalanced ecosystem), however, nationally, or regionally relevant target ranges do not exist. Interestingly, a rare giant springtail (*Holacanthella*) was found in one mature plantation forestry site. This springtail, native to New Zealand, is recognised as an indicator for native forest health and is possibly the first documented record in a plantation forest[9]. A selection of observed invertebrates is shown in Figure 5.

[9] Stevens, M.I., Winter, D.J., Morris, R., McCartney, J. and Greenslade, P., 2007. New Zealand's giant Collembola: new information on distribution and morphology for Holacanthella Börner, 1906 (Neanuridae: Uchidanurinae). *New Zealand Journal of Zoology*, *34*(1), pp.63-78.

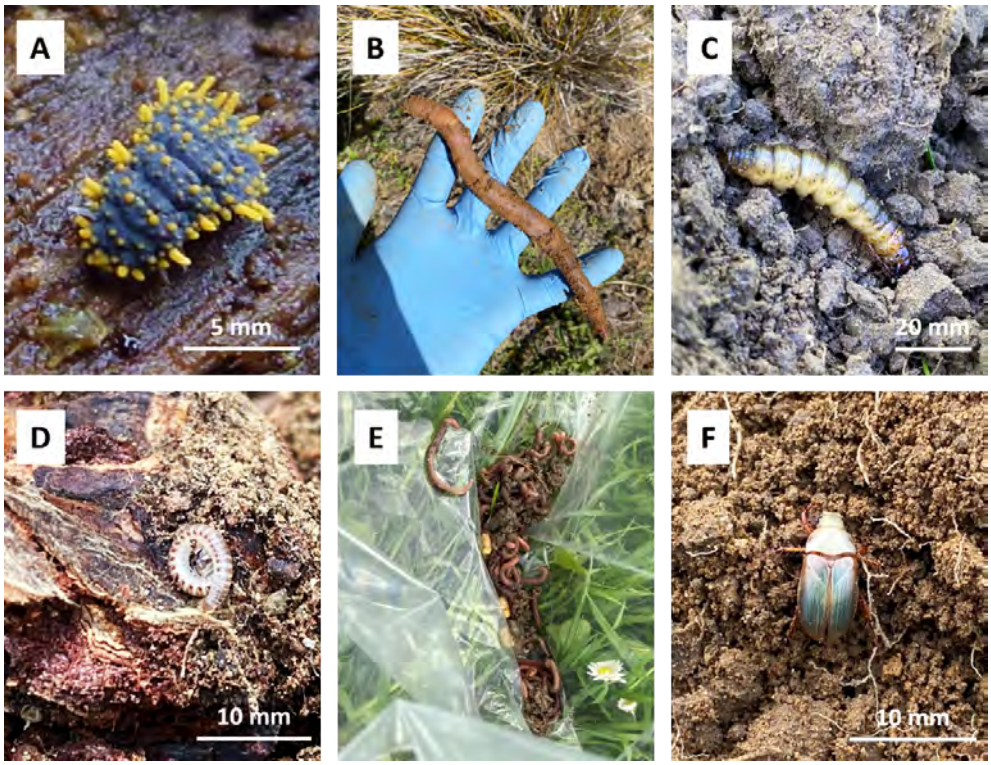


Figure 5. Selection of soil invertebrates collected as part of the soil biological health addition to the monitoring programme. A) an example of an endemic *Holacanthella* giant springtail[10] found at a forestry site; B) native giant earthworm in tussocks at >1,000m; C) A common porina moth pest found in pasture but not at damaging levels; D) Millipedes are detritovores and were common in forestry where they decompose the abundant plant matter; E) a particular site where >60 earthworms were found in one 20x20x20 cm hole ; F) native Mānuka scarab beetle that are similar to grass grubs and considered a pasture pest. Scales are approximate. All collected macroinvertebrates were released after collection and identification.

S-MAP SOIL MAPPING

[21] The ORC has been supporting the expansion of the S-map soil mapping in Otago, prioritising contiguous areas of the highest capability land (LUC classes 1-3) that has not yet been mapped (Figure 6). S-map is produced by Manaaki Whenua Landcare Research soil scientists and is the leading soil map resource available in the country. Recent S-Map work in Otago has been 80% co-funded by MPI and the remainder by the ORC soil mapping programme.

[10] Photo from Dwinter 2017 under CC BY-SA 3.0. *Holacanthella paucispinosa*, Fraser's Gully, Dunedin, New Zealand.

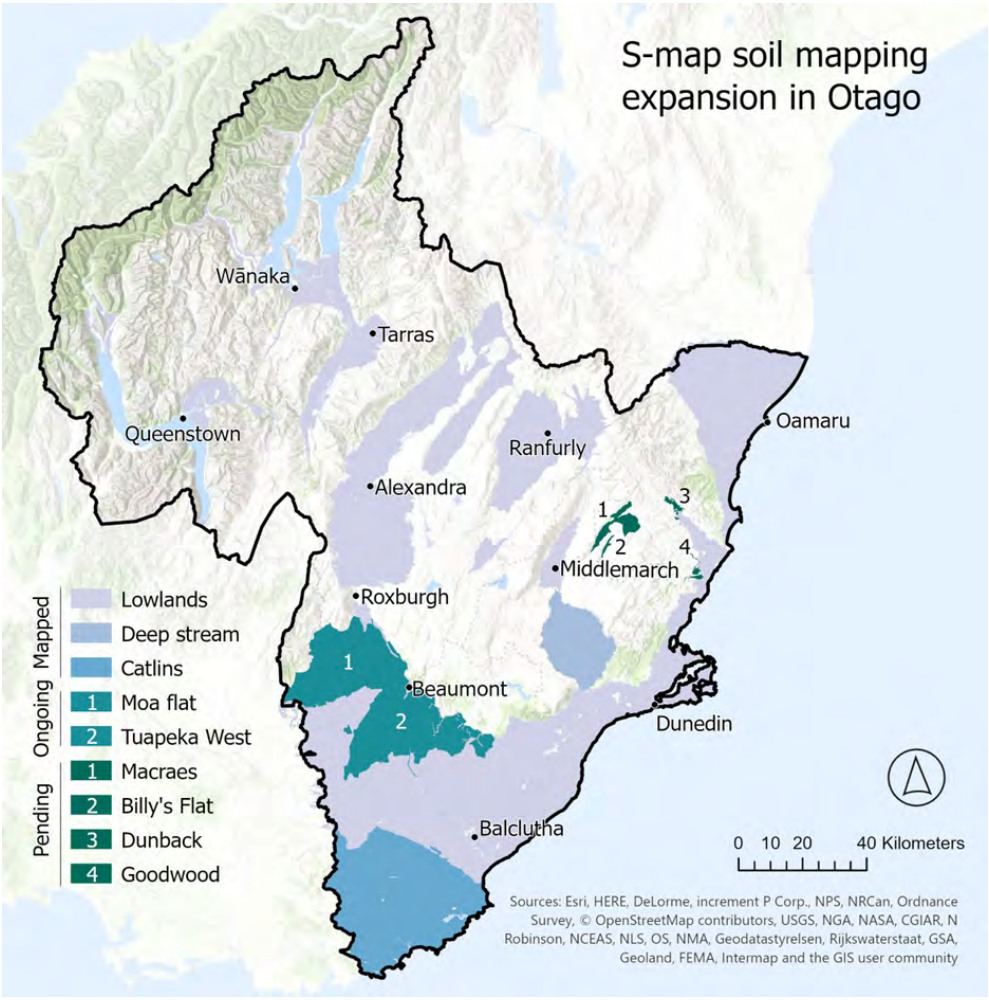


Figure 6. Map of the areas in Otago that have S-Map coverage (mapped), where mapping is ongoing and where planned mapping is pending.

[22] S-Map is freely available and is a valuable tool for managing primary industry activities, a key input in Overseer nutrient budgeting software and useful for developing effective farm plans. S-Map also includes vulnerability classes that inform management of the risks and opportunities of different soils. In addition, S-Map can be used to calibrate the New Zealand Land Resource Inventory (NZLRI) Land Use Capability (LUC) grading of productive land which currently uses data collected over 40 years ago at a broader scale than S-Map. As such, S-Map is a useful tool in the identification and delineation of productive land as required by the National Policy Statement for Highly Productive Land.

[23] Currently, 32% of Otago is mapped with a further 4% on its way over the next few years (Table 3). Most of the productive lower lying land has full coverage and by 2025, 98% of Otago's LUC classes 1-3 (most productive) will be included in S-Map. Further expansion of S-map will be programmed, with co-funding from central government where available.

Table 3. Summary statistics of the areas in Otago where S-map coverage exists, is ongoing or is planned. *Have a high proportion of LUC classes 4 and 5 land.

S-map expansion areas	Year completed	Area (000's ha)	Proportion LUC classes **1-3** (%)	Proportion of Otago (%)
Otago lowlands	2005	820	41	26
Deep stream	2020	43	2*	1
Catlins	2023	146	16*	5
Moa flat and Tuapeka West	*2024*	130	18*	4
Macraes areas, Dunback and Goodwood	*2025 (planned)*	10	79	0.3
Total		1,149		36

WEBSITE UPDATE AND SOIL FACTSHEETS

[24] Soil and land related information available on the ORC website has been updated, with new content created to better communicate the land and soil work programme and Otago-specific land and soil resources and how they might be sustainably managed:

Webpage	Content
Soil in Otago	Background on soil in Otago, downloadable soil factsheets, soil mapping and soil naming information.
Soil health monitoring	Background on the soil health monitoring programme, it's indicators and whether they meet the target ranges in each land use.
Soil and land data	Information on what data is collected and why it is useful with links to the Environmental Data Portal.
Managing soil	Information on good management practices for enhancing and maintaining soil health.
Fertiliser management	Information on industry agreed good management practices for fertiliser use.
Land use	Background on land uses in Otago with the extents of each category.

[25] As part of the Soil in Otago page, factsheets were developed for each of the eight New Zealand Soil Classification orders that make up 99% of the soil in Otago (Figure 7). An example factsheet can be found in Appendix 3. These include the characteristics, vulnerabilities, occurrences, and management considerations of the soil order. The factsheets were developed with input from soil scientists, catchment, and industry groups to ensure they were accessible and informative for a range of users.

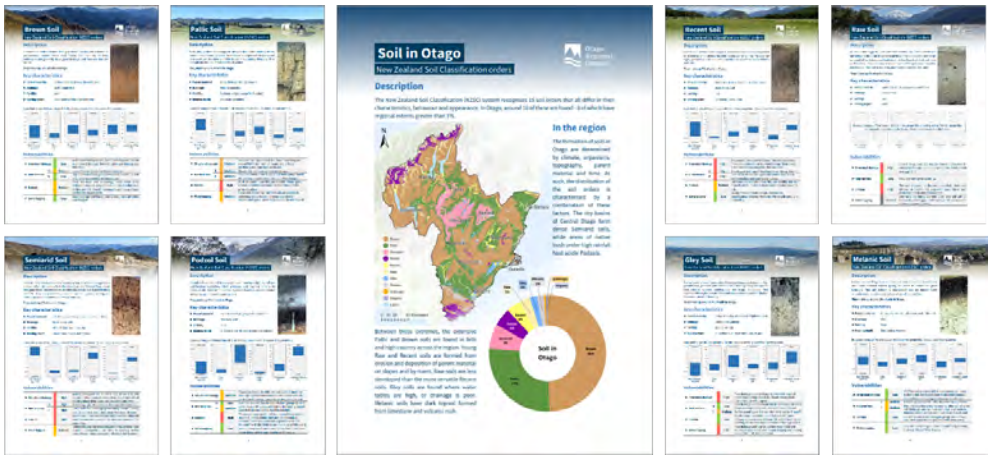


Figure 7. A series of soil factsheets were developed for each of the eight most common soil orders in Otago and a general overview factsheet covering all orders. See Appendix 3 for an example factsheet.

OPTIONS

[26] N/A

CONSIDERATIONS

Strategic Framework and Policy Considerations

[27] This work promotes best practice land management, for soil conservation, water quality and water use efficiency.

Financial Considerations

[28] The Land and Soil work programme is a funded and planned work stream.

Significance and Engagement Considerations

[29] N/A

Legislative and Risk Considerations

[30] N/A

Climate Change Considerations

[31] Monitoring networks are being designed with climate change as a key consideration and will help to monitor any environmental changes in response to climate change.

Communications Considerations

[32] N/A

NEXT STEPS

[33] These projects will continue as outlined above.

ATTACHMENTS

1. Appendix 1: Soil health measurement data [**9.4.1** - 1 page]
2. Appendix 2: Example Soil health report [**9.4.2** - 8 pages]

3. Appendix 3: Example pallic soil factsheet [**9.4.3** - 4 pages]

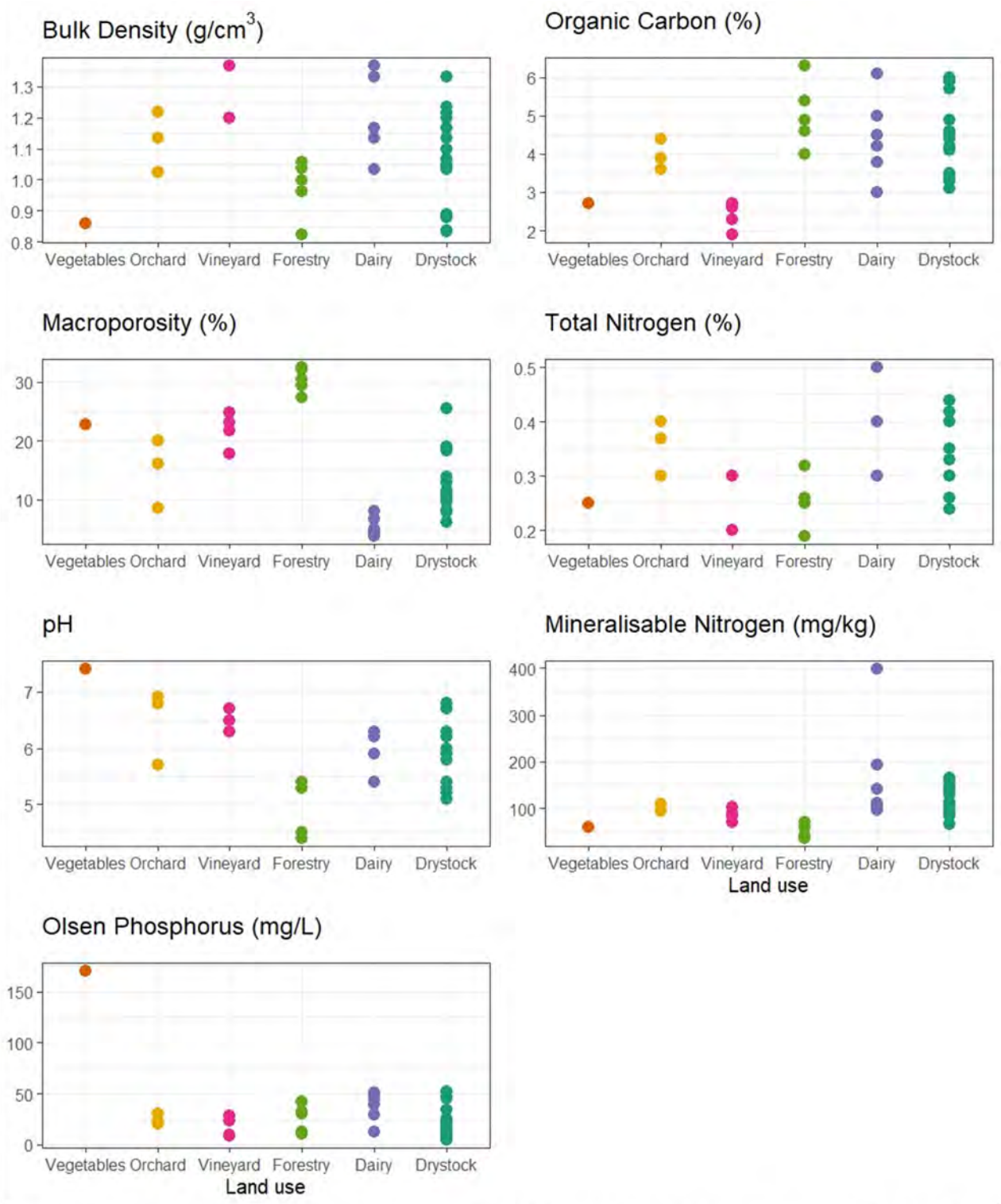


Figure. The plotted data for the seven soil health monitoring programme indicators by land use. Number of sites were 18 (drystock), 6 (dairy), 5 (forestry), 4 (vineyards), 3 (orchards) and 1 (vegetables).

Otago Regional Council

Soil Health Report

ORCSQ13

Dr Erik Button, Land & Soil Scientist

March 2024

What is it?

A report of the results from the sampling of your soil and what it means. This is part of the State of the Environment programme that monitors soil health in Otago and other regions to understand the long-term trends of soil health in Aotearoa New Zealand and to support evidence-based decision making.

Please note - *the information within this report will never be used in relation to compliance or consent situations and all personal information will be anonymised. Presentation of the data will always be without the specific location or defining characteristics.*

Report structure

1. Site description	General site information
2. Soil description	Soil classification, texture, horizons and depth of the soil
3. Soil physics & chemistry	Physical and chemical soil indicators and what they mean
4. Potentially toxic elements	Trace metal analyses and what they mean
5. Conclusion	Summary and soil health rating

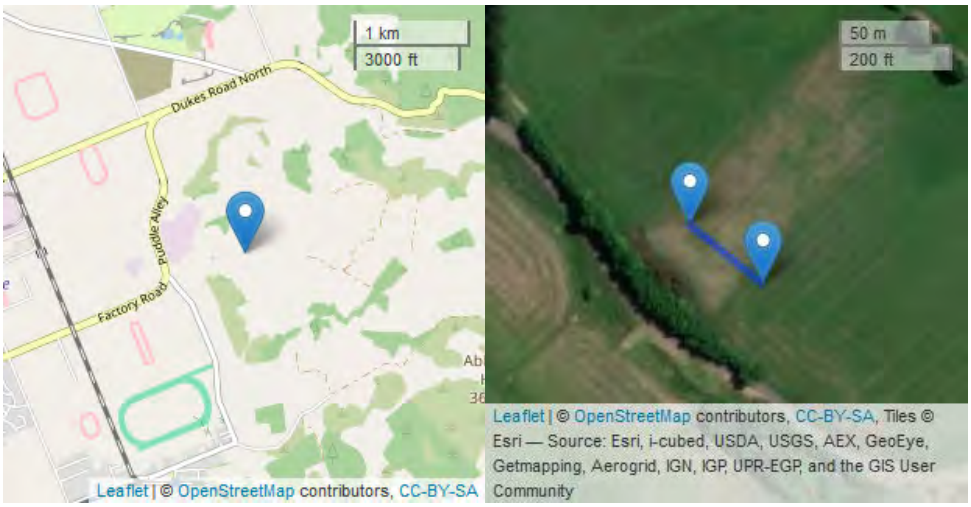
The target ranges used in 3, 4 and 5 were determined (predominantly in terms of production) for different soil orders and land uses from an expert panel of New Zealand scientists (Sparling et al., 2008; Mackey et al. 2013). These may be revised in the future. The methodology used can be found in the National Environmental Standard (NEMS, 2022).

1. Site description

General

Date sampled	10-Oct-22
Teritorial authority	Dunedin City Council
Freshwater Management Unit	Dunedin & Coast
Catchment	Taieri/Taiari River
Landform	Undulating thick schist loess hills
Land use	Sheep
Vegetation	Dense low quality pasture - 65% grass, 15% moss, 10% clover, 5% flat weeds
Average rainfall (mm/year)	880
Elevation (m)	88
Slope	Rolling (8-15°)
Drainage	Poor
Irrigation	No
Additional	Land has received no fertiliser for over 70 years

Location



Maps of the site and the location of the 50 m transect that was sampled.

2. Soil description

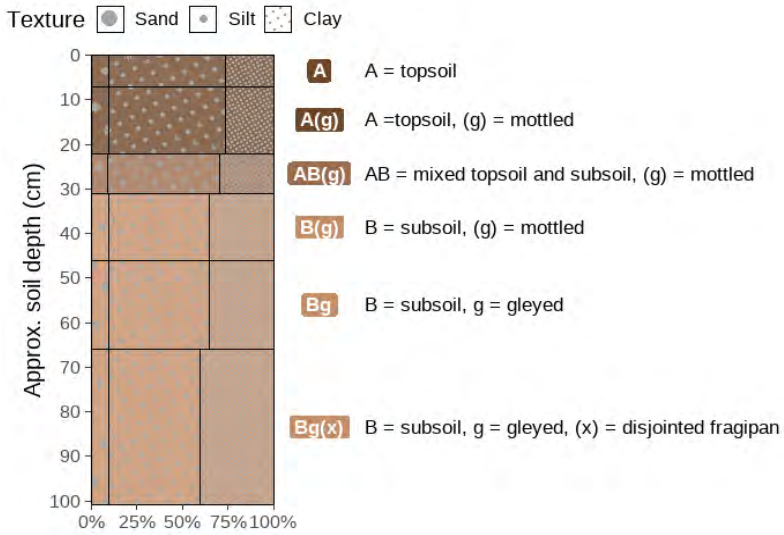
Soil classification

Soil is classified to understand its formation, qualities, and limitations. The New Zealand Soil Classification (NZSC) system is the modern system used to classify the soils of Aotearoa New Zealand (Hewitt, 2010).

Your soil is a Argillic Perch-gley Pallic soil. These are soils with pale coloured subsoils, low amounts of iron oxides, weak structure and high density subsurface horizons, formed in predominantly in schist or greywacke loess. They are dry in summer, wet in winter, and occur primarily in the eastern North and South Islands covering 27% of Otago. It has an argillic horizon and experiences periodic wetness caused by a perched water table. See how this corresponds with other soil classification systems below.

Soil order (NZSC)	Argillic Perch-gley Pallic
Soil texture depth	Deep silty over clay
S-map soil family (sibling code)	Waitohi (Ytoh_1a.1)
Regional soil series (GrowOtago code)	Warepa (Wr0zR)

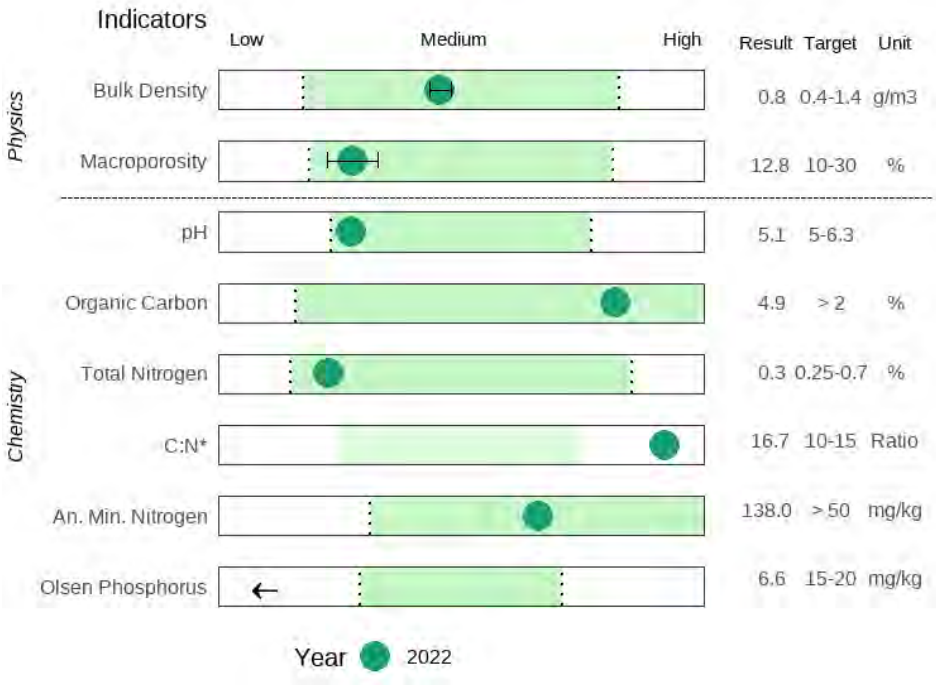
Soil profile and texture



The horizons and their depths give important context to the land, its formation and its capacity to support plant growth. Fr example, a deep topsoil can provide more water and nutrients than a shallow topsoil.

Soil texture is the relative proportion of sand (0.02-2 mm), silt (0.002-0.02 mm) and clay (<0.002 mm) particles. The texture largely determines the drainage, aeration, and nutrient retention characteristics of the soil. For example, lighter sandier soils hold less moisture than heavier clayier soil. A loam texture has an even mixture of particle sizes and is usually an ideal soil for growing.

3. Soil physics and chemistry



*C:N is presented for context and not included in the soil health assessment in 5.

Soil physics tells us about the structure and mechanical and hydrological behaviour of the soil. As such, it can be an indicator of compaction and erosion risk. The data is averaged from three soil cores (10 cm diameter; 0-7.5 cm) collected 15 m apart along a 50 m transect. The lines through the points on the graphs represent the standard error of the mean, a measure of variability.

Soil chemistry helps us understand the chemical characteristics of the soil which are affected by the mineralogy, environment, and management of the soil. The data is from a bulked sample of 25 soil cores (2.5 cm diameter; 0-10 cm) taken every 2 m along a 50 m transect.

Indicator	What it means
Bulk Density	A high bulk density relates to the compaction of the soil, which can limit plants access to water and nutrients in the soil and increase surface water runoff. A low density means the soil will be very loose and could be susceptible to erosion.
Macroporosity	Large soil pores allow space for air and water transport through the soil, which is important for plant growth, drainage and aeration.
pH	Dictates the availability of nutrients and the nature of chemical reactions taking place. There is no 'correct' pH as plants are adapted to different pH levels. Soil can naturally acidify over time but fertilisers also contribute to lowering the pH. A low pH increases the bioavailability of ions that are toxic to plant roots.
Organic Carbon (C)	An important energy source for soil micro-organisms involved in nutrient cycling. It is a good indicator for biological activity, fertility and water and nutrient retention.
Total Nitrogen (N)	N is the most commonly limiting nutrient. Total N gives an indication of the N status of the soil. Inorganic N (e.g. urea) is accessible to plants for uptake and organic N (e.g. proteins) can be converted into this by micro-organisms decomposing organic matter.
C:N	Determines the release of plant-available N by micro-organisms. A low ratio means micro-organisms are C limited and so organic matter is decomposed to release N which plants can uptake. A high ratio means micro-organisms are N limited and so they outcompete plants, meaning less N is available to plants.
Anaerobically Mineralisable N	Indicates how much N may become available to plants in the soil in the long term (i.e. organic N reserves) and is an indicator for micro-organism biomass.
Olsen Phosphorus (P)	P is commonly the second most limiting nutrient to plant growth. Low P levels are likely to be limiting plant growth and high P levels increase the risk of P loss to waterways which can impact water quality.

Other elements (sulphur, potassium and micronutrients) important for animal health but not for soil and environmental health are not included in this programme. Find more information about these here.

4. Potentially toxic elements

Trace elements are naturally present in the soil at small concentrations, however, at elevated levels they can cause risk to human and animal health. The dotted lines in the figure below represent the critical limits.

*The tiers for cadmium concentrations are related to phosphate fertiliser management and are defined here.

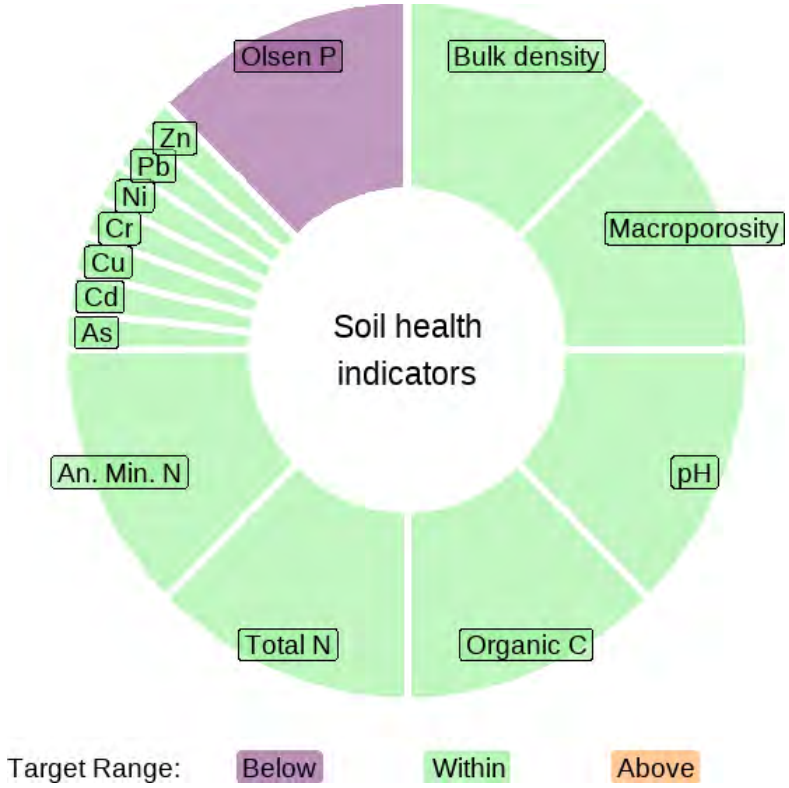
The potential sources of contamination in Aotearoa New Zealand are in the table below.

Elements	Potential sources
Arsenic	Wood preservatives and alloys
Cadmium	Phosphorus-based fertiliser, alloys, batteries
Chromium	Wood preservatives, pesticides, alloys, dyes
Copper	Copper-based fungicides and pesticides, wood preservatives, paints
Lead	Lead-based paints and petrol, batteries, metal products
Nickel	Alloys and batteries
Zinc	Wood preservatives, facial livestock eczema ointments, car tyre threads, alloys, paints

5. Conclusion

What does this mean?

Soil health is dynamic, meaning it can change due to impacts from the environment and/or management. To reach the full potential of soil for production, biodiversity, and other environmental functions, staying within the target ranges is recommended. See which indicators we found to be within the target ranges below.



From the 14 soil health indicators we tested in your soil, it was within the target range in 13.

For guidelines on soil management you can find useful information here. For fertiliser management it is recommended to work with the 4Rs: *right place, right time, right rate and right product*. Find out more information here.

We plan to return to your property in 2027 to re-sample from the same location to understand the soil health trend over time. We will be in touch closer to the time to arrange access. Thank you very much for taking part in the programme.

Any questions? If you have any questions related to the information contained within this report, don't hesitate to contact me.

Dr Erik Button
SCIENTIST - LAND & SOIL
M 027 246 4666
erik.button@orc.govt.nz
www.orc.govt.nz

Disclaimer - *Otago Regional Council are not responsible for the result of any decisions made based on the information contained within this report. This report is not intended as a basis for fertiliser requirements.*

References

Sparling G., Lilburne, L., Vojvodić-Vuković M. 2008. Provisional targets for soil quality indicators in New Zealand. Landcare Research Science Series no. 34. Manaaki Whenua Press, Lincoln, New Zealand. First published in 2003 by Landcare Research New Zealand Ltd, reissued in 2008, with minor amendments.

Mackay A., Dominati E., Taylor M.D. 2013. Soil quality indicators: the next generation. Report prepared for Land Monitoring Forum of Regional Councils. Client report number: RE500/2012/025. Hamilton, AgResearch Ltd.

National Environmental Monitoring Standard (NEMS), 2022. Soil Quality and Trace Elements - Sampling, Measuring, and Managing Soil Quality and Trace Element Data. https://www.nems.org.nz/.

Hewitt A.E., 2010. New Zealand soil classification. Manaaki Whenua Landcare Research science series.

Pallic Soil

New Zealand Soil Classification (NZSC) orders

Otago Regional Council

Description

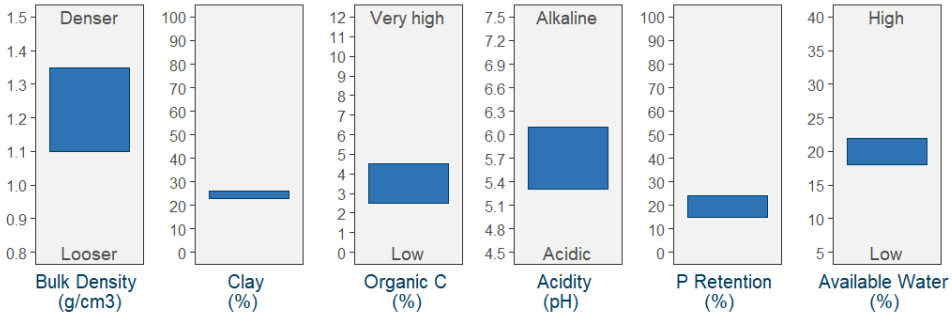
Pallic soils, as their name suggests, are pale due to low contents of iron oxides. They are mainly formed from fine wind-deposited silt (loess) and have weak soil structure and high density in subsurface horizons. They are typically dry in summer and wet in winter.

They make up 27% of soils in Otago.

Key characteristics

- **Parent material** — Loess from schist or greywacke
- **Drainage** — Poor to imperfect
- **Fertility** — Medium to high (except for Sulphur)
- **Rooting depth** — Moderate to limited

Expected ranges of Pallic topsoil (0-10 cm) key properties[2]. *C is carbon, P is phosphorus.*

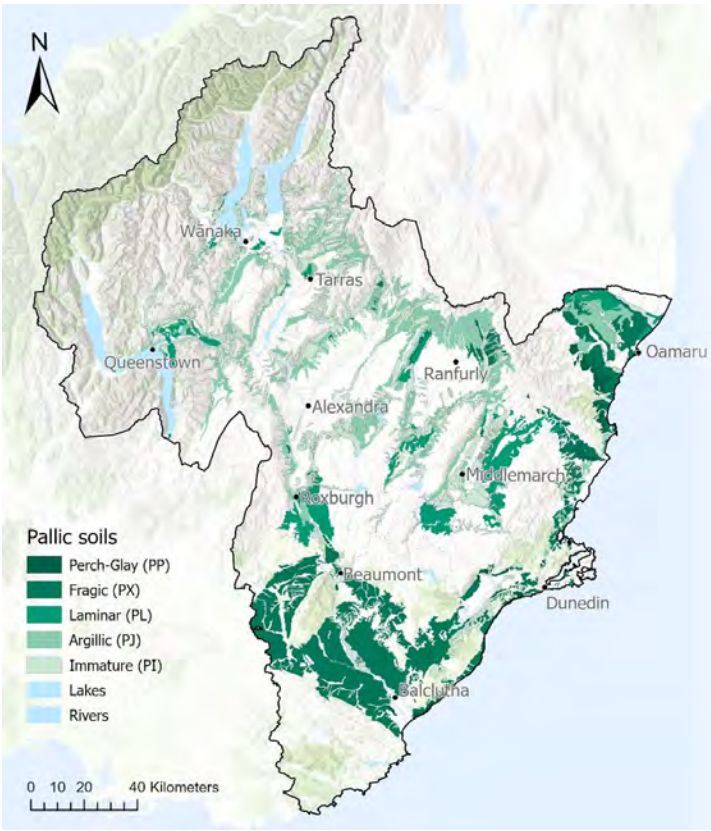


Vulnerabilities

▶ **Structural damage**	**Medium**	Impaired drainage or weak structure means they are susceptible to damage from pugging and heavy machinery use, especially when wet.
▶ **Nutrient loss** **N**	**Medium**	Greater risk for the better drained groups.
▶ **Nutrient loss** **P**	**Medium**	Low P retention means P easily lost from surface runoff. Bypass flow via soil cracks can occur after drought.
▶ **Erosion**	**High**	Weak structure means they are erodible. Tunnel gully erosion is common on slopes. Wind erosion is a risk when ploughed.
▶ **Waterlogging**	**Medium**	Fragic and Perch-Gley Pallic soils are susceptible to waterlogging due to poor drainage and almost impermeable pans. Other Pallic soils are better drained.

Soil Infosheet Pallic Soil

Otago Regional Council



Occurrence

Pallic soil mainly occurs on the rolling downlands in Otago. Generally, they are found in areas of annual rainfall between 500 and 800 mm. They are in places where summer drought is common and are often waterlogged in winter.

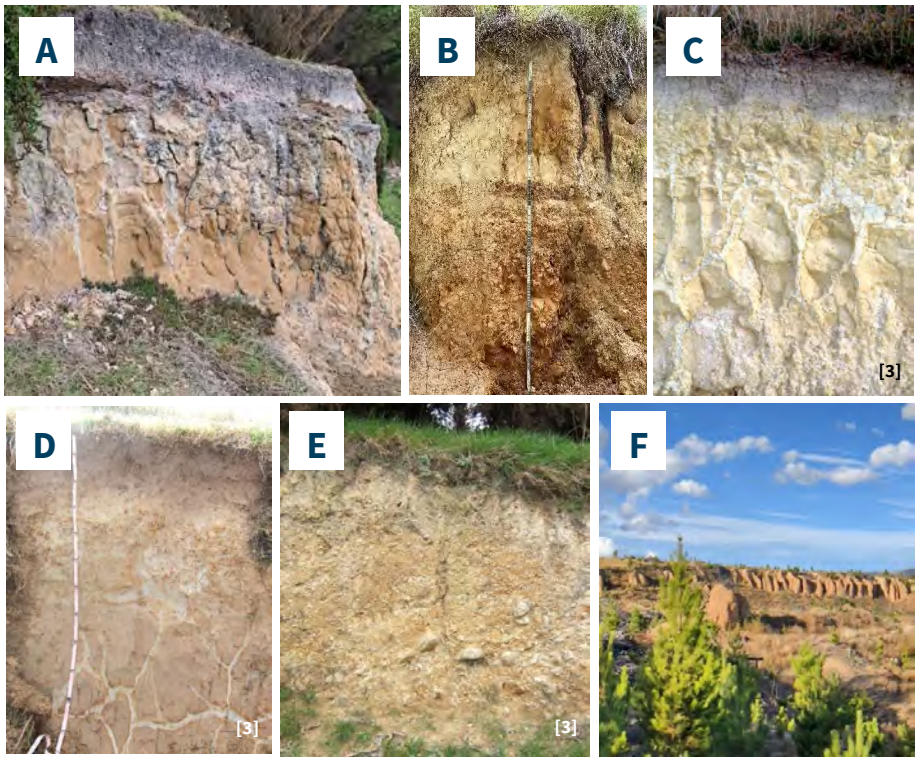
The map shows the regional extent of the different NZSC groups of Pallic soil. For more detailed mapping see page 4.

NZSC group	%*	Description[2]	Management considerations[2]
Perch-Gley	2	Prolonged periodic wetness caused by a perched water table.	Remain wet over winter and into spring. Heavy grazing can promote pugging and runoff of sediment and faecal matter. Drains are widely used to reduce waterlogging.
Fragic	32	Dense brittle pan in the subsoil that impedes drainage and rooting.	Restricted potential rooting depth. Caution is needed if cultivating as the soil has high propensity for wind and rill erosion. Minimal or no-till establishment of cultivation is best.
Laminar	12	Clay accumulation as thin subsoil bands.	Productive versatile soils due to deep rooting potential and satisfactory permeability. Suited to irrigation.
Argillic	19	Clay accumulation as thin coatings on peds or in pores.	Versatile with deep rooting potential. Suited to irrigation.
Immature	34	No pan, or argillic horizon, weakly expressed Pallic Soil features.	High versatility, because of their deep rooting potential, which enables exploitation of the high available water capacity in the subsoil. Can be highly productive. Suited to irrigation.

*Extent of each group as a percentage relative to all Pallic soils in the Otago region.

In the landscape

In Otago, Pallic soils are predominantly used for pastoral grazing. In Central Otago, mostly Immature Pallic soils dominate the rolling hills and merge into Semiarid soils where drier and Brown soils where wetter. Fragic Pallic soils are the next most extensive of the Pallic groups and are formed from loess on stable slopes in South Clutha and North Otago. Laminar Pallic soils are mainly present in the rolling hills around Ettrick, Ngapara, Moonlight and Queenstown. Perch-Gley Pallic are restricted to pockets of wet areas generally close to the coast and often at the foot slopes of hills, where they are associated with Gley soils.



A Cutting showing the pale-orange loess parent material below the pan of a Fragic Pallic soil. **B** Old Argillic Pallic soil with clay accumulated in the deeper horizons. **C** & **D** A pale poorly drained Perch-Gley Pallic soil, where pale gleyed lines show the blocky structure and frequency of wetting. **E** Cutting of a stony Immature Pallic soil. **F** The clay-containing loess of Argillic Pallic soil near Naseby.

Sustainable management

► **Erosion & Structure**	Maintain vegetation cover, no-till crop establishment and wind breaks can reduce erosion. Avoid working and grazing (or only lightly) when the soil is wet and build organic matter.
► **Nutrients**	It is recommended to always work with the 4Rs for fertiliser management: *right place, right time, right rate and right product*. Find out more information on fertiliser management here.
► **General**	For general guidelines on sustainable soil management you can find some useful links here.

Soil maps

► Fundamental Soil Layer	
Owner	Manaaki Whenua Landcare Research
Recommended use	Use at larger scales for general overview
Coverage	100%
Scale	1:50,000
Soil naming	NZSC
Development	Will be replaced by S-map
Link	soils-maps.landcareresearch.co.nz

► growOTAGO	
Owner	Otago Regional Council
Recommended use	Only use where S-map not available
Coverage	100% of Otago (by lowland and upland)
Scale	1:50,000
Soil naming	Old regional soil series names
Development	Not planned
Link	maps.orc.govt.nz/OtagoMaps/

► S-map	
Owner	Manaaki Whenua Landcare Research
Recommended use	Best available map. Use where present
Coverage	~30% of Otago
Scale	1:50,000
Soil naming	New S-map series names and NZSC
Development	Mapping ongoing
Link	smap.landcareresearch.co.nz/

For the te ao Māori of oneone (soil), including kaupapa Māori, history, and soil names, you can find more information here.

Contact For any questions you may have contact: science.enquiries@orc.govt.nz

Note - This Infosheet generalises typical average properties of the specified soil order and groups. It has been prepared in good faith by trained staff within time and budgetary limits. However, no responsibility or liability can be taken for the accuracy of the information and interpretations. Expert advice should be sought before making decisions on individual farms. The characteristics of the soil at a specific location may differ from those described here. The vulnerability ratings given in the table on page 1 are generalised and should not be taken as absolutes for this soil in all situations. The actual risk depends on the environmental and management conditions prevailing at a particular place and time.

References

[1] Manaaki Whenua - Landcare Research 2023. The New Zealand SoilsMapViewer. https://doi.org/10.26060/9vfz hw43. Photos reproduced with permission.
[2] Hewitt, A.E., Balks, M. R. and Lowe, D.J., 2021. The Soils of Aotearoa New Zealand. Chapter 10 Pallic Soils. Springer International Publishing. Pages 145-162. Fragic Pallic soil profile.
[3] New Zealand Society of Soil Science and Manaaki Whenua - Landcare Research photo library. Photos reproduced with permission.

9.5. Contact Recreation 2024 Annual Report Card

Prepared for:	Environmental Science and Policy Committee
Report No.	SPS2405
Activity:	Environmental - Water Quality and Quantity SOE
Author:	Helen Trotter, Water Quality Scientist
Endorsed by:	Anita Dawe, General Manager Policy and Science
Date:	27 June 2024

PURPOSE

[1] The contact recreation programme monitors faecal indicator bacteria and potentially toxic cyanobacteria at 20 freshwater and 16 coastal sites across the Otago Region to assess risks to human health during the summer bathing period.

[2] This report provides an overview of the programme and accompanies the attached report card summarising the results of weekly monitoring undertaken during the 2023-24 season.

EXECUTIVE SUMMARY

[3] The contact recreation monitoring programme assesses recreational water quality at primary contact sites weekly between December and March each year. Faecal indicator bacteria *Escherichia coli* (freshwater) and enterococci (saltwater) are measured as a proxy for the presence of pathogens that may cause illness when ingested.

[4] Cyanobacteria (toxic algae) that can produce harmful cyanotoxins are monitored in rivers, where they bloom as dense mats on the stream bed (benthic cyanobacteria), and in lakes, where they tend to float in the water column (planktonic cyanobacteria).

[5] Microbial water quality and cyanobacteria results are assessed against national guidelines and reported on the Land Air Water Aotearoa (LAWA) website. Otago Regional Council (ORC) notifies Te Whatu Ora – Health New Zealand of results that exceed the guidelines, and health warnings are issued according to the programme protocols.

[6] In the 2023-2024 season, 560 routine samples for faecal indicator bacteria were taken at 33 primary contact sites, and 93 % of samples had water quality that was ‘suitable for swimming’ at the time of sampling.

[7] For 15 samples (3 %) across 10 sites, bacteria concentrations indicated the site was ‘unsuitable for swimming’ at the time of sampling and a health warning was issued. A further 21 results (4 %) across seven sites, met the ‘caution advised’ guideline due to slightly elevated bacteria concentrations.

[8] ORC ordered faecal source tracking (FST) to investigate potential bacteria sources on 20 samples from eight sites where exceedances were observed. The FST identified ruminant and/or avian sources for Kākanui Estuary, Waianakarua River at Graves Dam,

Waikouaiti River at Bucklands, Manuherekia River at Shaky Bridge and Lake Wakatipu at Frankton Bay. None of the samples had a human source detected.

[9] ORC sampled weekly for cyanobacteria at six lake sites and five river sites. Planktonic cyanobacteria blooms were identified at four lakes (Butchers Dam, Lake Waihola, Pinders Pond and Falls Dam), and levels triggered the 'action (red mode)' guideline. Warnings were in place for between 3 and 8 weeks at these sites. Benthic cyanobacteria cover did not exceed the 'surveillance (green mode)' guideline at the monitored river sites.

[10] Cyanobacteria blooms are naturally occurring and typically associated with extended periods of stable, warm weather, as was experienced in parts of Otago this summer. Blooms of cyanobacteria in lakes and rivers pose a potential health risk to the public (and pets) in waterways across Otago.

[11] An assessment of long-term *E. coli* results for freshwater sites during the bathing season, in accordance with the National Policy Statement for Freshwater Management (NPSFM, 2020), found that 65 % of freshwater primary contact sites have 'excellent' or 'good' grades. Six sites (35 %) are graded 'poor'; Taieri River at Waipiata, Taieri River at Outram, Waikouaiti River at Bucklands, Manuherekia River at Shaky Bridge, Waianakarua River at Graves Dam (interim grade) and Arrow River at Cornwall Street (interim grade).

RECOMMENDATION

That the Committee:

1) ***Notes** this report.*

BACKGROUND

[12] Human contact (for recreation) is a compulsory value of freshwater under the NPSFM (2020) relating to how people connect with the water through recreational activities such as swimming, boating, and fishing. This value has three compulsory attributes.

[13] The *'E. col*i (primary contact sites)' attribute, described in the NPSFM (Appendix 2B, Table 22), assesses the condition of primary contact sites based on 5 years of weekly monitoring during the bathing season only.

[14] Two further attributes, '*Escherichia coli* (*E. coli*)' and 'Cyanobacteria (planktonic)', are assessed on long-term, year-round data collected at State of the Environment sites. ORC reports these data in State of the Environment water quality reports (at least 5-yearly).

[15] The requirements of the NPSFM (2020) are in line with the frameworks outlined by the National Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas (MfE & MoH, 2003) and the New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters: Interim Guidelines (MfE & MoH, 2009). The ORC contact recreation monitoring programme and response protocols are informed by these guidelines.

[16] The annual report card presents an overview of the programme and a summary of the results, including an assessment of long-term grades for freshwater sites (NPSFM

attribute *E. coli* – primary contact sites).

[17] The report card format intends to share key information with a broad, non-technical audience, improve community engagement and understanding, and will complement a more detailed technical report aligning with the 5-yearly State of the Environment reporting cycle. Actual data are published to the ORC Environmental Data Portal and LAWA as required by the NPSFM (2020).

DISCUSSION

[18] Bacteria concentration exceedances in the 2023-24 season were most often associated with moderate to heavy rainfall in the 24-48 hrs preceding sampling. Increased run-off from urban and rural land carries contaminants to waterways and is associated with elevated bacteria concentrations.

[19] Three sites had markedly more exceedances compared to other sites (≥40 % of samples): Waianakarua at Graves Dam, Kākanui Estuary and Manuherekia River at Shaky Bridge.

- Waianakarua River has been monitored for two seasons and often has high *E. coli* concentrations. FST has indicated that *E. coli* sources are avian (attributed to upstream gull colonies).

- The closing of the estuary mouth affects water quality in the Kākanui Estuary by reducing the flushing of contaminants and promoting algae growth. During the summer of 2023-24, persistent low river flows and prevailing weather conditions resulted in the estuary mouth being closed for extended periods, contributing to the frequently elevated bacteria concentrations observed.

- Manuherekia River flows were low throughout the summer period. While high bacteria levels were observed following rainfall, they were also persistent throughout the low flow period. FST indicates ruminant (and avian) sources. It is likely that irrigation by-wash is a key source of bacterial contamination during low flow periods.

[20] There are six sites with ‘poor’ long-term grades. These sites tend to be in catchments affected by run-off from agricultural land-use and FST has confirmed ruminants as the key source of faecal contamination. Avian sources also contribute to high bacteria levels at some sites.

[21] The long-term grade changed for four sites following the 2023-24 season:

- Lake Wakatipu at Queenstown Bay - ‘poor’ to ‘excellent’
- Lakes Hayes at Mill Creek shallows - ‘poor’ to ‘excellent’
- Lake Wakatipu at Frankton Bay - ‘fair’ to ‘excellent’
- Lake Wanaka at Roys Bay - ‘excellent’ to ‘good’

[22] In most of these cases ‘improvements’ in grade are due to a small number of exceedances in 2018-19 no longer being included in the 5-year record and do not

indicate any actual change in water quality at these sites.

[23] Long-term grades and shifts across grades between years may not always reflect broader patterns in water quality as they use 95th-percentile results. This means a small number of high results can influence the grade. A site with ongoing faecal contamination and one with just one or two exceedances following high rainfall might both be classified as 'poor'. It is, therefore, useful to consider the percentage of samples exceeding the guidelines over the 5-year period, alongside the long-term grade.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[1] This programme supports the *enhancing environmental management* and *healthy water* strategic priorities:

- Enhancing access to and communication of data and knowledge
- Monitoring and investigating the health of Otago's fresh and coastal water
- Providing the best available information on Otago's water resources

Financial Considerations

[2] This work is planned and funded through the annual work programme.

Significance and Engagement Considerations

[3] During the bathing season (December to March), and in preparation for the season, engagement is ongoing between stakeholders e.g., territorial authorities and Te Whatu Ora – Health New Zealand according to ORC contact recreation monitoring programme and response protocols.

Legislative and Risk Considerations

[4] This report and programme comply with the relevant statutory obligations of ORC, including but not restricted to, the Resource Management Act (1991) and National Policy Statement for Freshwater Management (2020).

[5] The NPSFM (2020) requires councils to develop action plans aimed at improving water quality at sites below the 'national bottom line' (graded 'poor'). This monitoring assists with identifying where action plans are required.

Climate Change Considerations

[6] Programme amendments (to sites, monitoring periods or methods) to consider the effects of climate change will be addressed during the ongoing annual review of the programme.

Communications Considerations

[7] The ORC Communications Team implements the programme communications plan prior to and throughout the contact recreation that includes targeted public awareness

messaging and communication of health warnings to the community.

[8] Ongoing public awareness and education about recreational water quality (both microbial and cyanobacteria risks) is required to enable the public to make informed choices about where and when they choose to recreate.

NEXT STEPS

[9] The 2024-25 contact recreation monitoring period will commence in December 2024.

[10] Future work directions include exploring options for real-time monitoring to improve reporting efficiency, targeted sampling programmes for sites with frequent exceedances to investigate potential contaminant sources, and reviewing sites and procedures ahead of each season to ensure the programme maintains appropriate coverage across the region.

REFERENCES

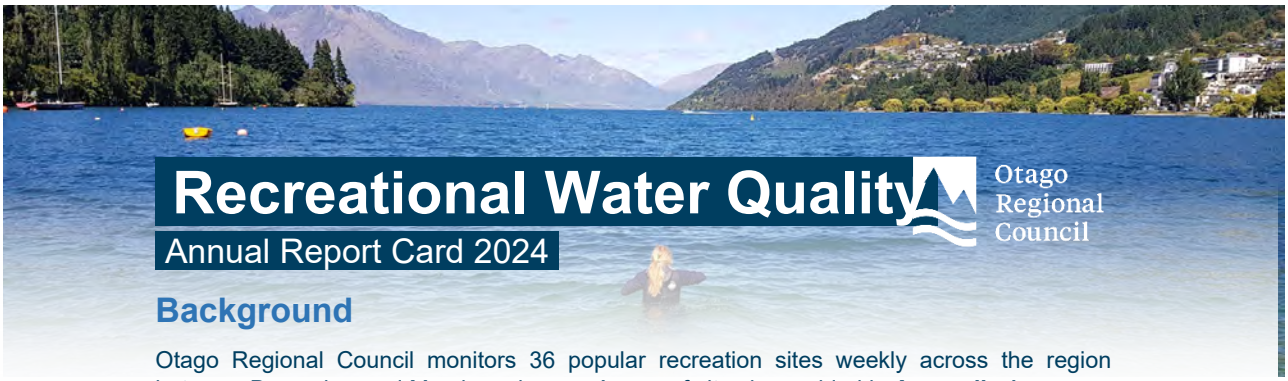
Ministry for the Environment and Ministry of Health (2003). *Microbiological water quality guidelines for marine and freshwater recreational areas*. Ministry for the Environment, Wellington.

Ministry for the Environment and Ministry of Health (2009). *New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters – Interim Guidelines*. Prepared for the Ministry for the Environment and the Ministry of Health by SA Wood, DP Hamilton, WJ Paul, KA Safi and WM Williamson. Wellington: Ministry for the Environment

Ministry for the Environment (2017). *National Policy Statement for Freshwater Management 2020* (amended January 2024). Ministry for the Environment, Wellington.

ATTACHMENTS

1. RWQ Annual Report Card 2024 [**9.5.1** - 6 pages]



Recreational Water Quality

Annual Report Card 2024

Otago Regional Council

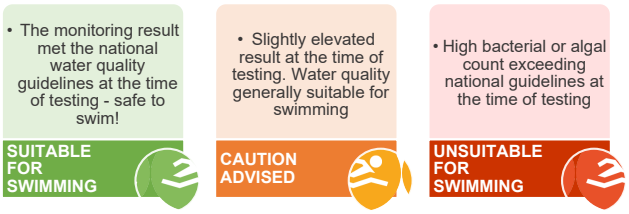
Background

Otago Regional Council monitors 36 popular recreation sites weekly across the region between December and March each year. A map of sites is provided in **Appendix 1**.

We test the water for *Escherichia coli* (*E. coli*) at freshwater sites and enterococci at coastal sites. These bacteria are indicators of faecal contamination and risk of illness from disease-causing pathogens.

We also monitor cyanobacteria or toxic algae in both lakes and rivers. Naturally occurring toxic algae can produce cyanotoxins which pose a risk to human and animal health.

National Microbiological[1] and Cyanobacteria Guidelines[2] are used to assess the individual results and determine whether the water quality is safe for swimming.



Results are reported on LAWA using a traffic light system and we work with Health New Zealand – Te Whatu Ora and district councils to notify the public of any health warnings.

Summer 2023-24 results

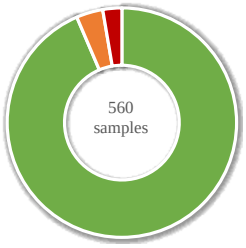
Microbial water quality (*E. coli* and enterococci)

► 560 water samples were collected over the summer bathing period

► 93 % of samples found water quality was suitable for swimming at the time of sampling

► 4 % of samples exceeded the caution advised guideline due to slightly elevated bacteria levels

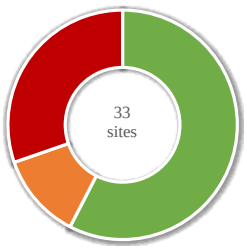
► 3 % of samples found water quality was unsuitable for swimming and a health warning was issued to the public



Most sites (58 %) were safe for swimming every time we tested. A further 12 % were generally safe for swimming, but 'caution was advised' after at least one sample due to slightly elevated bacteria levels.

Water quality 'unsuitable for swimming' for at least one sample at 30 % of sites – for most of these sites this was due to a single high bacteria result, typically following rainfall.

Results for individual sites are presented in **Appendix 2**.



Cyanobacteria (toxic algae)

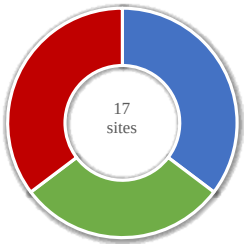
Toxic algae blooms were observed in 4 of the 6 monitored lakes and health warnings were in place for 3-8 weeks at these sites. Toxic algae did not exceed the % coverage guidelines at any of the five river sites monitored for recreational water quality.

ORC issued warnings for an additional three river sites and one lake site where staff found high levels of toxic algae during their routine State of the Environment monitoring.

► **Lakes**	Butchers Dam, Lake Waihola, Pinders Pond, Falls Dam, Lake Tuakitoto
► **Rivers**	Manuherekia River (Ophir), Kauru River (Ewings), Waianakarua River (Browns Pump)

National Freshwater Policy

Under the National Policy Statement for Freshwater Management (2020)[3] regional councils must assess primary contact sites using the 95th percentile from five years of bathing season data to group sites into four bands or grades (Excellent, Good, Fair and Poor). Results for individual sites are presented in **Appendix 3**.



► 65 % of sites are graded Excellent or Good

► 35 % of sites are graded Poor (below the national bottom line). No sites are graded Fair

► The grades for 5 of the 17 freshwater recreational water quality sites are interim because they have been monitored for less than 5 years

Challenges & opportunities

When it rains contaminants are carried from rural and urban land to our waterways in run-off and stormwater. This means that even sites with good water quality can sometimes have high bacteria levels after heavy rainfall. For some sites other factors (both natural and as a result of human activities) can contribute to high levels of bacteria. In the 2023-24 monitoring period three sites had elevated bacteria levels more often than others (>40 % of samples).

► **Kākanui Estuary**	Low flows and prevailing weather conditions during the summer meant the estuary mouth was often closed and reduced the flushing of contaminants from the estuary. Faecal source tracking identified ruminant (e.g., cows, sheep) and avian (gull) sources of bacteria.
► **Waianakarua River**	Monitoring at Graves Dam has found frequent high levels of bacteria associated with upstream gull colonies. Faecal source tracking has also identified ruminant sources.
► **Manuherekia River**	High bacteria concentration at the Shaky Bridge site were associated with rainfall and low flows. In low flow conditions irrigation by-wash can impact water quality. Faecal source tracking has found ruminant and avian sources contribute to high bacteria levels at this site.

Recreational Water Quality Annual Report Card 2024

Otago Regional Council

The warm, stable weather experienced for extended periods in some parts of Otago this summer were ideal conditions for **toxic algal blooms** to occur. While toxic algae are naturally occurring, elevated nutrient and sediment inputs can further promote their growth. However, blooms can also occur in rivers with relatively good water quality so it challenging to predict where blooms will occur and to monitor trends.

We can't monitor all sites where toxic algae occur, so the programme includes targeted public awareness communications to improve knowledge about the risks and how to identify blooms.

Want to learn more?

Find factsheets, weekly monitoring results, long-term grades & health warnings for routinely monitored sites at **LAWA www.lawa.org.nz**

Additional toxic algae warnings are listed on the Toxic Algae Notifications page on our website **www.orc.govt.nz/toxic algae**

Ongoing improvements & new technologies

ORC is exploring new monitoring solutions that could provide real-time data about recreational water quality. This will enable us to quickly communicate health risks to the public, without waiting for results back from a lab. The use of DNA analysis for Faecal Source Tracking is also helping us to identify sources of faecal contamination.

We regularly review our programme to ensure we have good coverage of popular sites and potential risks across Otago. This year ORC added two new sites to the programme (Kawarau River and Arrow River).

Informing our communities

Keeping you and your whānau safe from illness when swimming is all about understanding the risks and knowing how to make good choices about where and when to swim.

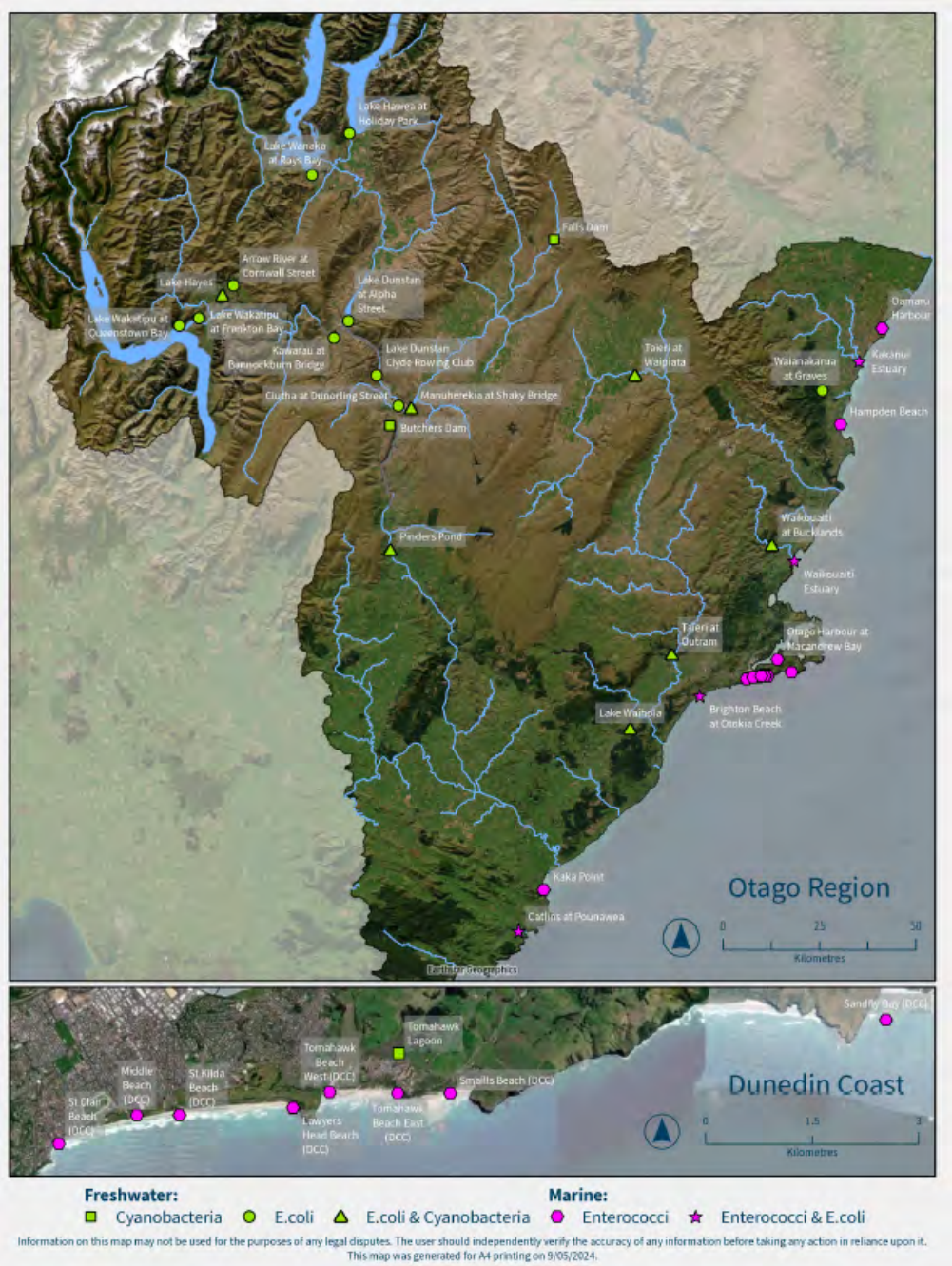
We continue to work with Health New Zealand - Te Whatu Ora and other agencies to raise public awareness about recreational water quality and provide information and data through LAWA, the ORC website and social media.

Contact Have a question? Get in touch with us science.enquiries@orc.govt.nz

References

[1] Ministry for the Environment and Ministry of Health (2003). Microbiological water quality guidelines for marine and freshwater recreational areas. Ministry for the Environment, Wellington.
[2] Ministry for the Environment and Ministry of Health (2009). New Zealand Guidelines for Cyanobacteria in Recreational Fresh Waters – Interim Guidelines. Prepared for the Ministry for the Environment and the Ministry of Health by SA Wood, DP Hamilton, WJ Paul, KA Safi and WM Williamson. Wellington: Ministry for the Environment
[3] Ministry for the Environment (2017). National Policy Statement for Freshwater Management 2020 (amended January 2024). Ministry for the Environment, Wellington

Appendix 1: Monitored primary contact sites in Otago



Appendix 2: 2023-24 Recreational water quality monitoring results by site (and Freshwater Management Unit)

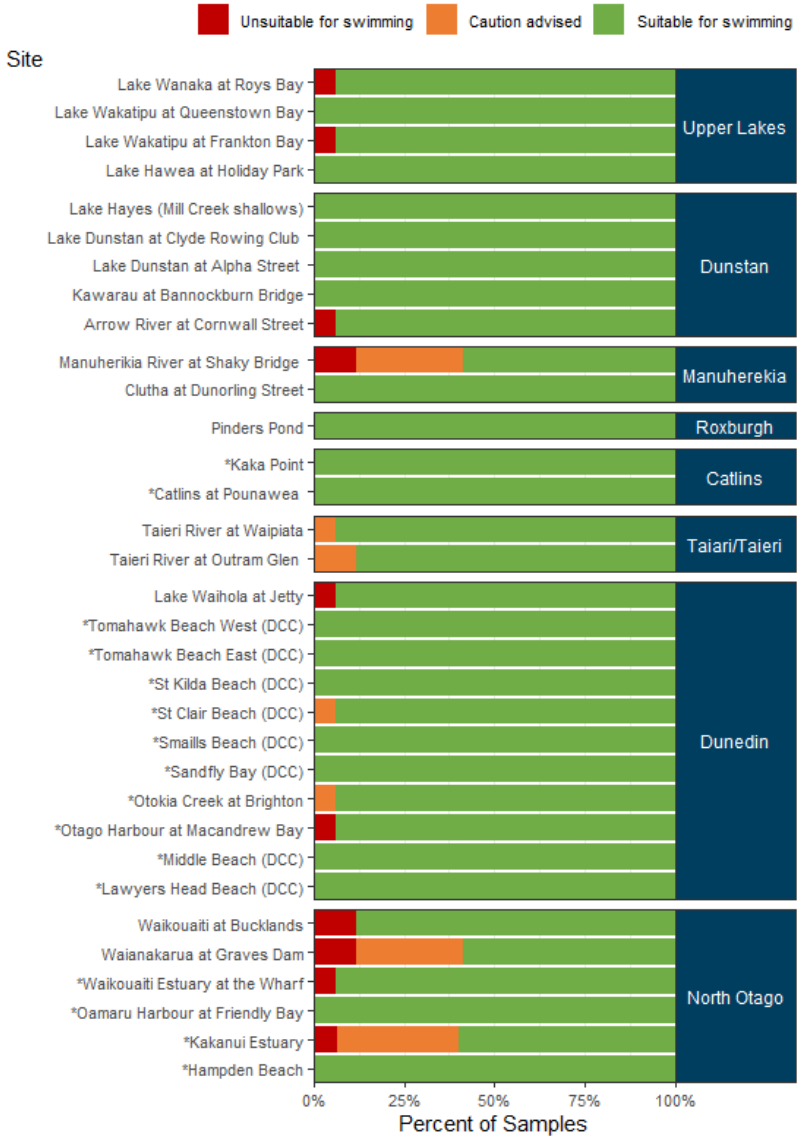


Figure 1. Percentage of samples which met surveillance (suitable for swimming), alert (caution advised) and action (unsuitable for swimming) guidelines for sites monitored weekly across Otago (grouped by Freshwater Management Unit FMU/Rohe) in the 2023-24 bathing season. For freshwater sites *E. coli* concentrations were assessed; for coastal sites (marked *) enterococci concentrations were assessed.

Appendix 3: Long-term grades for recreational water quality monitoring sites (2019-2024)

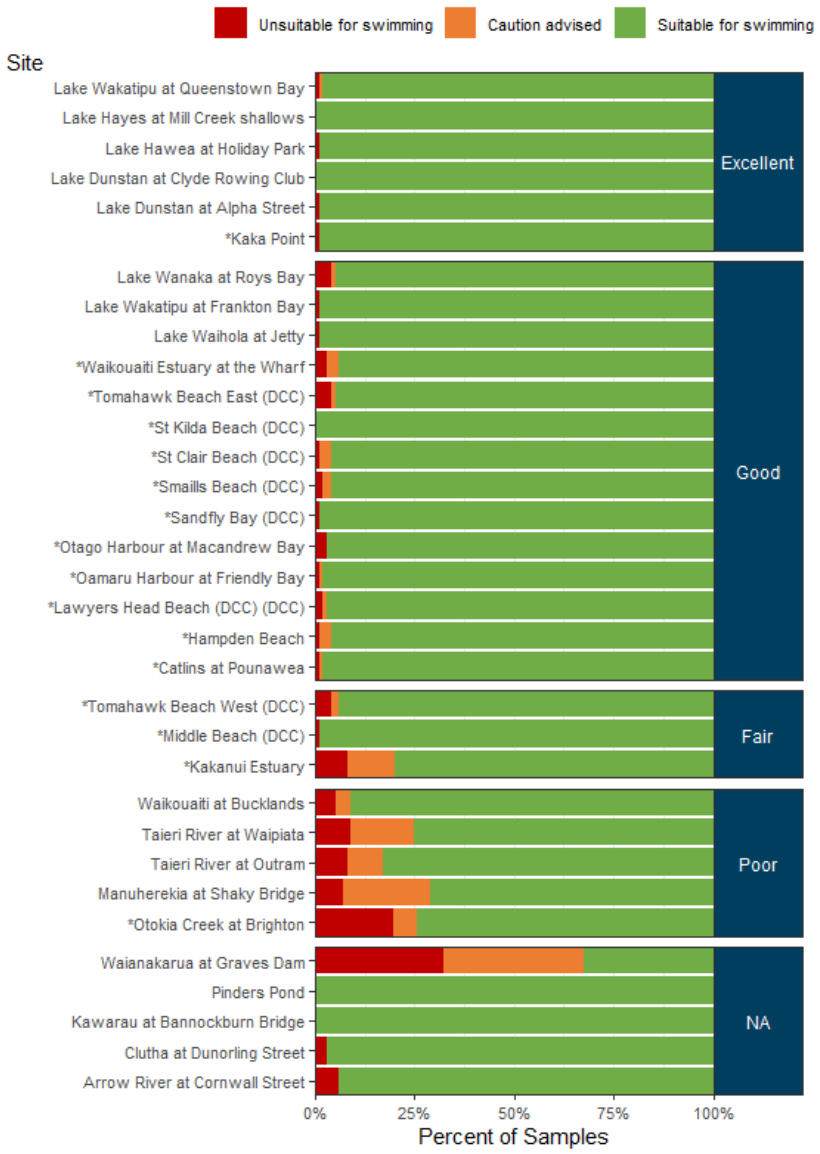


Figure 2. Percentage of samples over the past 5 years which met surveillance (suitable for swimming), alert (caution advised) and action (unsuitable for swimming) guidelines for primary contact sites monitored weekly across Otago, grouped by the associated long-term grades (blue panels). Long-term grades are based on hazen 95th percentile results from 5 seasons of data (2019-20 to 2023-24). For freshwater sites E. coli concentrations were assessed; for coastal sites (marked *) enterococci concentrations were assessed. Sites grouped in the 'NA' panel have been monitored for less than 5-years and therefore a long-term grade has not been applied.