# **Environmental Implementation Committee 8 May** 2024



Meeting will be held in the Council Chamber at Level 2, Philip Laing House 144 Rattray Street, Dunedin ORC Official YouTube Livestream

#### Members:

Cr Bryan Scott (Co-Chair)

Cr Kate Wilson (Co-Chair)

Cr Alexa Forbes

Cr Gary Kelliher

Cr Lloyd McCall

Cr Michael Laws

Cr Kevin Malcolm

Cr Tim Mepham

Cr Andrew Noone

Cr Gretchen Robertson

Cr Alan Somerville

Cr Elliot Weir

Senior Officer: Richard Saunders, Chief Executive

Meeting Support: Kylie Darragh, Governance Support Officer

08 May 2024 09:00 AM

Agenda Topic Page

Agenda 1

- 1. WELCOME
- 2. APOLOGIES

No apologies were received prior to publication of the agenda.

3. PUBLIC FORUM

No requests to speak were received prior to the publication of this agenda.

CONFIRMATION OF AGENDA

Note: Any additions must be approved by resolution with an explanation

# 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. Councillor Declarations of Interests are published to the ORC website.

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# 10. CLOSURE



# **Environmental Implementation Committee MINUTES**

Minutes of an ordinary meeting of the Environmental Implementation Committee held in the Council Chamber, Level 2 Philip Laing House, 144 Rattray Street, Dunedin on Thursday 8 February 2024, commencing at 9:00 AM.

https://www.youtube.com/live/rcF6bRvrDVM?si=bySXSPTbb8SvmEXG

#### **PRESENT**

Cr Kate Wilson

(Chairperson)

Cr Bryan Scott

Cr Gary Kelliher

Cr Kevin Malcolm

Cr Lloyd McCall

Cr Tim Mepham

Cr Andrew Noone

Cr Gretchen Robertson

Cr Alan Somerville

Cr Elliot Weir

#### 1. WELCOME

Chair Kate Wilson welcomed Councillors, members of the public and staff to the meeting at 9:00AM 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), Kylie Darragh (Governance Support)

#### 2. APOLOGIES

**Resolution:** Cr Wilson Moved, Cr Noone Seconded: That the apologies for Cr Forbes be accepted.

**MOTION CARRIED** 

#### 3. PUBLIC FORUM

No requests to address the Committee under Public Forum were received.

#### 4. CONFIRMATION OF AGENDA

The agenda was confirmed as published.

#### 5. DECLARATIONS OF INTERESTS

No changes to Councillor Declarations of Interests were noted.

#### 6. CONFIRMATION OF MINUTES

Cr Noone noted there needed to be follow up on Resolution EIC23-111 as an Action Item, with this noted, it was moved by Cr Malcolm:

# Resolution: Cr Malcolm Moved, Cr Kelliher Seconded

That the minutes of the (public portion of the) Environmental Implementation meetings held on 9 August 2023 and 8 November 2023 be confirmed as a true and accurate record.

**MOTION CARRIED** 

9:05 AM Cr Weir joined the meeting.

#### 7. MATTERS FOR CONSIDERATION

#### 7.1. Site-Led Programme Update (YouTube 10:55mins)

This report provided an update on progress of the Site-Led terrestrial pest management programmes and sought approval for the allocation of the Site-Led Budget 2023/2024 (\$150,000) for a Site-Led Programme grant delivered through a contestable funding process. Gavin Palmer (General Manager, Operations) Sophie Gibson-Pinn (Community Coordinator Biosecurity), Libby Caldwell (Manager Environmental Implementation) and, online, Sarah Irvine (Team Leader Environmental Implementation) and were available to respond to questions.

#### Resolution EIC24-101: Cr Malcolm Moved, Cr Somerville Seconded

That the Environmental Implementation Committee:

**a. Notes** this report and progress made to support the Site-Led terrestrial programmes to date.

#### **MOTION CARRIED**

A division was called:

#### Resolution EIC24-102: Cr Malcolm Moved, Cr Somerville Seconded

That the Environmental Implementation Committee:

**b.** Recommends to Council to approve the allocation of \$146,200 from the existing budget for the Site-Led Programme to be delivered through a direct funding process for specific projects to achieve RPMP objectives (Option 3).

For	Cr Kelliher, Cr Malcolm, Cr McCall, Cr Noone, Cr Robertson, Cr Somerville, Cr Wilson
Against	Cr Mepham, Cr Scott, Cr Weir
Abstained	

#### **MOTION CARRIED**

#### Resolution EIC24-103: Cr Malcolm Moved, Cr Somerville Seconded

That the Environmental Implementation Committee:

**c.** Recommends to Council to approve that the allocation of funding is recommended by the existing Eco Fund Panel.

#### **MOTION CARRIED**

Against - Cr Lloyd McCall.

#### Resolution EIC24-104: Cr Noone Moved, Cr Malcolm Seconded

That the Environmental Implementation Committee:

d. Requests that staff provide an update on progress of the lagarosiphon Site Led Project MOTION CARRIED

#### 8. CLOSURE

10:20 A.M.	d Chair Wilson declared the meeting closed with a karakia at
Chairperson	Date

Meeting Date	Documen t	Item	Status	Action Required	Assignee/s	Action Taken	Due Date
08/11/20 23	Environm ental Implemen tation Committe e 2023.11.0 8	OPS2226 Regional Wilding Conifer Cost Benefit Analysis and business case	In Progress	Option 1 - ORC directly engaging with central government for an increase in funding required for the Otago region as part of the National Wilding Conifer Control programme.	Chairperson, Chief Executive, Councillor, General Manager Operations	O8/03/2024 Governance Support Officer  Cost Benefit Analysis and business case to be followed up with further actions.  11/03/2024 Governance Support Officer  Chair, Deputy and CE met with Hon Andrew Hoggard (Minister of Biosecurity) 8/2/24. The conversation covered the wilding conifer programme, Otago's high vulnerability to invasion, effects of wildings, Otago's recent business case, the importance and clear benefits of continuing the programme.	30/04/2024
08/02/20 24	Environm ental Implemen tation Committe e - 8 February 2024	GOV2345 Site Led Program me Update	In Progress	Resolution EIC24-104: Cr Noone Moved, Cr Malcolm Seconded That the Environmental Implementation Committee: d. Requests that staff provide an update on progress of the lagarosiphon Site Led Project	General Manager Operations	11/03/2024 Executive Assistant, Operations  Update to be provided to May 2024 meeting of the Environmental Implementation Committee.	30/04/2024

#### 9.1. Eco Fund Application Recommendations

**Prepared for:** Environmental Implementation Committee

Report No. OPS2411

Activity: Governance Report

Author: Elodie Letendre, Environmental Initiatives Coordinator

Anna Molloy, Principal Advisor Environmental Implementation

**Endorsed by:** Gavin Palmer, General Manager Operations

**Date:** 23 April 2024

#### **PURPOSE**

To seek endorsement of the recommended applications for ECO Fund and Incentives Funding for the March 2024 round, as well as the recommended funding to targeted groups under the Terrestrial Site-Led programme fund.

#### **EXECUTIVE SUMMARY**

- [2] ECO Fund supports community led projects that protect, enhance and promote Otago's environment. The Otago Regional Council (ORC) provided \$318,600 to the ECO Fund for the March 2024 round.
- [3] Additional contestable community Incentives Funding was provided for to support 2021-31 Long Term Plan priorities. This includes funding for: sustained rabbit management (\$100,000), native planting after plant pest removal (\$50,000), native planting for water quality (\$50,000), and biodiversity enhancement on protected private land (\$100,000). A one-off large-scale biodiversity Incentive Funding (\$300,000) to accommodate large scale funding requests was endorsed at the Environmental Implementation Committee meeting on 8 November 2023. These funding amounts total \$918,600.
- [4] The March 2024 funding round including the additional Incentives Funding received 65 applications seeking a total of \$2,706,577 from the \$918,600 available. The ECO Fund Assessment Panel met on 22 April 2024 to assess the applications. Following the assessment, the Assessment Panel has recommended 33 applications to Council for funding to a total value of \$854,733.92 (see paragraph 15).
- Direct funding (\$146,200) to support community groups undertaking pest management work within the Terrestrial Site-Led Programme areas was approved by Council on 22 February 2024 based on recommendations from the Environmental Implementation Committee on 8 February 2024. The Terrestrial Site-Led Working Group carried out a process to identify priority sites with high biodiversity and cultural values and engaged with community groups within these sites. It recommended allocating \$146,200 to five groups to undertake pest management in the priority sites.
- [6] The ECO Fund and associated incentives funding programme will be reviewed in 2024 to ensure it is still fit for purpose and aligns with the Long-Term Plan 2024-34 objectives and outcomes.

#### **RECOMMENDATION**

That the Environmental Implementation Committee recommends that Council:

- 1) **Approves** the funding recommendations of the ECO Fund Assessment Panel for the March 2024 round to a total value of \$854,733.92, as outlined in tables 2 to 7.
- 2) **Approves** the funding recommendation of the direct funding to support community groups undertaking pest management work within the Terrestrial Site-Led Programme areas as outlined in Table 8.
- 3) **Notes** that a review of ECO Fund and associated incentives will be completed by October 2024 in time for the next funding round and to reflect priorities in the Long-Term Plan 2024-34.

#### **BACKGROUND**

- [7] The ECO (Environment. Community. Otago) Fund supports community driven projects that protect, enhance and/or promote Otago's environment. The ORC provided \$318,600 to the ECO Fund for the March 2024 round.
- [8] The ECO Fund was established in July 2018. The ECO Fund (including Incentives Funding) has funded 133 projects, from 286 applications, totalling \$1,732,861 out of \$4.87 million requested over nine rounds. On average, each round has been oversubscribed by approximately 300%.
- [9] Funding available in 2024 was \$918,600. This includes:
  - a. \$318,600 ECO Fund general
  - b. \$50,000 native planting after pest plant removal
  - c. \$50,000 native planting for water quality
  - d. \$100,000 biodiversity enhancement on protected private land
  - e. \$100,000 sustained rabbit management
  - f. \$300,000 large-scale biodiversity grants
- [10] At their meeting on 6 December 2023, based on the recommendation of the Environmental Implementation Committee of 8 November 2023, Council noted the funding available and retained the ECO Fund process, eligibility and assessment criteria from 2023. Council also approved the one-off large scale biodiversity grant at this meeting.
- [11] Council approved the allocation of \$146,200 to the Terrestrial Site-Led Programme in February 2024. Council decided that this funding would be delivered through direct funding for specific projects to achieve Otago Regional Pest Management Plan 2019-2029 (RPMP) objectives. It was also specified that the allocation of funding would be recommended by the ECO Fund assessment panel to Council.
- [12] The ECO Fund and incentive funding operates within the ECO Fund Terms and Conditions, including eligibility criteria (Attachment 1), and additional criteria for incentive funding programs where required (Attachment 2).

#### **DISCUSSION**

#### **Applications**

The ECO Fund 2024 round was open for applications between 1 March 2024 and 2 April 2024 via online application form. A total of 65 applications were received seeking a total of \$2,706,577 from the \$918,600 available as detailed in Table 1 below.

Table 1 Summary of funds rea	uncted for the March 2024 roun	nd of ECO Fund and additional Incent	ivoc Eundina
Table 1 – Summary of funds red	uested for the Warch 2024 roun	ia of ECO Funa ana additional incent	ives Funding.

March 2024 Funding Round					
Category	Number of applications	Funds requested	Funds available		
ECO Fund	31	\$989,091.15	\$318,600		
Incentives Funding - sustained rabbit management	10	\$249,740.78	\$100,000		
Incentives Funding - native planting after plant pest removal	4	\$47,978.17	\$50,000		
Incentives Funding - native planting for water quality	0	\$0	\$50,000		
Incentives Funding - biodiversity enhancement on protected private land	10	\$149,379.00	\$100,000		
Large-scale biodiversity	10	\$1,270,387.82	\$300,000		
TOTAL	65	\$2,706,576.92	\$918,600		

[14] Administration of the ECO Fund is a multi-staged process. This process is detailed in Figure 1 below. This paper to the Environmental Implementation Committee marks Step 5 in the process.

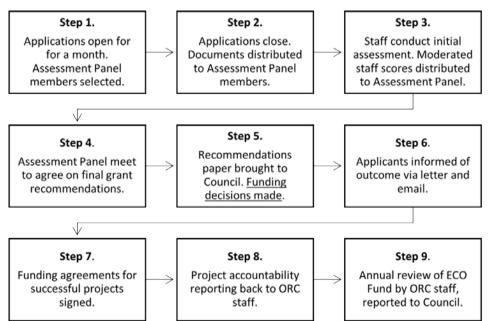


Figure 1 – ECO Fund process for administration.

- [15] Terrestrial Site-Led projects were identified using the following steps:
  - a. Prioritising site and cultural values A Values, Threats, and Impacts Assessment was used to guide site prioritisation. From this, a scoring process was developed to quantify the biodiversity values of the sites. Cultural environmental values and cultural wāhi taoka values provided by mana whenua Working Group representatives were also added to the site prioritisation scoring process. Sites were then ranked, with Aramoana and Sandymount Sandfly Bay identified as the two highest-ranking sites with the highest priority biodiversity and cultural values.
  - b. Community groups undertaking relevant pest animal and plant work within these areas were identified from the terrestrial *Site-Led Stocktake Report*. These

- groups, along with associated external stakeholders (e.g. DOC, DCC) were invited to a community hui for each priority area to promote collaboration and initiate the early stages of a whole of site plan and discuss funding requirements to achieve Terrestrial Site-Led Programme objectives in these areas on 27 March 2024. Refer to **Attachment 3**.
- c. Following the community hui, the Working Group consolidated options for direct funding community groups for each site to progress the Terrestrial Site-Led programme objectives. The Working Group then provided these recommendations to the ECO Fund Assessment Panel for consideration.

#### Assessment

- [16] Applications to the ECO Fund were assessed against the criteria listed in **Attachment 4** of this paper. Each application was given a score out of 32. Funding recommendations are determined by how highly an application scores relative to the other applications assessed in the funding round. Applications that did not meet the eligibility criteria in the ECO Fund Terms and Conditions (**Attachment 1 and 2**) were not considered for funding.
- [17] A four member staff panel independently reviewed and scored applications, then met on 15 April 2024 to conduct an initial assessment of applications and provide a single moderated staff score for each application to the Assessment Panel. The Assessment Panel, consisting of three Councillors and one mana whenua representative, also independently reviewed and scored applications where possible. The Assessment Panel met on 22 April 2024 to agree on scores and determine final recommendations for funding to be brought to Council for approval. Noting that one Councillor was unable to attend the meeting due to illness, but provided overall review comments which were considered by the Panel.
- [18] The Assessment Panel did not consider 12 of the 65 applications for assessment. This was because the applications were incomplete or did not clearly meet eligibility criteria in the Terms and Conditions of the ECO Fund.
- [19] Following the assessment process for the March 2024 round, the Assessment Panel are recommending 33 applications for funding at a total value of \$854,733.92: 10 applications totalling \$314,434.00 from ECO Fund and 23 applications totalling \$540,279.92 from the additional Incentives Funding. The recommended projects for funding from the Panel to Council are detailed in Tables 2-7 below.

Table 2 - ECO Fund - Recommended projects and funding allocation March 2024 round

Organisation	Project Name	Project Activity	Recommended Grant amount
Mokihi Reforestation Trust	Mokihi Reforestation Trust planting sites	Native revegetation	\$29,520.22
Penguin Rescue	Improving yellow-eyed penguin health through screening blood	Threatened species	\$11,500.00
Aspiring Biodiversity Trust	Makarore/Makarora Ōtānenui/Wilkin Catchment threatened species project - From ridge to river	Pest animal control	\$50,000.00

Tūmai Beach Restoration Trust	Tūmai beach coastal forest restoration	Native revegetation	\$47,402.99
Alexandra Primary School	Native moth and butterfly habitat restoration	Native revegetation	\$2,000.00
Hampden School	Planting the seeds of ecosystems restoration through a native nursery at Hampden School	Plant nursery	\$15,000.00
Seek Weeds and Terminate (SWAT) under the umbrella of Save the Otago Peninsula Inc	Otago Peninsula Darwin's Barberry containment project	Pest plant control	\$35,836.30
Kyeburn catchment Ltd	Kye Burn Central Otago roundhead galaxias restoration	Pest animal control	\$48,540.00
Puketapu Community Trust	Waihemo recreation reserve regeneration	Pest animal control and native revegetation	\$49,780.00
Friends of Burns Reserve Trust	Sycamore in Burns Park Scenic Reserve and environs	Pest plant control	\$24,874.50
Total	1	<u> </u>	\$314,454.00

Table 3 – Incentives – Planting after Pest Plant Control - Recommended projects and funding allocation for March 2024 round

Organisation	Project Name	Project Activity	Recommended Grant amount
The Rotary Club of Oamaru	Rotary Glen native planting	Native planting	\$13,078.95
Otago Fish & Game	Bendigo Wildlife Reserve	Native planting	\$5,000.00
Hāwea Charitable Trust	Enhancing Lake Hāwea's indigenous biodiversity: Rowley Bay-Stage 3	Native planting	\$5,678.17
Lower Manorburn Reserve working group/committee	Lower Manorburn Reserve wilding conifer removal and native revegetation project	Native planting	\$11,414.30 (part)
Total	1	1	\$35,171.42

Table 4 – Incentives – Planting for Water Quality - Recommended projects and funding allocation for March 2024 round

Organisation	Project Name	Project Activity	Recommended Grant amount
Friends of Bullock Creek Inc	Bullock Creek	Native planting	\$6,675.00
Maheno School	Maheno School native plants project	Native planting	\$5,000.00
Total	'	•	\$11,675.00

Table 5 – Incentives – Biodiversity Enhancement of Protected Private Land - Recommended projects and funding allocation for March 2024 round

Organisation	Project Name	Project Activity	Recommended Grant amount
Pūrākaunui Block Incorporated	Pūrākaunui Block Inc - Saltmarsh restoration plan	Pest plant control and native planting	\$15,000.00
Remarkables Station National Trust Limited	Remarkables Station sycamore Control	Pest plant control	\$15,000.00
Soho Property Limited	AT220 trapping expansion	Pest animal control	\$8,500.00
David Malloch	Woody weed control at Bendoran Farm covenant, Waikouaiti	Pest plant control	\$14,400.00
Rachel Gibb	19 Ellesmere Street covenant	Pest plant control and native planting	\$8,084.50
Roselle Farm	Roselle QEII bush restoration	Pest plant control	\$2,449.00
Auldamor Ltd	Auldamor Farm covenant	Native planting	\$15,000.00
The Matai Hill Trust/Neo Leaders Ltd	Matai Hill restoration	Pest plant control	\$15,000.00
Total	'	,	\$93,433.50

Table 6 – Incentives – Sustained Rabbit Management - Recommended projects and funding allocation for March 2024 round

Organisation	Project Name	Project Activity	Recommended Grant amount
Pukehau Ahu Whenua Trust	Neighbours' knowledge exchange- collaborative best practice rabbit management	Pest animal control	\$11,478.00
Hidden Hills Residents Association	Hidden Hills rabbit project certification training	Pest animal control	\$860.44
Luggate Heights Residents Group	Rabbit exclusion fencing, Luggate Heights	Pest animal control	\$12,500.00
Lovells Flat Rabbit Control Group	Lovells Flat rabbit control fencing	Pest animal control	\$34,863.30
Otago Peninsula Biodiversity Group	Rabbit control on the Otago Peninsula	Pest animal control	\$25,833.95
Maungawera Biodiversity Group Inc	Maungawera Valley rabbit containment	Pest animal control	\$14,464.31 (part)
Total	1	'	\$100,000.00

Table 7 – Incentives – Large Scale Biodiversity - Recommended projects and funding allocation for March 2024 round

Organisation	Project Name	Project Activity	Recommended
			Grant amount

Southern Lakes	Makarora Biodiversity	Pest animal control	\$111,608.00
Sanctuary Trust	Protection		
Royal Forest and Bird	Hilltops to sea - restoring	Pest animal control	\$137,779.82
Protection Society of	priority habitats and species		
New Zealand Inc	along the Otago coast.		
The Wildlife Hospital	Critical Hoiho Interventions -	Threatened species	\$50,612.18 (part)
Trust	2024 Breeding Season		
Total			\$300,000.00

- [20] Recommendations result in a total underspend of \$63,866.08. This is comprised of an underspend for:
  - a. ECO Fund of \$4,146.00,
  - b. Planting after pest plant control of \$14,828.58,
  - c. Planting for water quality of \$38,325.00, and
  - d. Biodiversity enhancement on protected private land of \$6,566.50.
- [21] All funding was fully allocated for the Incentives Funding sustained rabbit management and Incentives Funding Large-scale biodiversity. Incentives funding is ring-fenced, and the amount undersubscribed cannot be re-allocated to applications in different categories. The Assessment Panel recommended that underspend from funding categories be returned to the budget for use next round, if approved.
- [22] The amount recommended to be granted to some projects is less than that requested. This was due to the project being ranked lowest within the limit of funds available and hence can only be offered funding for the remaining balance of funds available.
- [23] A summary of applications declined in the March 2024 round of ECO Fund is provided in **Attachment 5**. A map showing the location of all applications received is provided in **Attachment 6**.
- [24] The Terrestrial Site-Led Working Group provided a list of recommended projects to be directly funded to the Assessment Panel. Information about the site plan and associated projects that will achieve the relevant objectives in the RPMP was also provided (refer to **Attachment 3**). The Assessment Panel reviewed and accepted the recommendations of the Terrestrial Site-Led Working Group. The recommended projects and funding allocated is provided in Table 8 below. The amounts recommended to be allocated sum to the total amount available for the Terrestrial Site-Led Programme there is no underspend.

Table 8 – Terrestrial Site-Led Programme - Recommended projects and funding allocation

Community Group		Area	Recommended Direct Funding
Avanagana	Aramoana Ecological Area	Extension mustelid trap network	\$6,000
Aramoana Conservation Trust	Sea Lion Creche and Penguin Forest	Mustelid and rats trap line maintenance	\$1,500
Whole Site-Led Aramoana area	Pest plant control and revegetation	\$11,965	
The Halo Project	Aramoana Ecological Area	Track clearing for trap lines	\$2,000

	Hayward Point Scenic Reserve Mustelid and rats trap network		\$22,550
	Whole Site-Led Aramoana area	Pest plant control and revegetation and monitoring pest plants	\$29,085
Total Programme E	xpenditure - Aramoana	1	\$73,100
Forest and Bird	Sandymount Extend mustelid and feral cats Reserve tītī colony network and trail cameras		\$32,800
OPBG	Sandymount Mustelid and feral cats Project manager, cameras, trap maintenance, drone surveillance and control		\$28,820
SWAT	Pikiwhara – Sandfly Bay Site-Led Barberry, Sycamore and Banana passionfruit		\$11,480
Total Programme Expenditure – Sandymount – Sandfly Bay			\$73,100
Total Terrestrial Site-Led Programme expenditure			\$146,200

#### **ECO Fund Review**

- [25] The ECO Fund is reviewed annually with the last major review being late 2021 and those changes implemented in the April 2022 round. A smaller review was undertaken in late 2022 but no major changes were recommended. No review was undertaken in 2023 as the previous years' reviews had covered what was required to this date.
- [26] A review of the ECO Fund is now timely as we have a full-time position coordinating the ECO Fund and associated incentive funds and there may be further funding opportunities for community through a process like the ECO Fund arising from the Long-Term Plan 2024-34.
- [27] The review will start following the approval of the 2024 round projects and once the 2024-2034 Long Term Plan outcomes are known. The review will be completed in time to implement any changes in the next ECO Fund round (likely to be early to mid-2025 unless the review recommends otherwise).
- [28] The broad scope of the review will include:
  - a. Ensuring alignment with ORC work programmes and priorities as detailed in the Long-Term Plan 2024-34 (including any further funding). This includes reviewing the scope of the ECO Fund taking into consideration LTP consultation.
  - b. Assessing the potential to strategically align the ECO Fund and any other funding with targeted on-ground priorities arising from catchment action plans or other strategic plans.
  - c. Reviewing the timing of the annual funding round to encourage best uptake by the community and to ensure the Fund is efficiently operated and expended.
  - d. Seeking feedback from recent applicants to the ECO Fund and obtaining feedback from past and present members of the ECO Fund Assessment Panel.
  - e. Reviewing the assessment criteria of the Fund to ensure it is fit for purpose.
  - f. Reviewing the Terms and Conditions for funding including eligibility criteria to ensure they are clear and equitable for the purposes of the ECO Fund and ORC objectives.

[29] Changes to the administrative processes such as forms, webpages and communications will not form part of the review as these are undertaken each year on an as needed basis.

#### **OPTIONS**

#### **ECO Fund**

- [30] Option One endorse the recommendations of the Assessment Panel to award funding to the 33 applications as listed in paragraph 15 (Tables 2-7), to a total value of \$854,733.92.
- Option Two reject the recommendations of the Assessment Panel and direct the Panel to reassess the applications.

#### **Terrestrial Site-Led**

- Option One endorse the recommendations of the Site-Led Working Group and the Assessment Panel to directly fund the applications listed in Table 8 to a total value of \$146,200.
- Option Two reject the recommendations for Site-Led projects and ask the Assessment Panel to re-assess how the Site-Led objectives will be achieved through funding community groups.

#### **ECO Fund Review**

[34] There are no options for the ECO Fund Review as this is for noting only.

#### **CONSIDERATIONS**

#### **Strategic Framework and Policy Considerations**

[35] This paper does not trigger policy considerations.

#### **Financial Considerations**

[36] The Council has a total of \$318,600 budgeted for the March 2024 round of the ECO Fund with a further \$600,000 budgeted for additional Incentives Funding.

#### **Significance and Engagement**

[37] This paper does not trigger ORC's policy on Significance and Engagement.

#### **Legislative and Risk Considerations**

[38] This paper does not trigger legislative considerations.

#### **Climate Change Considerations**

[39] This paper does not trigger climate change considerations.

#### **Communications Considerations**

[40] All successful and unsuccessful applicants to the March 2024 round will be communicated with to inform them of outcome and provide the option for feedback.

#### **NEXT STEPS**

[41] Following a final Council decision on funding, staff will progress the next steps of the ECO Fund process detailed in Figure 1. The immediate next steps will be to advise

- applicants of the outcomes and to draw up funding agreements with successful applicants, including Terrestrial Site-Led projects.
- [42] ORC staff will implement a review of the ECO Fund process to identify and act on opportunities for improvement. This review and subsequent improvements will be completed prior to the next ECO Fund round opening.

#### **ATTACHMENTS**

- 1. Att 1 ECO Fund Terms and Conditions 2024 [9.1.1 2 pages]
- 2. Att 2 Incentives Funding Additional Criteria 2024 [9.1.2 2 pages]
- 3. Att 3 Site- Led Programme Site Management Plans 240424 [9.1.3 14 pages]
- 4. Att 4 ECO Fund Assessment Criteria 2024 [9.1.4 7 pages]
- 5. Att 5 List of Applications Declined 2024 Round [9.1.5 3 pages]
- 6. Att 6 ECO Fund Applications Map 2024 [9.1.6 1 page]

# Funding terms and conditions

#### General

- Projects must meet the objectives of the ECO Fund and align with at least one ORC strategic
  priority to eligible. Note that projects for Incentives Funding Biodiversity enhancement on
  protected private land do not need to meet the objective for enabling community driven
  environmental activities.
- Except for multi-year projects, projects must be completed within 12 months of receiving funding.
- All applications for each round are assessed and ranked against the ECO Fund assessment criteria (link to criteria to be provided).
- All funding is GST exclusive. All financial information provided in an application must be
  exclusive of GST.
- The ECO fund supports both one-off projects and those running over multiple years for up to 3 years. For multiple year funding, funds will be released annually conditional upon appropriate project reports which demonstrate meaningful progress being submitted.
- Successful applicants must agree to Otago Regional Council promoting their project.
- Applicants must have completed accountability (final) reports for any previous ECO Fund grants received to be eligible for funding.
- If work funded is not completed within the specified time frame or funds are not spent as agreed, Otago Regional Council reserves the right to demand the return of funds.
- The ECO Fund does not provide funding for:
  - o commercial or private gain
  - o government organisations
  - o projects created to comply with Resource Consent conditions
  - responses to any actual or potential enforcement action (excluding projects under the sustained rabbit control programme)
  - o the purpose of seed capital
  - o individuals
  - maintenance for existing projects
  - retrospective costs

#### **Applications**

- Applicants can only submit one application per funding round.
- Projects must have a defined start and finish date.
- Applicants must disclose any other funding they have applied for or received for their project.
- Funding is capped per project and applicant at \$50,000 for ECO Fund and Incentives Funding

   Sustained rabbit management; and \$15,000 for Incentives Funding Native planting after plant pest removal, Native planting for water quality, and Biodiversity enhancement of protected private land. Projects between \$50,000 and \$150,000 are eligible to the Incentives Funding Large-scale biodiversity outcomes.
- If funding is requested for salary costs, only 50% will be funded. Applicants need to
  demonstrate that requested salary funding is not more than 50% of total cost, and detail
  where the additional funding will come from e.g., applicant 50% contribution to salary could
  be from other grants, existing group funds, or existing staff capacity or volunteer
  contributions allocated to the same project position.

#### Assessment

- All applications are assessed and ranked against the ECO Fund assessment criteria.
- Applicants agree to be available (if requested) for a phone call and/or site visit with ORC staff as part of the assessment process at a day and time suitable to the applicant.
- If an applicant is unsuccessful in one round of the ECO Fund, they may apply again in a subsequent funding round.
- Decisions made by Otago Regional Council are final and are made at our sole discretion.
- Applicants may not speak to their applications at the Council meetings or approach representatives on Council to speak on their behalf.

#### **Decision and Grant**

- Successful applicants must accept the grant by signing an acceptance letter and funding agreement.
- Recipients must pay all costs associated with the project. ECO Fund grants will be transferred to recipients' nominated bank accounts.
- Nominated bank accounts cannot be private accounts; it must be an account in the-name of
  the applicant. Grant funds will not be paid into individuals bank accounts, corporate bank
  accounts.
- Successful applicants must agree to report on the project outcomes to ORC within a specified timeframe, and account for how funds were spent. Successful applicants must agree to submit progress reports, where applicable, and a final report on the project outcomes to ORC within a specified timeframe, and account for how funds were spent.
- Successful applicants agree to report on their project at a council meeting, if requested.
- Funds granted expire 6 months after Council approval. If the applicant fails to comply with the Otago Regional Council's terms and conditions within 6 months (unless otherwise agreed), the funding lapses.
- Grants are approved subject to the Otago Regional Council being satisfied that the
  information given by recipients is true and correct. Otago Regional Council reserves the right
  to refuse grant funding, and/or request return of grant funding where it determines that it
  has been misled, that the applicant or recipient has omitted relevant information, or if the
  recipient enters into receivership, liquidation or ceases to exist (e.g., removed from
  register).

#### Attachment 2 – Incentive Funding Additional Criteria

#### Incentives Funding – sustained rabbit management: additional criteria

This fund supports coordinated community-led rabbit management throughout Otago. It aims to provide community groups, or groups of neighbours working collaboratively, with an opportunity to lead the improvement of rabbit management in their area.

#### Funding is available for:

- Groups of landowners (five or more adjacent landholdings)
- Non-profit community organisations e.g., community association, charitable trust, incorporated society
- Individual properties with the following status:
  - o Māori customary land
  - o Māori freehold land
  - o Crown land reserved for Māori
  - General land within the boundary of an original native reserve, if that land is still owned or partly owned by Māori

#### Funding is not available for:

- Individuals or work on individual properties (unless operating collaboratively with neighbours or as a community)
- Territorial authorities or government agencies
- Rabbit control costs

#### Examples of community led approaches eligible for funding

Note that priority will be given to facilitating community groups or groups of neighbours working collaboratively over fencing costs.

### Working together

- Forming a community group to coordinate rabbit management in your area
- Forming a community group to collect landowner contributions for collective rabbit management
- Developing collaborative long-term rabbit management plans / community action plan
- Forming new partnerships with other groups including community, government agencies, school groups, absentee landholders, landcare groups and mana whenua groups

#### Building and sharing skills and knowledge

- Building community capacity for best practice rabbit management techniques, e.g., hosting community workshops, training in best practice, hosting expert guests.
- Raising awareness of your programme via media, e.g. You Tube clips, webinars
- Show casing community groups participating in best practice rabbit management
- Producing advertising material to promote your community plan
- Designing rabbit management signage for your local area

#### Rabbit exclusion costs

 Newly created groups (within first year) implementing long-term rabbit exclusion i.e., fencing across multiple properties (number of properties required will depend on local context)

#### Innovation

- Trialling new techniques to inform best practice rabbit management
- Trialling creative new community engagement / collaboration ideas

#### Monitoring

- Developing a citizen science programme to monitor rabbit numbers in your area
- Developing tools to monitor and map rabbit densities in your area
- Collecting data to assist with local area rabbit management planning

# Incentives Funding – biodiversity enhancement on protected private land: additional criteria

This fund supports landowners in Otago that have been proactive in protecting indigenous biodiversity values on their land to maintain or enhance those values.

Applications for this fund can be from individual landowners and do not need to engage or involve the community.

For the purposes of this fund, protected private land is defined as land not in public ownership i.e., freehold and/or Māori-owned land.

Protected private land could include covenants e.g., QEII covenants or Ngā Whenua Rāhui (NWR) kawenata; and/or and Significant Natural Areas (SNAs) or Regionally Significant Wetlands scheduled in District or Regional Plans.

For clarity, it does not include Public Conservation Land, council reserves, LINZ-administered land e.g., Crown Pastoral Lease, or Pamu (Landcorp).

### Incentives Funding – large scale biodiversity projects

This fund is for projects with large-scale or significant biodiversity outcomes.

Projects may involve pest management, habitat enhancement, protection of high value areas, etc.

Projects funded are to be between \$50,000 to \$150,000 and must be expended by 30 June 2025.



# Site-Led Programme Site Management Plans

## **Background Information**

A paper was presented to the Environmental Implementation Committee to approve the allocation of \$146,200 budget to the terrestrial Site-Led Programme areas on 8<sup>th</sup> February 2024.

The decision from the Committee meeting was to approve allocation of \$146,200 from the existing budget for the Site-Led Programme to be delivered through a direct funding process for specific projects to achieve Regional Pest Management Plan 2019-2029 (RPMP) objectives (see Appendix 1 & 2 for Site-Led Programme Objectives). The Committee also specified that the allocation of funding be recommended by the existing ECO Fund assessment panel.

The Site-Led Values, Threats, and Impacts Assessment was used to guide site prioritization. From this, a scoring process was developed to quantify the biodiversity values of the sites. Cultural environmental values and cultural wāhi taoka values provided by mana whenua Working Group representatives were also added to the site prioritisation scoring process. Sites were then ranked, with Aramoana and Pikiwhara (Sandymount) – Sandfly Bay identified as the two highest-ranking sites with the highest priority biodiversity and cultural values.

The selected sites were agreed at a Working Group hui and community groups undertaking relevant pest animal and plant work within these areas were identified from the *Site-Led Stocktake Report*. These groups, along with associated external stakeholders (e.g. DOC, DCC) were invited to a community hui for each priority area to promote collaboration and initiate the early stages of a whole of site plan and discuss funding requirements to achieve Site-Led Programme RPMP objectives in these areas on 27<sup>th</sup> March 2024.

Following the community huis, the Working Group consolidated options for direct funding community groups for each site, to progress the Site-Led Programme objectives, and provided recommendation to the ECO Fund Assessment panel.

This plan details the goals, proposed activities and expected outcomes for the Aramoana and Pikiwhara – Sandfly Bay areas, and outlines how the community groups identified in this plan will work towards the objectives of the RPMP.



# Aramoana Site Management Plan

# Aramoana Site-Led Community Hui

Event details: Wednesday 27<sup>th</sup> March 9:30am – 12 noon, Pioneer Hall, Port Chalmers

**Attendees**: Otago Regional Council Site-Led Working Group Representatives (3), Aramoana Conservation Trust (2), The Halo Project (1), and Department of Conservation (DOC; 1).

Apologies: Dunedin City Council, Delta, The Halo Project.

**No response:** Aramoana League Inc, West Harbour Community Board, NZ Sea Lion Trust, Leopard Seals.org.

# Aramoana Stakeholder Goals Identified at the Hui

Goal Type	Goals	Process
Community Goals	Community collaboration     Peace     Education on pest plant control     Education on pest animal control	Stick with the process     Volunteer workshops     Social activities – volunteer gatherings tagged with education at events.     Online and physical resources     ORC support – Biosecurity Officers and Catchment Advisors
Habitat Goals	<ul> <li>More habitat for Sea Lions and Hoiho</li> <li>Wildlife at Aramoana first</li> <li>Good Hoiho habitat – no Banana passionfruit</li> <li>Safe habitat for seabirds expanding headlands and beaches.</li> <li>Native Sea Lion habitat</li> </ul>	Protect habitat for Sea Lion and Hoiho colonies
Species Goals	Heaps of Hoiho chicks and Sea Lions     Thriving sea bird population     Protection of the taonga species from humans and predators	<ul> <li>Protect Sea Lions, Hoiho, and sea bird habitats</li> <li>Intensify mustelid and rat control around seabird habitat</li> </ul>
Ecosystem Goals	Enhancing the wilderness     Coastal forest ecosystem     Threatened endangered flora within coastal ecosystem.     Healthy sand dune systems     Healthy functioning ecosystem to support all native wildlife	<ul> <li>Dunes and salt marsh</li> <li>Kaikai Beach</li> <li>Established dunes and forests to ensure that pest plants are being continuously controlled.</li> <li>Podocarp coastal ecosystem – remove pest plant species and promote forest to expand.</li> </ul>



# Priority Sites identified at the Hui

- 1. Aramoana Ecological Area
- 2. Heyward Point
- 3. Sea Lion creche and penguin forest
- 4. Whole Site-Led Aramoana area including Kaikai Beach



# Funding allocation for Aramoana

Please note that the figures provided below are estimated costs only. These are not quotes and were provided by community group members during discussions at the Aramoana Hui to initiate development of the plan and proportion direct funding accordingly to the groups based on activities that each group would be responsible for. Community groups will provide in-kind contribution in the form of volunteer hours to facilitate this site management plan.



#### Aramoana Ecological Area

**Background:** Over the last 10 years, the Aramoana Conservation Trust's goal has been to preserve and enhance the unique flora and fauna in the ecologically significant saltwater wetlands from the impacts of invasive pest plant and animal species in the Aramoana Ecological Area.

**Aims:** To conserve the ecologically significant saltwater wetlands and protect the native species living there from the impacts of mustelids.

Action	Groups involved	Estimated Cost
Extend / replace existing trap network for mustelids to wet area	Aramoana Conservation Trust	\$6,000
Track clearing labour for establishment of trap lines	The Halo Project	\$2,000
Total		\$8,000

**Expected outcomes:** Building community capacity in the pest management space to increase the number of mustelids caught in trap network for the benefit of this regionally significant wetland and biodiversity. Creation of tracks along track lines to facilitate community members to check traps regularly.

#### Heyward Point Scenic Reserve

**Background:** The Halo Project, with support from Kāti Huirapa Rūnaka ki Puketeraki, have developed a sea bird restoration plan through an intensive mustelid and rat trapping network, and revegetation project at Heyward Point. This plan has been drafted but was on hold due to lack of funding, therefore, the Site-Led Programme has been proposed as a source of funding to initiate this project. DOC have also provided support for the project as Heyward Point Scenic Reserve is a DOC Ecosystem Management Unit (EMU).

Aims: To establish an intensive trap network for rats and mustelids will improve the protection of nationally declining Black-backed gull nesting sites. To protect and expand rare coastal podocarp forest and to enhance coastal shrublands and coastal turf communities. To promote potential habitat and nesting sites for additional sea bird species including the Spotted shag, Black-billed gull, Red-billed gull, Otago shag, Sooty shearwater (tītī), Fairy prion, Broad-billed prion, Royal spoonbill, and Southern Blue penguin (Kororā).



Proposed Action	Groups involved	Estimated Cost
Create an intensive trap network for rats and mustelids at Heyward Point	The Halo Project	\$20,050
Track clearing labour for establishment of trap lines	The Halo Project	\$2,500
Total		\$22,550

**Expected outcomes:** Establish a trap network with rats and mustelids caught on trap line to reduce sea bird chick predation. If managed appropriately, this habitat has potential to support additional nesting sites for native sea bird species in the future (e.g. Spotted shag, Red-billed gull, Sooty shearwater, Otago shag, Fairy prion, Broad-billed prion, Royal spoonbill, and Kororā).

#### Sea Lion Creche and Penguin Forest

**Background:** Over the last 10 years, the Aramoana Conservation Trust's has been actively conserving the ecologically sensitive Hoiho colony and Sea Lion creche. The Trust has a working relationship with The Halo Project and has received support from them to establish a trap network to manage pest animals.

**Aims:** To continue to conserve and protect known nesting sites for Hoiho and Sea Lions, specifically around nesting and pupping sites through maintaining existing trap lines for mustelids and rats.

Proposed Action	Groups involved	Estimated Cost
Trap maintenance of existing trap lines for mustelids and rats	Aramoana Conservation Trust	\$1,500
Total		\$1,500

**Expected outcomes:** Maintain trap network with rats and mustelids caught on trap line to protect vulnerable Hoiho chicks and Sea Lion pups.



#### The Whole Site-Led Aramoana area

**Background:** Little is known around the status of pest plants in the wider Aramoana Site-Led area. The Aramoana Site-Led area contains DOC EMU's, regionally significant coastal podocarp forest remnants, and ecologically significant saltwater wetlands.

Aims: To carry out monitoring and surveillance of Site-Led pest plant species and provide information to community groups and residents on the presence of pest plant species throughout the Aramoana area to inform future management. Based on surveillance findings, we plan to implement revegetation through facilitating the removal of invasive pest plant species and replacing them with native species using the <a href="Otago Native Planting Guide">Otago Native Planting Guide</a> to prevent pest plants reestablishing. Sites will be prioritised for pest plant management and revegetation based on community values and remaining Programme budget.

Proposed Action	Groups involved	Estimated Cost
Monitoring and surveillance of pest plants for Aramoana Site-Led area, including Kaikai Beach. Combined volunteer and field team initiative.	The Halo Project	\$17,120
Implementation and removal of pest plants and ongoing biosecurity maintenance, and revegetation for Aramoana Site-Led area, including Kaikai Beach.	The Halo Project	\$11,965
Implementation and removal of pest plants and ongoing biosecurity maintenance, and revegetation for Aramoana Site-Led area, including Kaikai Beach.	Aramoana Conservation Trust	\$11,965
Total	\$41,050	

**Expected outcomes:** A surveillance report detailing the presence or absence of Site-Led pest plant species across the Aramoana Site-Led area is available to the community to facilitate pest plant control. Resources will be made available to residents, supporting people to identify and control pest plants in their backyards. The allocation of remaining programme budget for Aramoana to implement pest plant removal and revegetation in prioritized areas. Native revegetation has been included in this plan and is an important step for long-term sustainability of pest plant management to prevent future infestation.

This surveillance would provide valuable ecological data for the Aramoana Site-Led area and sites such as Kaikai Beach that are labelled data deficient. This would also support the recent restoration project at Kaikai Beach completed by the Halo Project/Source to Sea, where Kaikai beach was identified as a regionally significant wetland that backs up to coastal forest remnant at Heyward Point. There is also further potential benefits as a recent Manaki Whenua report detailed that Hoiho used to live at Kaikai beach and Aramoana. Following the recent stock exclusion fencing and restoration efforts, this is a highly viable location for rehabilitation.



# Cost Breakdown by Community Group

Community Group	Area	Proposed Action	Total Estimated Fund Allocation
Aramoana Conservation Trust	Aramoana Ecological Area	Extend / replace existing trap network for mustelids to wet area	\$6,000
	Sea Lion Creche and Penguin Forest	Trap maintenance of existing trap lines for mustelids and rats	\$1,500
	Whole Site-Led Aramoana area	Implementation and removal of pest plants and ongoing biosecurity maintenance, and revegetation for Aramoana Site-Led area, including Kaikai Beach	\$11,965
	Total		\$19,465
	Aramoana Ecological Area	Track clearing labour for establishment of trap lines	\$2,000
	Hayward Point Scenic Reserve	Create an intensive trap network for rats and mustelids at Heyward Point Track clearing labour for establishment of trap lines	\$22,550
The Halo Project	Whole Site-Led Aramoana area	Monitoring and surveillance of pest plants for Aramoana Site-Led area, including Kaikai Beach. Combined volunteer and field team initiative. Implementation and removal of pest plants and ongoing biosecurity maintenance, and revegetation for Aramoana Site-Led area, including Kaikai Beach.	\$29,085
	Total		\$53,635
Total Programme Estimated Expenditure			\$73,100

# **Budget availability**

In February, the Environmental Implementation Committee decision to approve the allocation of \$146,200 through a direct funding process. During a Site-Led Working Group meeting, the group agreed to equally divide the approved budget across the two-highest priority sites. As a result the total available budget for the Aramoana area is \$73,100.

**Recommendation: Approve** the allocation of budget for the Aramoana Site-Led area as laid out in the above plan.



# Pikiwhara (Sandymount) – Sandfly Bay Site Management Plan

# Pikiwhara - Sandfly Bay Site-Led Community Hui

Event details: Wednesday 27<sup>th</sup> March 1:30 pm – 5:00 pm, Macandrew Bay Boat Club

**Attendees**: Otago Regional Council Site-Led Working Group Representatives (3), Ōtakōu Site-Led Working Group Representative (1), Otago Peninsula Biodiversity Group (OPBG; 1), Forest and Bird (2), Seek Weeds and Terminate (SWAT; 2), and the Department of Conservation (DOC; 1).

Apologies: Predator Free Dunedin.

# Pikiwhara – Sandfly Bay Stakeholder Goals Identified at the Hui

Goal Type	Goals	Process
Habitat Values	Enhance habitat for native terrestrial and sea birds, marine mammals, skinks, geckos and invertebrates     Protect remining forest remnants     Healthy habitat for species	Reduce the risk of transported exotic pest plant seeds establishing and seed source by eradicating Darwin's Barberry seed source area around Pukehiki     Reduce weed/seed source from surrounding properties
Ecosystem Values	Pest free peninsula involving possum eradication, long term goal eradication or suppression of other pest species to increase positive biodiversity outcomes     Landscape of the area     Outlier control? Survey unfeasible?	Long term eradication or suppression of pest species
Species Values	Sea birds – burrow nesting tītī, cliff nesting Red-billed gull, Spotted shag and White fronted tern, Black-backed gull, beach nesting Oystercatchers Prioritise indigenous species over introduced species Maintain Sooty shearwater – tītī colony Hoiho – Yellow-eyed penguin Kororā – Little blue penguin Jewelled Gecko NZ Fur sea colony Leopard seal Crabeater seal Mataī Kororā in Telfers Bay and E end of Sandfiy Bay Coastal Hebe declining Thick-leaved scurvy grass – Lepidium crassum on Sandymount headland Variable Oystercatcher on Sandfly Bay Native Renunculus recens on bluff entrance to Lover's Leap	Control of introduced predators to enable successful breeding and fledging Reduce predation of native species from rats and mice Eradication, not management of introduced pest species Maintain native plant species present at Sandymount
Cultural Values	Wahi Tipuna     Wahi Taoka	Use traditional Māori names in Site-Led     Programme



Community Values

- Ventifact polished rocks in sandbanks
- Manage tourist impacts
- Communities engaged in conservation work
- Control lupins to altering native habitat and preventing smothering of native plants

# Priority Sites identified at the Hui

- 1. Pikiwhara Reserve tītī colony
- 2. Pikiwhara Sandfly Bay Management Area



# Funding allocation for Pikiwhara – Sandfly Bay

Please note that the figures provided below are estimated costs only. These are not quotes and were provided by community group members during discussions at the Pikiwhara – Sandfly Bay Hui to initiate development of the plan and proportion direct funding accordingly to the groups based on activities that each group would be responsible for. Community groups will provide in-kind contribution in the form of volunteer, staff, and contractor hours to facilitate this site management plan.



#### Pikiwhara Reserve tītī colony

Background: The Forest and Bird managed Pikiwhara tītī colony is one of the largest remaining mainland colonies and in good seasons can produce over 100 chicks, however, this summer it suffered a devastating loss of 21 chicks due to ferret predation (see ODT article Ferrets kill at least 21 tītī chicks at colony). This burrowing seabird colony ecosystem in coastal Otago is incredibly vulnerable to introduced mammalian predators such as ferrets. Forest and Bird have worked at this site since initiating introduced predator control in 2016, during two seasons (2019 and 2024) ferrets were responsible for

OPBG are also currently working towards an eradication of possums in this area with a deadline of September 2024 to complete this work. In the final stages of this project, using drones to identify possums and ground-based contractors to shoot possums is a highly effective method of possum control, especially at low densities.

**Aim:** To develop a trial to inform future projects for mustelid control. This trial aims to protect the tītī colony nesting at Sandfly Bay, and to potentially provide habitat for other native sea bird species through expanding an existing trap network for mustelids and feral cats. To support the final stages of the possum eradication programme through use of thermal drones and contractors.

Proposed Action	Groups involved	Estimated Cost
Extend / replace existing trap network for live capture traps mustelids and feral cats	Forest and Bird	\$18,800
Trail cameras (20) and field phone/tablet	Forest and Bird	\$9,000
Track clearing labour for establishment and maintenance of trap lines	Forest and Bird	\$5,000
Project manager (0.1 FTE) for mustelid and feral cat trap network	OPBG	\$8,320
Trail cameras (30)	OPBG	\$10,500
Trap maintenance, lures, and bait for all pest animal species	OPBG	\$1,000
Drone surveillance and hunting, 3 nights	OPBG	\$9,000
Total		\$61,620



**Expected outcomes:** A trial is implemented and facilitated by a Project Manager knowledgeable of the site and pest animal trapping methodology to increase the number of mustelid and feral cat live capture trap lines to increase fledging sea bird success rates, and to provide a better understanding of effective trapping techniques for mustelids to help inform future projects. Eradication of possums is achieved in the Pikiwhara area.

#### Pikiwhara – Sandfly Bay Site-Led management area

**Background:** Little is known around the status of pest plants in the wider Pikiwhara – Sandfly Bay Site-Led area. *The Values, Threats, and Impacts Assessment* illustrates Pikiwhara contains Naturally Uncommon Ecosystems (with basic cliffs, scarps, tors, and volcanic boulder fields; see <a href="https://www.landcareresearch.co.nz/publications/naturally-uncommon-ecosystems/">www.landcareresearch.co.nz/publications/naturally-uncommon-ecosystems/</a>), is a DOC EMU, and is regarded as an area of significant biodiversity value by DCC.

Furthermore, Banana Passionfruit, Chilean Flame Creeper and Darwin's Barberry are defined in the Regional Pest Management Plan as Site-Led species. These are highly invasive pest plants which if present in this site, could cause significant ecological affects and smother native vegetation. Furthermore, Banana Passionfruit and Darwin's Barberry seeds are highly palatable and are well-dispersed by native birds.

The Pikiwhara – Sandfly Bay area is also home to several native sea birds (tītī, Hoiho, Kororā, Redbilled Gull, Spotted Shag, White-fronted Tern, Black-backed Gull, Variable Oystercatcher), Pinnipeds (New Zealand Fur Sea, Sea Lion, Leopard Seal, Crabeater Seal), and native plant species (Mataī, Coastal Hebe, Thick-leaved scurvy grass, *Renunculus recens*, *Lepidium crassum*). Many of which would benefit from increased predator trapping as outlined above (see Pikiwhara Reserve tītī colony), and from either baseline surveillance to inform the current status of pest plants in the Pikiwhara – Sandfly Bay area, or management of seed source plants at Pukehiki.

**Aim:** To either carry out drone baseline surveillance of Site-Led pest plant species and provide information to community groups on the presence of pest plant species throughout the Pikiwhara – Sandfly Bay area, or to manage seed source plants at Pukehiki.

Proposed Action	Groups involved	Estimated Cost
Drone baseline surveillance for Darwin's Barberry (July-August), Sycamore and Banana passionfruit at Pikiwhara – Sandfly Bay, or management of seed source plants at Pukehiki	SWAT	\$9,480
Herbicide gel	SWAT	\$1,000
GPS + 1 Year subscription	SWAT	\$1,000
Total		\$11,480



**Expected outcomes:** Either a baseline surveillance report detailing the presence or absence of Site-Led pest plant species across the Pikiwhara – Sandfly Bay area is available to the community to facilitate pest plant control, or pest plants are removed at Pukehiki to remove potential seed sources.

# Cost Breakdown by Community Group

Community Group	Area	Proposed Action	Total Estimated Fund Allocation
Forest and Bird	Sandymount Reserve tītī colony	Extend / replace existing trap network for live capture traps mustelids and feral cats Trail cameras (20) and field phone/tablet Track clearing labour for establishment and maintenance of trap lines	\$32,800
	Total		\$32,800
OPBG	Sandymount Reserve tītī colony	Project manager (0.1 FTE) for mustelid and feral cat trap network. Trail cameras (30). Trap maintenance, lures, and bait for all pest animal species. Drone surveillance and hunting, 3 nights.	\$28,820
	Total		\$28,820
SWAT	Pikiwhara – Sandfly Bay Site-Led management area	Drone baseline surveillance for Darwin's Barberry (July-August), Sycamore and Banana passionfruit at Pikiwhara – Sandfly Bay, or management of seed source plants at Pukehiki. Herbicide gel. GPS + 1 Year subscription.	\$11,480
	Total		\$11,480
Total Programme Estimated Expenditure		\$73,100	

# **Budget availability**

In February, the Environmental Implementation Committee decision to approve the allocation of \$146,200 through a direct funding process. During a Site-Led Working Group meeting, the group agreed to equally divide the approved budget across the two-highest priority sites. As a result the total available budget for the Pikiwhara – Sandfly Bay area is \$73,100.

**Recommendation: Approve** the allocation of budget for the Pikiwhara – Sandfly Bay Site-Led area as laid out in the above plan.



# Appendix 1. Site-Led Programme Otago Peninsula Objectives

#### 6.5.4 Site-led programmes on the Otago Peninsula

The management aims and the range of methods to be used to accomplish the aims for the pest to be managed under the site-led programme for the Otago Peninsula are set out in Table 26 below.

Table 28: Aims and means of achievement for site-led programmes on the Otago

#### Objective, principal measures and rules

#### Plan Objective 6.5.4.a

Over the duration of the Plan:

- preclude establishment of feral deer, feral goats, feral pigs and Bennett's wallaby, and bringing about the desired levels of
- b) eradicate possums and
- implement sustained control of feral cats.
   rats, hedgehogs and.
- d) progressively contain mustelids on the Otago Peninsula (identified on Map 3, Appendix 3) to avoid, mitigate or prevent damage to the indigenous ecosystem values at this also.

#### Plan Objective 6.5.4.b.

Over the duration of the Plan, progressively contain:

- a) banana passionfruit;
- b) Chilean flame creeper.
- c) Darwin's barberry
- d) Sycamore
- e) Gunnera, and
- f) tradescantia

on the Otago Peninsula (identified on Map 3. Appendix 3) to avoid, mitigate or prevent damage to the indigenous ecosystem values at this site.

#### Plan Rule 6.5.4.1

No person shall keep, hold, enclose or otherwise harbour in any place, either in transit to or present on the Otago Peninsula (identified on Map 3 in Appendix 3) any.

- a) Bennett's wallaby:
- b) feral deer,
- c) feral goat;
- d) feral pig.
- e) mustelid:
- f) feral cat:
- g) hedgehog; or
- For the purpose of this rule place includes any

building, conveyance, craft, land, or structure.

A breach of this rule creates an offence under section 154N(19) of the Act.

#### Advice note

Sections 52 and 53 of the Biosecurity Act 1993, which prevent the communication, release, spread, sale and propagation of pests, must be complied with. These sections should be referred to in full in the Biosecurity Act 1993.

#### Principal measures to be used

Otago Regional Council will take a lead role in supporting community groups and agencies in bringing about the desired levels of environmental protection to this site.

Appropriate measures drawn from the suite of activities listed under collaboration, requirement to act, council inspection, service delivery, advocacy and education described in section 5.3 of the Plan will be used by Olago Regional Council to achieve Objectives 6.5.4.a and 6.5.4.b.

It is not proposed to introduce occupier control rules at this stage. However, this may become necessary in the future to maintain public investment of actions or funding or where lack of cooperation could jeopardise achieving the Objectives.

How the Otago Regional Council intends to deliver these objectives with the community is described more fully in the Biosecurity Strategy.

#### Explanation of rule

The reason for this rule is to help achieve the exclusion, eradication or control of these pests from the Otago Perlinsula



# Appendix 2. Site-Led Programme West Harbour – Mt Cargill Objectives

#### 6.5.5 Site-led programmes at West Harbour - Mt. Cargill area

The management aims and the range of methods to be used to accomplish the aims for the pest to be managed under the site-led programme at West Harbour - Mt. Cargill are set out in Table 27 below.

# Table 27: Aims and means of achievement for site-led programmes at West Harbour - Mt.

#### Objective, principal measures and rules

#### Plan Objective 6.5.5.a

Over the duration of the Plan:

- a) preclude establishment of feral deer and Bennett's wallaby; and
- b) implement sustained control of feral cats, feral goats, feral pigs, rats, hedgehogs, and Appropriate measures drawn from the suite of
- progressively contain mustelids, and
- progressively contain possums to achieve a d)

at West Harbour - Mt. Cargill (identified on Map 3 in Appendix 3) to avoid, mitigate or prevent damage to the indigenous ecosystem values at

#### Plan Objective 6.5.5.b

Over the duration of the Plan, progressively contain

- a) banana passionfruit;
- b) Childan flame creeper;
- c) sycamore
- d) gunnera:
- e) Darwin's barberry, and
- f) tradescantla

at West Harbour - Mt. Cargill (identified on Map 3 in Appendix 3) to avoid, mitigate or prevent damage to the indigenous ecosystem values at this site.

#### Plan Rule 6.5.5.1 Explanation of rule

No person shall keep, hold, enclose or otherwise. The reason for this rule is to help achieve the harbour in any place, either in transit to or exclusion, eradication or control present at West Harbour – Mt. Cargill (identified from West Harbour – Mt. Cargill. on Map 3 in Appendix 3) any

- a) Bennett's wallaby;
- b) feral deer.
- c) feral goat; d) feral pig;
- e) mustelid:
- feral cat
- g) hedgehog or

### h) possum.

For the purpose of this rule place includes any building, conveyance, craft, land, or structure

A breach of this rule creates an offence under section 154N(19) of the Act.

Sections 52 and 53 of the Biosecurity Act 1993, which prevent the communication, release, spread, sale and propagation of pests, must be complied with. These sections should be referred to in full in the Biosecurity Act 1993.

#### Principal measures to be used

Otago Regional Council will take a lead role in supporting community groups and agencles in bringing about the desired levels of environmental protection to this site

activities listed under collaboration.

requirement to act, council inspection. service delivery, advocacy and education described in section 5.3 of the Plan will be used. by Otago Regional Council to achieve Objectives 6.5.5.a and 6.5.5.b.

It is not proposed to introduce occupier control rules at this stage. However, it may become necessary in the future to maintain public investment of actions or funding or where lack of cooperation could jeopardise achieving the Objectives.

How the Otago Regional Council intends to deliver these objectives with the community is described more fully in the Biosecurity Strategy.

exclusion, eradication or control of these pests

# Project Assessment Criteria, Guidance and Scoring

Criteria	Guidance	Scoring
Project objectives are realistic, and actions are likely to achieve the objectives	<ul> <li>Setting a clear project objective helps track the success of the project. Objectives should be realistic and able to be achieved within the timeframe of the project.</li> <li>The project should outline what actions will be undertaken to achieve the objective. There should be a clear linkage between the action and the intended objective.</li> <li>Consider overall group objectives and assess specific project actions in application in terms of contribution to that overall group objective / vision.</li> <li>Projects that are implementing existing catchment group plans could be considered as higher scoring.</li> </ul>	4 = Objectives are realistic and highly likely to be achieved within the timeframe. Obvious links between actions and objectives 3 = Objectives are realistic and likely to be achieved within the timeframe. Some linkage between the actions and objectives 2 = Objectives could be achievable, but project planning does not clearly demonstrate how proposed actions will lead to objectives 1 = Objectives are limited, and actions are not linked to the project objectives and unlikely to be achieved within the timeframe 0 = Objectives are unrealistic, irrelevant or unachievable.

Criteria	Guidance	Scoring
Project is technically sound	<ul> <li>The likelihood of a successful project is increased when the applicants are well informed or experts in the area.</li> <li>Projects should demonstrate that the planned approach is technically feasible and reflects best management practice.</li> <li>This could be through the expertise of the project applicants or through information they have sought and intend on implementing.</li> </ul>	4 = Proponent has sought appropriate advice and/ or have the relevant expertise. Best practice is clearly being proposed.  3 = Proponent has sought some advice and/ or has some relevant experience. Best practice is mostly being proposed.  2 = Proponent has sought some advice and/ or has some relevant experience. Best practice is not being proposed or is not clear.  1 = Proponent has not demonstrated advice was sought or what relevant experience is being utilised. Best practice is not being proposed or is not clear.  0 = Best practice is not being implemented and proposed techniques are questionable.

Criteria	Guidance	Scoring				
Impact of the project – scale	The impact a project can have can be assessed by:	4 = Significant environmental benefits at a district or regional scale.				
	<ul> <li>Scale, how effective and far reaching will the project outcomes be. For example, regional benefits, district wide benefits, site or</li> </ul>	3 = Moderate environmental benefits at multi-site or local scale.				
	property scale.	2 = Benefits are site scale.				
		1 = Benefits are likely but are indirect and/o intangible.				
		0 = No clear benefits to the environment.				
Impact of the project –	The impact a project can have can be assessed by:	4 = Environmental benefits for long-term. (20+ years)				
timeframe	<ul> <li>Longevity, how enduring will the project outcomes be.</li> <li>How will this be maintained.</li> <li>Intervention level, is the project addressing the cause or symptom of a problem.</li> </ul>	3 = Environmental benefits medium-term (6-20 years).				
		2 = Environmental benefits short-term (<5 years).				
		1 = Benefits are likely but are indirect and/or intangible and timeframes are difficult to assess.				
		0 = No clear benefits to the environment over any timeframe.				

Criteria	Guidance	Scoring
Special site values	Projects that protect or enhance sites with special environmental values add value to the outcomes ECO Fund is seeking. Special site values could include:  • At-risk or threatened species, • Rare or much reduced-ecosystem types. • Important or distinctive habitat types.	<ul> <li>4 = Project addresses a first-tier biodiversity priority: <ul> <li>threatened naturally uncommon system,</li> <li>habitats of threatened taxa endemic to Otago, and</li> <li>habitats of Nationally Critic species.</li> </ul> </li> <li>3 = Project addresses a second-tier biodiversity priority: <ul> <li>all other naturally uncommon ecosystems, and</li> <li>'unnaturally rare' ecosystems.</li> </ul> </li> <li>2 = Project addresses a third-tier biodiversity priority: <ul> <li>all other priority sites (as indicated by the Leathwick work).</li> </ul> </li> <li>1 = Project does not address a biodiversity priority but has clear biodiversity outcomes.</li> </ul>

Criteria	Guidance	Scoring
Level of community engagement	A key objective for the ECO Fund is community involvement. This criterion assesses how much community involvement is being proposed and how far reaching that involvement may be.	<ul> <li>4 = Project is led by a community group and engages with other members of the community.</li> <li>3 = Project is led and implemented by a community group with some community engagement.</li> <li>2 = Not led by community but involves community in the implementation.</li> <li>1 = No community groups involved but outcomes will benefit or be utilised by the community.</li> <li>0 = No community involvement or benefit.</li> </ul>

Criteria	Guidance	Scoring
Value for money	<ul> <li>Considering any level of investment contributed by the applicant, that is, their level of investment is a good measure for value for money.</li> <li>See Funding Details section in application.</li> <li>Applicant investment can include in-kind contributions such as labour or volunteer hours, monetary input from the group itself or project partners.</li> <li>However, contributions from other grants are not considered applicant's investment and should not be used to leverage funding.</li> </ul>	4 = Project is more than 1:1 cost sharing between fund requested and fund contributed.  3 = Project is 1:1 (or within 5%) cost sharing  2 = Project is 1:2 applicant vs ECO Fund requested.  1 = Project has some applicant contribution but not clear or costed.  0 = Project relies solely on ECO Fund and/or other grants.
New applicants	<ul> <li>It is good to encourage new applicants to access funding.</li> <li>However, previous applicants are also typically involved in good works and maintaining momentum can be good.</li> <li>Some previous successful applicants may not have completed all previous commitments, e.g., reporting.</li> </ul>	2 = New applicant or previously unsuccessful applicant to the ECO Fund (with eligible project).  1 = Previous successful applicants with all requirements completed on time.  0 = Previous successful applicant with outstanding reports or other commitments.

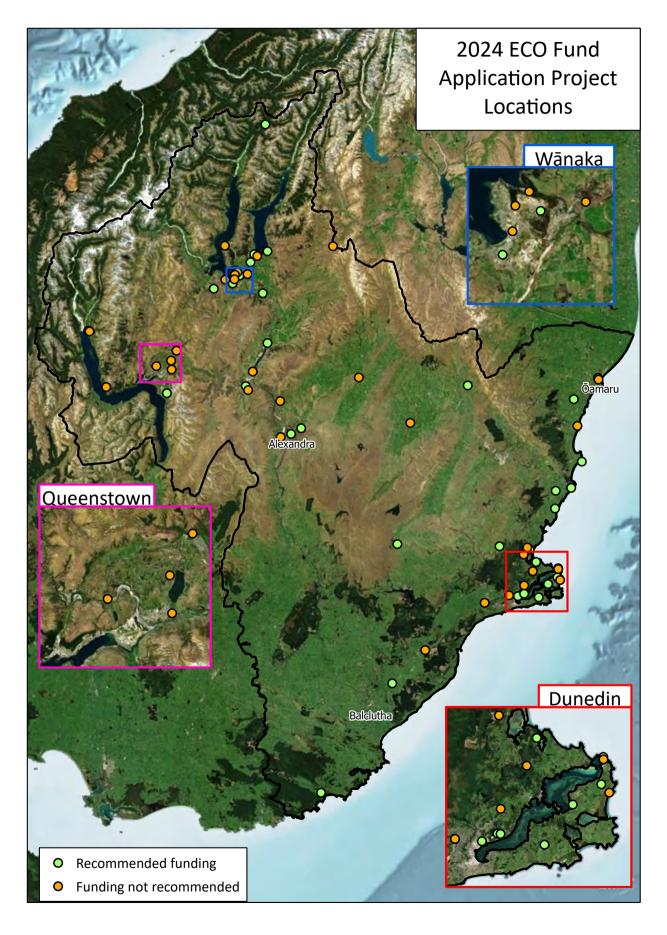
Criteria	Guidance	Scoring
Other funding	<ul> <li>ECO Fund has many repeat applicants and some with significant other funding to achieve their objectives, enabling them to commit resources to applying for additional funding.</li> <li>Community groups without significant additional funding should receive a boost to their score to encourage new groups, new projects and a diversity and spread of ECO Fund projects.</li> </ul>	2 = Community group has no other significant funding sources (total <\$100k).  1 = Community group has other significant funding sources (total \$100-\$500k).  0 = Community group has other significant funding sources (total >\$500k).

2024 ECO Fund and Incentives Funding – List of applications declined

Organisation	Project name	Project activity	Amount requested	Recommendation		
ECO Fund						
The Glenorchy Community Association Inc	The Glenorchy community plant nursery	Community plant nursery	\$30,000.00	Decline – ineligible Application does not meet the required 50% wages contribution		
Whakatipu Wildlife Trust	Working towards a predator free Whakatipu Basin - Years 2 to 5	Pest animal control	\$97,525.00	Decline – ineligible Funding sought exceeded the maximum amount for this funding category		
Reid Family Trust	Porteous Hill restoration	Native planting and pest control	\$37,228.00	Decline – ineligible Application does not demonstrate the project is community-led		
Bridesdale Bush Trust	Bridesdale community nursery shed & Hayes Creek wetland restoration	Native planting	\$123,175.84	Decline – ineligible Funding sought exceeded the maximum amount for this funding category		
Aroha Kaikorai Valley Trust	Aroha Kaikorai Valley predator control network	Pest animal control	\$38,942.00	Decline – ineligible Application does not meet the required 50% wages contribution		
Yellow-eyed Penguin Trust	Restoration of a regionally significant wetland on Otago Peninsula	Pest animal control and native planting	\$49,502.79	Decline – ineligible Application does not meet the required 50% wages contribution		
Bike Wanaka	Lismore Park Phase 2	Native planting	\$10,700.00	Decline - rank		
Shaping our Future	Defining 'right plant - right place' across Hāwea	Community consultation	\$4,711.00	Decline - rank		
Waitaki Branch Forest and Bird	Community native plant nursey	Community nursery	\$2,000.00	Decline - rank		
Open Valley Urban Ecosanctuary - Valley Project	Lindsay Creek community restoration, stage 1	Pest plant control	\$16,583.00	Decline - rank		
NZ Landcare Trust	Enhancing a degraded urban stream - a wetland enhancement project	Native planting	\$49,973.52	Decline - rank		
Te Poari a Pukekura	Whakakākahu o Pukekura	Pest animal control and native planting	\$50,000.00	Decline - rank		
WAI Wānaka	Drains are streams: Education and action	Education	\$20,256.00	Decline - rank		
Wanaka Backyard Trapping	Add two new predator trap lines in Wanaka	Pest animal control	\$11,150.00	Decline - rank		

Organisation	Project name	Project activity	Amount	Recommendation			
			requested				
Arrowtown Village Association	Bush Creek pedestrian and cycle bridge and gateway interpretation	Pest plant control and native planting	\$10,000.00	Decline - rank			
Blueskin Bay Wright Road Community Group	The Wright Road native tree community project	Pest plant control and native planting	Decline - rank				
Lindis Pass Conservation Group Incorporated Society (LPCG)	Lindis Pass invasive weed control	Pest plant \$20,000.00 control		Decline - rank			
Te Kākano Aotearoa Trust	Habitat restoration Native planting \$6,575.00		Decline - rank				
Incentive Funding - Nati	ve planting after pest plant co	ontrol					
Lower Shotover Conservation Trust	LSCT reforestation project	Pest control and native planting	\$25,000.00	Decline - rank			
Incentive Funding - Biod	liversity enhancement on pro	tected private land					
Earnscleugh Vineyards Ltd	nscleugh Vineyards Matatu		\$ 42,000.00	Decline – ineligible Funding sought exceeded the maximum amount for this funding category			
Dicey Wines	Native island trial	Native planting	\$15,000.00	Decline – ineligible Application does not meet the land protection eligibility criterion			
Incentive Funding - Sust	ained rabbit management						
Kirimoko Catchment Group	Kirimoko Phase 2: Cattle stops	Pest animal control	\$19,726.00	Decline – ineligible Second year request for fencing costs			
The Clarendon Community Rabbit Fencing Project	Clarendon Community rabbit fencing	Pest animal control	\$57,945.00	Decline – ineligible Funding sought exceeded the maximum amount for this funding category			
Bronwyn and Murray judge Partnership	Rabbit fencing Rakimarie Ecosanctuary-Bronwyn and Murray Judge Partnership	Pest animal control	\$21,432.00	Decline – ineligible Application does not meet the group of landholders requirement			
Glenorchy Community Golf Club	Rabbit proofing recreational grounds	Pest animal control	\$26,031.00	Decline - rank			
Incentive Funding - Larg	e-scale biodiversity grant						
Mana Tahuna Charitable Trust	Wai Whakaata Lake Hayes Catchment restoration	Pest plant control, sediment control and education	\$150,000.00	Decline – ineligible Application does not meet the required 50% wages contribution			

Organisation	Project name	Project activity	Amount requested	Recommendation		
Landscape Connections Trust	Restoring the forest health of Mihiwaka and Kapukataumahaka	Pest plant control and native planting	\$150,000.00	Decline – ineligible Project exceeds the deadline allowe d for this funding category		
Lake Dunstan Charitable Trust	Bridge to bridge restoration project	Pest plant control and native planting	\$150,000.00	Decline - rank		
Manuherekia Catchment Group	Identifying and protecting native biodiversity in the Manuherekia Catchment	Monitoring	\$75,000.00	Decline - rank		
Upper Clutha Wilding Tree Group	Upper Clutha Wilding Tree Group Operation 2024-25	Pest plant control	\$50,000.00	Decline - rank		
Ida Valley Catchment Group	Willows removal from the Poolburn Gorge	Pest Plant control	\$150,000.00	Decline - rank		
Upper Taieri Wai - Tiaki Maniototo	Maniototo goose management	Pest animal control	\$146,000.00	Decline - rank		



Environmental Implementation Committee - 8 May 2024

### 9.2. Integrated Catchment Management

Prepared for: Environmental Implementation Committee

Report No. OPS2408

Activity: Governance Report

Author: Anna Molloy, Principal Advisor Environmental Implementation

**Endorsed by:** Gavin Palmer, General Manager Operations

**Date:** 8 April 2024

### **PURPOSE**

[1] To provide an update on the Integrated Catchment Management (ICM) Programme.

### **EXECUTIVE SUMMARY**

- [2] The ICM Programme has been underway since mid-2022, with the establishment of the ICM Working Group and the selection of the Catlins Freshwater Management Unit (FMU) as the pilot for the development of the first Catchment Action Plan (CAP).
- [3] The ICM Working Group is continuing in a slightly revised format to provide robust guidance to the roll out of the ICM Programme.
- [4] The Catlins CAP development is progressing as scheduled and the work by mana whenua, the community, and others has been very collaborative. Their third workshop (out of approximately 6) is scheduled for late April 2024. As a 'pilot', this project is being evaluated by external evaluators appointed by ORC. The evaluators are working to a brief approved by the ICM Working Group.
- The work to establish a CAP development group for the Upper Lakes rohe is underway and slightly behind schedule. This is due to ORC taking time to establish our working partnership with appropriate mana whenua representatives before going to the wider community.
- [6] Preliminary scoping work is underway for the Taieri FMU CAP development process.
- [7] Work with catchment groups to help progress planning where requested is underway with workshops being facilitated by the Catchment Group Planner with the Lake Hawea Stakeholder Group. The Catchment Group Planner is working with others such as Otago Catchment Community Coordinators and the Senior Advisor Iwi Partnerships and Engagement to identify potential new groups who would like support for catchment action planning.

### **RECOMMENDATION**

That the Environmental Implementation Committee:

- 1) **Notes** this report.
- 2) **Recommends to Council to endorse** the boundary for the Upper Lakes Catchment Action Plan (CAP) being adjusted to best reflect the community of interest and to better enable integrated management.

### **BACKGROUND**

- [8] The ICM Programme originates in the ORC's Long-Term Plan 2021-31 (LTP) commitment to "lead the development, implementation, and review of integrated Catchment [Action] Plans in collaboration with iwi and community". While this is the LTP text, the intent of the ICM Programme is for ORC and iwi, in partnership, to work with the community and stakeholders to develop a plan of action for the long-term management of the catchment or catchments.
- [9] Following the LTP 2021-31 coming into effect in July 2021, the ICM Programme was developed with initial concepts in late 2021, with the Programme becoming more formalised in August 2022 when the ICM Working Group was established and the Catlins was selected by Council as the FMU for the first Catchment Action Plan (CAP) to be developed.
- [10] The ICM Working Group held its first meeting in February 2023, and completed the tasks set out for it (from the August 2022 Strategy and Planning Committee meeting) by October 2023. The ICM Working Group was re-established with revised Terms of Reference in November 2023 (refer to Environmental Implementation Committee 8 November 2023).
- [11] The Catlins Integrated Catchment Group (ICG) was established in September 2023 to codevelop the Catlins CAP. The Catlins ICG began meeting in October 2023.
- [12] The August 2023 Environmental Implementation Committee Meeting agreed to the next two rohe and FMU in the CAP rollout sequence being Upper Lakes rohe and the Taiari FMU.

### **DISCUSSION**

### **ICM Working Group Update**

- The ICM Working Group has met twice since it's re-establishment in November 2023 in December 2023 and February 2024. This is line with the revised schedule of bi-monthly meetings. Their next meeting will be likely be in April 2024.
- The ICM Working Group has continued to provide robust guidance to the ICM Programme and new members are getting up to speed very quickly. Members include representatives from Council (Councillors and staff), Aukaha, Te Ao Marama, and Otago Catchment Community. Temporary members from the area for the next CAP to be developed (Upper Lakes) will be sought once the arrangements with mana whenua partners are in place. The ICM Working Group will discuss the appointment of these temporary members at their next meeting.

### **Catlins CAP Update**

- The Catlins ICG has held three meetings and two workshops. The meetings were useful to allow time for members to get to know each other and the process for developing the CAP. The workshops are the collaborative process for the CAP development.
- The first workshop addressed the working vision for the CAP and the key values of the area that the ICG wants to maintain or protect. These values are based around environmental outcomes initially but also look at socio-economic values that are directly reliant on the environment e.g. sustainable tourism. Indicative goals for the values were also discussed, that is, how healthy does the group want the value to be.

- [17] The second workshop addressed the pressures (or problems) that the group sees as impacting on the health of the values. These pressures were then ranked by undertaking an assessment of the scope, severity and irreversibility of the problem. Looking at the things impacting on the values provides an opportunity to re-visit the values and check if they are defined at the appropriate scale or reflect the key component of what the community values. For example, pest species impact on "native bush" but some pests impact differently on different types of vegetation, so the value might be better split into the broad vegetation types in the Catlins.
- [18] A process diagram and where we are up to as well as a summary of the working drafts of outputs from these two workshops is in **Attachment 1**.
- [19] The next workshop for the Catlins ICG is set for late April and it will start to look at the 'situation model' for the values and pressures. That is, how are they linked and what is contributing to those pressures.
- [20] Between workshops the ICM Team that is supporting the ICG and facilitating the workshops will review, refine and add to the work undertaken by the group. This will include liaising with the Science Team to incorporate supporting data and knowledge where possible.
- [21] As this CAP is our pilot CAP it is important that we can learn from the process. External evaluators have been engaged by ORC to undertake an evaluation of the project. This will explore key success criteria through a series of questions asked of the ICM Team, ICM Working Group and Catlins ICG members, as well as assessing documents and other evidence that can answer if we planned for and implemented processes to achieve a successful outcome. The brief for the evaluation was approved by the ICM Working Group. The Evaluation Plan brief is in **Attachment 2.**
- [22] Outcomes from the Evaluation will be provided in future ICM Updates to the Environmental Implementation Committee as appropriate.

### **Upper Lakes CAP Update**

- [23] The Upper Lakes landscape is the next CAP due to be developed. It was intended to initiate the first meeting with an appropriate group of mana whenua, community and stakeholders in April 2024. However, given the complexity and number of groups in the Upper Lakes, it was agreed by the ICM Working Group that the partnership with mana whenua should be cemented before going to the wider community.
- [24] To do this the ICM Working Group sought advice from Aukaha and Te Ao Marama on who would be the appropriate mana whenua representatives from the seven rūnaka who have an interest in the Upper Lakes rohe. Discussions and meetings between rūnaka are still underway. This means that the Upper Lakes CAP development might not start in April, but it is important to ensure we have the right approach in place to maximise opportunity for success in the area.
- [25] The ICM Team expects to have representatives provided to commence work with as soon as they can.

- [26] Early work on the scope (geographic boundary) for the Upper Lakes has also occurred. The starting point for all CAPs is the FMU/rohe boundary as per the Regional Policy Statement. In the Upper Lakes this includes the catchment area for each of the three deep water lakes but excludes the townships and areas people from the Upper Lakes live, work and recreate in, such as Hawea or Wanaka. Options for the scope will be explored with the group that is established to develop the CAP for the Upper Lakes, including using the Queenstown Lakes District Boundary (QLDC). A map of the Upper Lakes rohe boundary and the QLDC boundary showing the key community locations is in Attachment 3.
- [27] Any proposed changes to the scope for the Upper Lakes CAP in terms of the geographic boundary will be discussed by the ICM Working Group regarding how this may affect neighbouring intended CAPs. Noting that the development of the CAP starting is dependent on the scope being established early this paper seeks endorsement of a flexible approach to the setting of the boundary.

### Taieri CAP Update

- [28] The Taieri FMU is proposed to be the next CAP for development after the Upper Lakes. The timing for the Taieri to begin is tentatively set for October 2024.
- [29] Some preliminary scoping work is underway for the Taieri by the ICM Team. This includes liaising with other key projects in the catchment such as the Nga Awa Project being managed in partnership between DOC, mana whenua and ORC and the Healthy Taieri Integrated Farm Planning Project being hosted by Upper Taieri Wai.

### Lake Hawea Stakeholder Group CAP Update

- [30] The Catchment Group Planner role is funded by the Ministry for Environment and works with catchment groups to help them with integrated catchment management and plans where requested. The Catchment Group Planner has been working with the Lake Hawea Stakeholder Group to facilitate the development of a CAP for that group. This work started in August 2023 and through a series of three workshops has drafted actions to address pressures on commonly identified values.
- [31] It was very important that the CAP for the Lake Hawea Stakeholder Group did not duplicate or re-do the significant amount of planning and issues identification that has been undertaken by various community groups previously. The Catchment Group Planner collated all previous plans and presented to the group an overview of identified values and pressures on those values (issues).
- [32] The Lake Hawea Stakeholder Group then workshopped the values and pressures, ranked those pressures and drafted high level actions (or strategies) to address the problems. Work is continuing with the Group to further develop the strategies into annual and medium-term operational plans.
- [33] The Catchment Group Planner is also discussing potential new groups to support with Otago Catchment Community Coordinators and the Senior Advisor Iwi Partnerships and Engagement.

### **CONSIDERATIONS**

**Strategic Framework and Policy Considerations** 

[34] There are no strategic framework or policy considerations for this paper.

#### **Financial Considerations**

[35] There are no financial considerations for this paper.

### **Significance and Engagement**

- [36] The engagement with community is very important for the ICM Programme as the success of the Programme depends on the community 'owning' this process. The approach undertaken is based firmly on appropriate and genuine collaboration with the community.
- [37] The ORC's partnership with mana whenua is very important. To date this has been given effect to through the membership of the ICM Working Group and having rūnaka representation on the Catlins ICG. Further work to establish a working partnership for the Upper Lakes is underway.

### **Legislative and Risk Considerations**

[38] There is no legislative risk for this paper.

### **Climate Change Considerations**

[39] There are no specific climate change considerations for this paper. Climate change as a contributing factor to pressures on the values in our landscape will be incorporated in the CAP development process.

### **Communications Considerations**

[40] The ICM Team works closely with the Communications Team to ensure appropriate and timely communications are in place for each step of the CAP development process. This is particularly important in the initial phases of establishing the ICGs.

### **NEXT STEPS**

[41] A workshop exploring options for how Council would like to 'endorse' CAPs when drafted is proposed to be held on 3<sup>rd</sup> July 2024. This will be followed by a Council paper based on the workshop discussion with recommendations for a defined process for endorsing CAPs.

### **ATTACHMENTS**

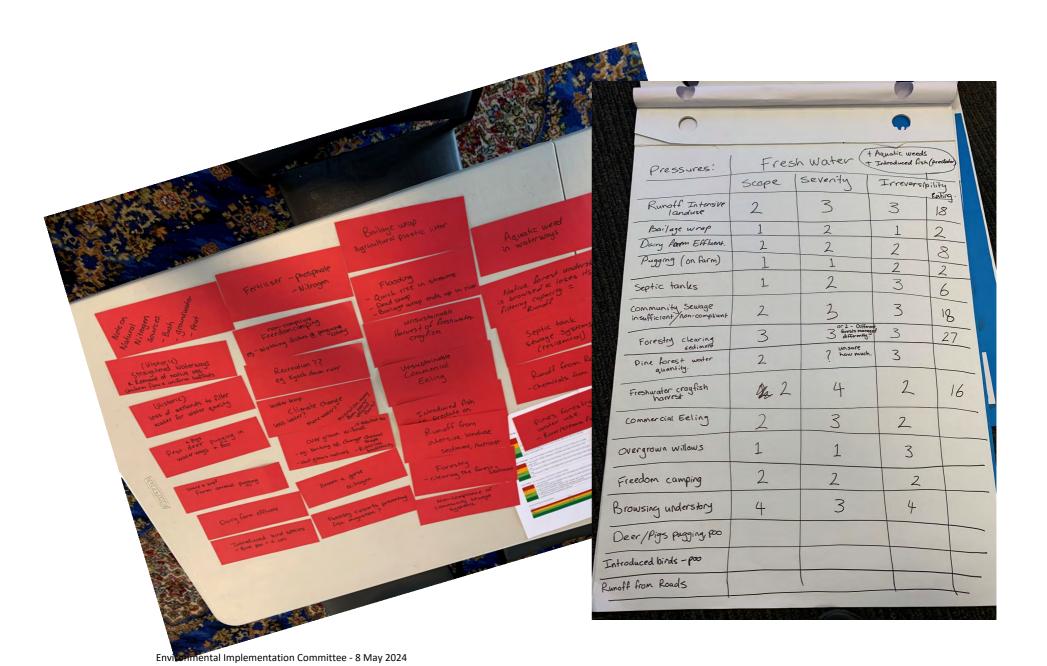
- 1. Att 1b Summary pressures workshop 2 draft [9.2.1 5 pages]
- 2. Att 1a Workshop 1 Outputs Story Book small [9.2.2 12 pages]
- 3. Att 2 Catlins CAP Project Evaluation Plan v1 0 [9.2.3 11 pages]
- 4. Att 3 QLDC Boundary versus Current Rohe showing detail at towns [9.2.4 1 page]

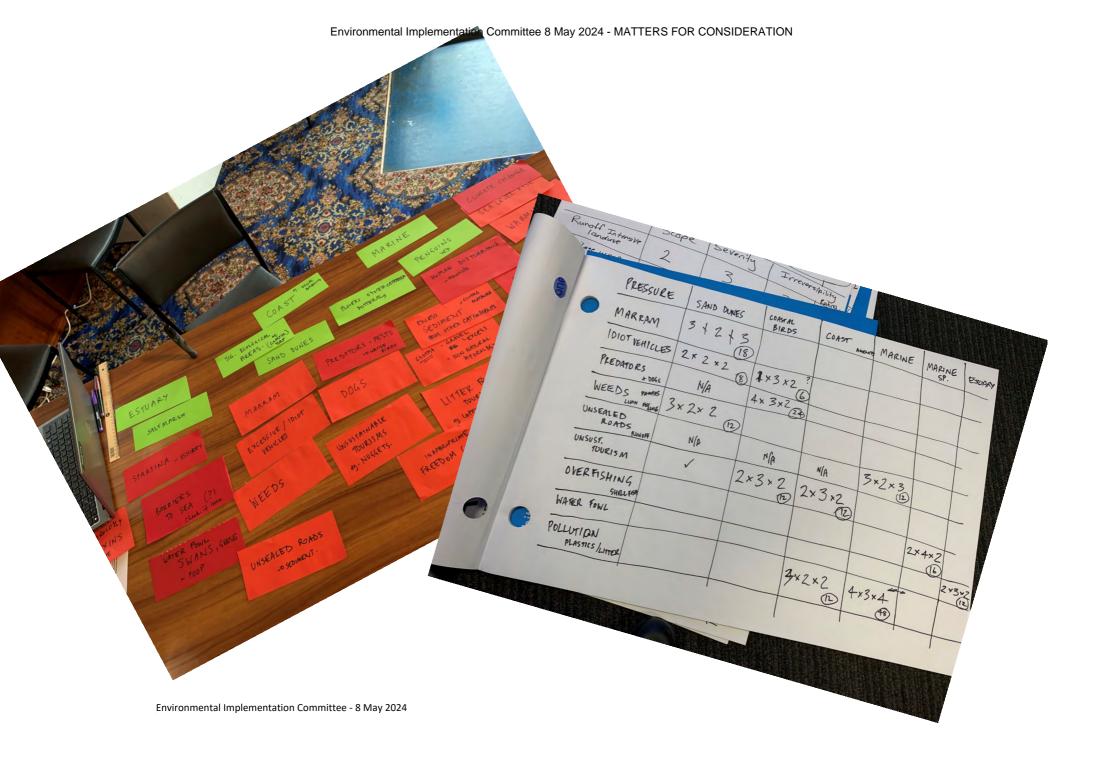
# **CAP Development**

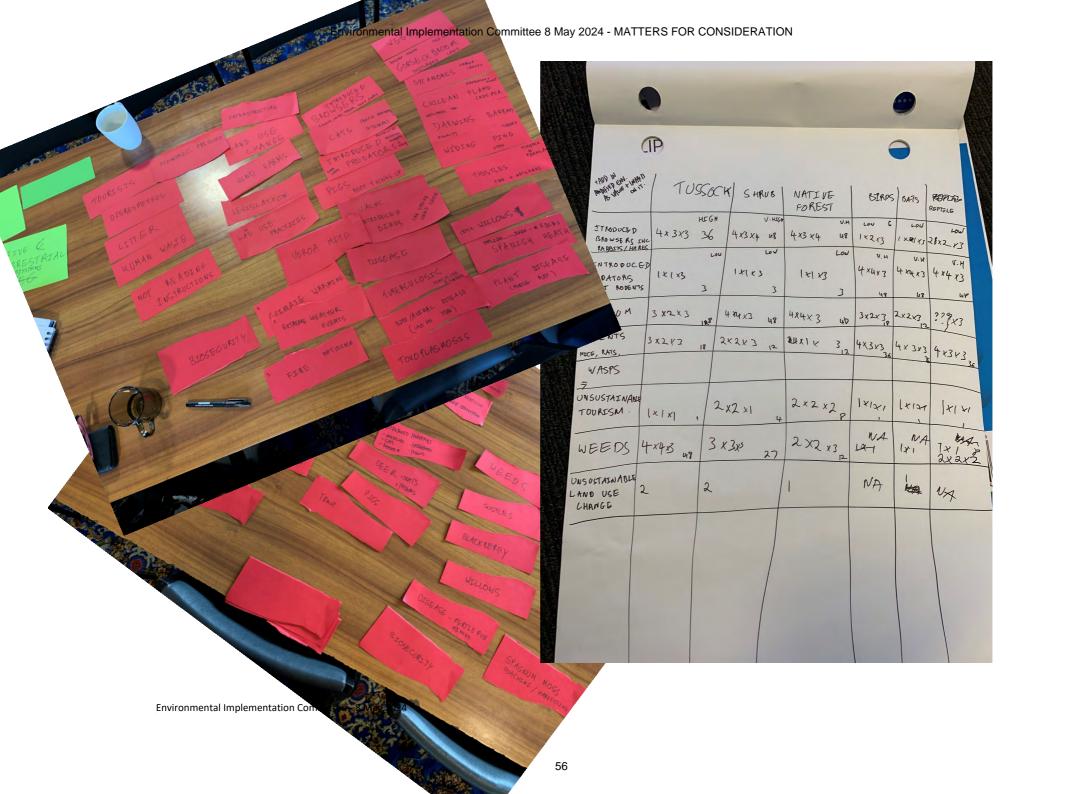


### Ranking pressures from Workshop 2

Ranking pressures in	UIII VVOIKS	nop z										
SCORES are calculated: Scope x severity x irreversibility	,	coastal and uarine	Water		Terrestrial ecosystems					Summary		
Values → Pressures↓	Marine species	Marine ecosystems	Freshwater	Wetlands	Tussock	Shrub	Native forest	Birds	Bats	Reptiles	threat rating	
Plastic pollution	4x3x4=48		3x3x3=27	3x3x3=27	n/a	n/a	n/a	n/a	n/a	n/a	34	High
Unsustainable land clearing practices												
	n/a	1x2x2=4	3x3x3=27	3x4x2=24	2x3x3=18	2x3x3=18	1x2x3=6	N/A	1x2x3=6	N/A	15	Medium
Introduced plants	N/A	2x2x3=18	1x1x3=3	2x3x2=18	4x4x3=48	3x3x3=27	2x2x3=12	N/A	N/A	2x2x2=8	19	Medium
Introduced mammals	4x3x2=24	n/a	4x3x4=48	2x3x2=18	4x3x3=36	4x3x4=48	4x3x4=48	4x4x3=48	4x4x3=48	4x4x3=48	41	Very high
Introduced fish	n/a	n/a	3x2x3=18	3x2x3=18	n/a	n/a	n/a	n/a	n/a	n/a	18	Medium
Introduced waterfowl												
	n/a	n/a	2x3x2=12	2x3x2=18	n/a	n/a	n/a	n/a	n/a	n/a	15	Medium
Unsustainable tourism	2x3x2=12	2x3x2=12	n/a	1x3x1=3	1x1x1=1	2x2x1=4	2x2x2=8	1x1x1=1	1x1x1=1	1x1x1=1	5	Low
Overharvesting (shellfish,												
freshwater crayfish and												
sphagnum moss)	2x4x2=16	n/a	2x4x2=16	1x3x1=1	n/a	n/a	n/a	n/a	n/a	n/a	12	Low
Contamination												
(unregulated sewage												
from homes, farm runoff,												
waterfowl excrement,	n/a	27772-12	2v2v2=10	27272-10	n/a	2/2	2/2	n/2	2/2	n/2	16	Modium
unsealed roads)	n/a	3x2x3=12	2x3x3=18	2x3x3=18	n/a	n/a	n/a	n/a	n/a	n/a	16	Medium













## **Crafting a Vision**

### **ORC** suggested vision

Catlins' locals are involved and connected to their place and can thrive here. Visitors and locals continue to sustainably enjoy the natural beauty, biodiversity, and landscapes that set the Catlins apart. The Catlins' ecologically rich environment is protected and enhanced and filled with native species.

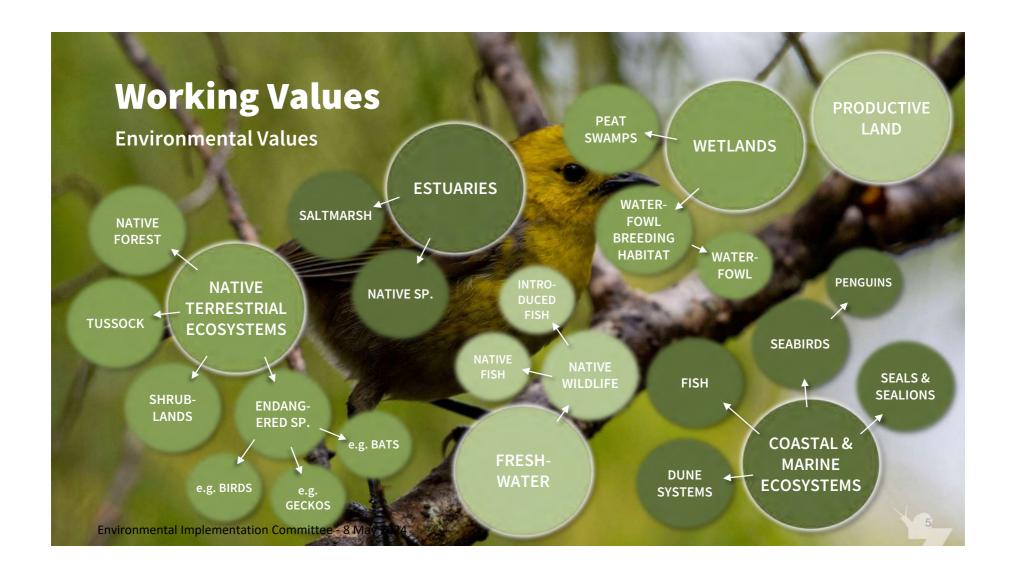
\*This does not include the suggested "safe access to waterways," "land use" and "integrated ownership" or "farming".

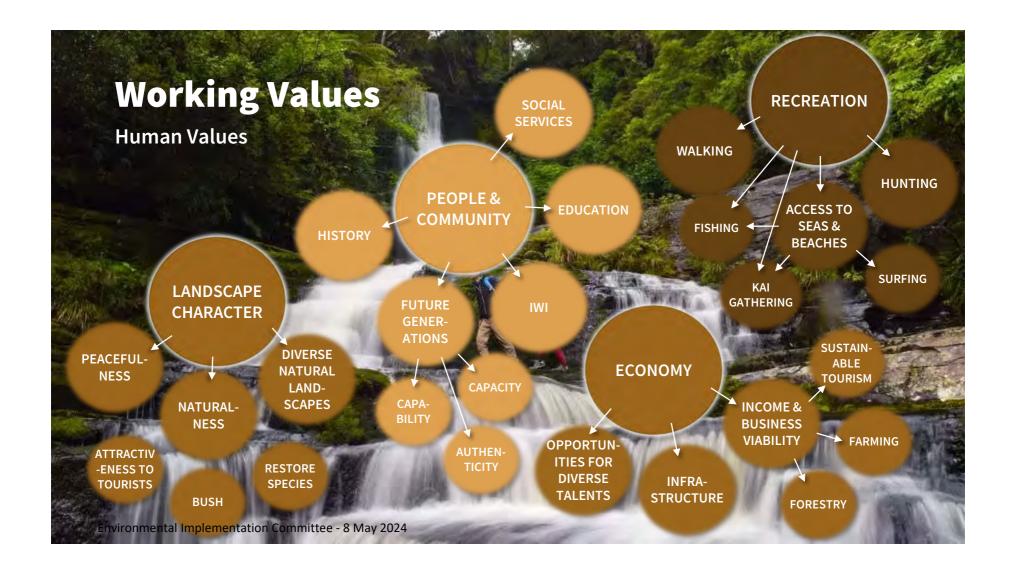
### **Alternative Suggestion One**

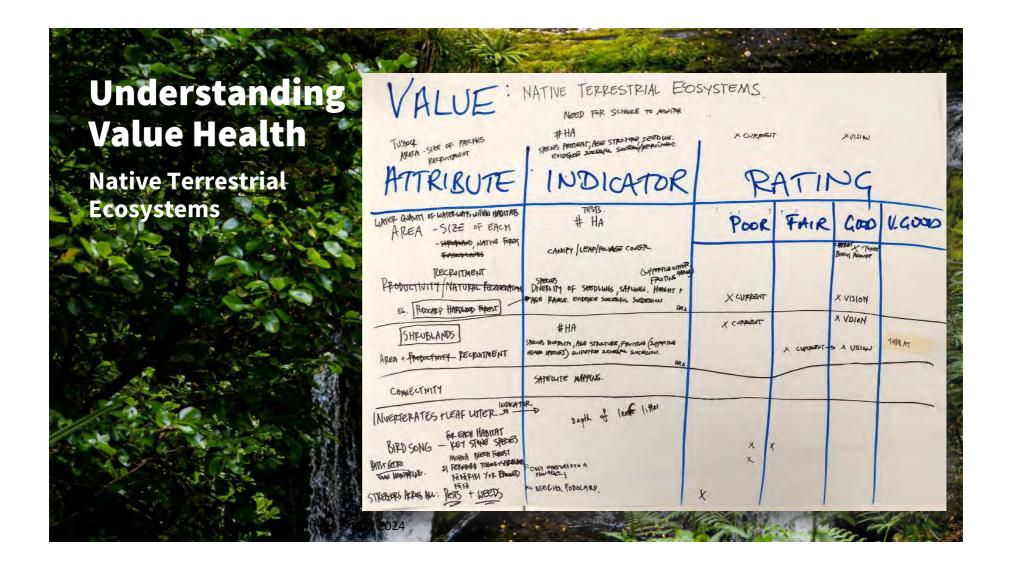
Deeply connected local communities thrive alongside soft-treading tourism within the enhanced native ecosystems that set the Catlins apart.

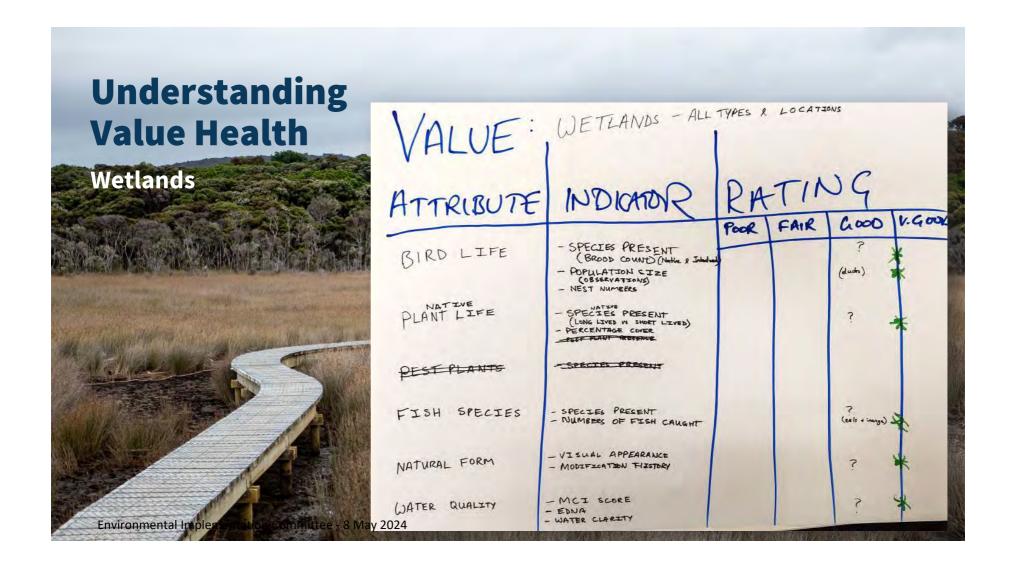
### **Alternative Suggestion Two**

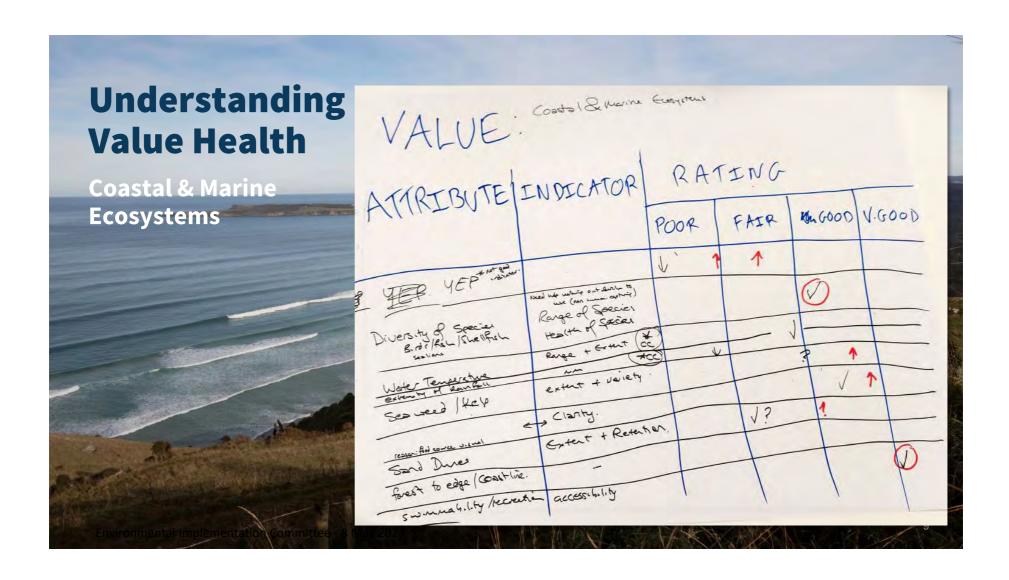
To enhance the health of the Catlins' environment so that residents and visitors can continue to enjoy the naturalness, beauty, biodiversity and landscapes that set this area apart.

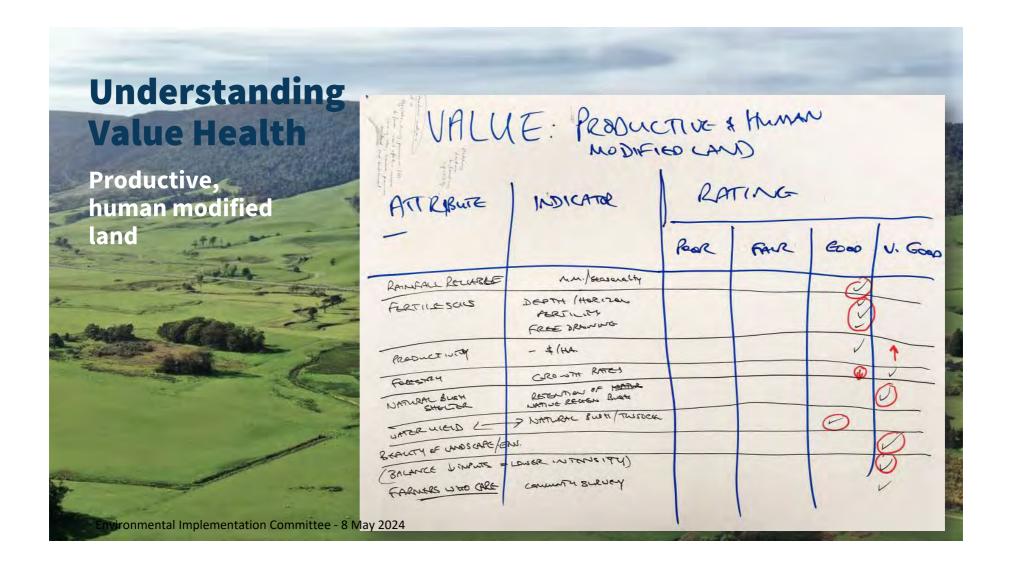


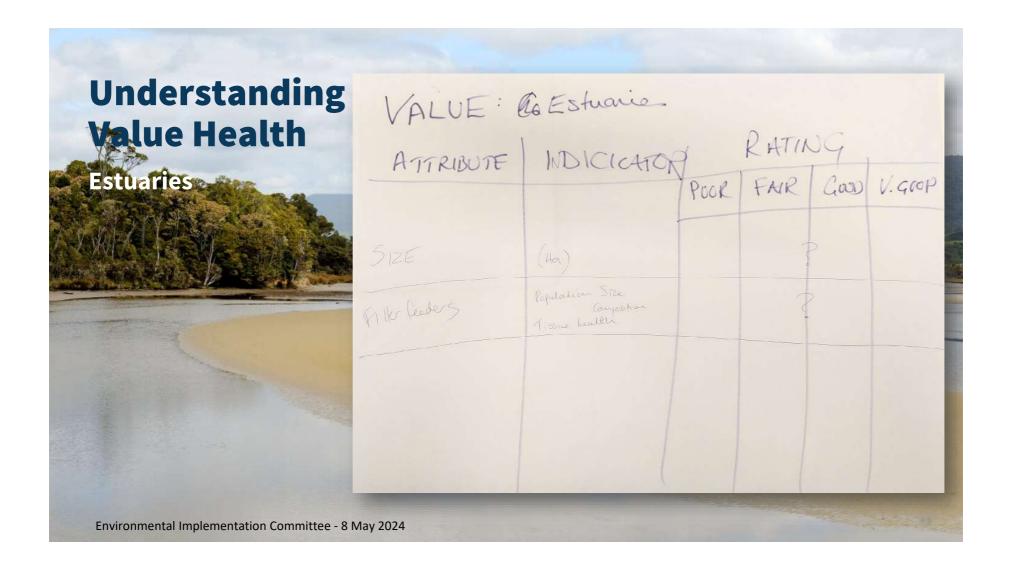


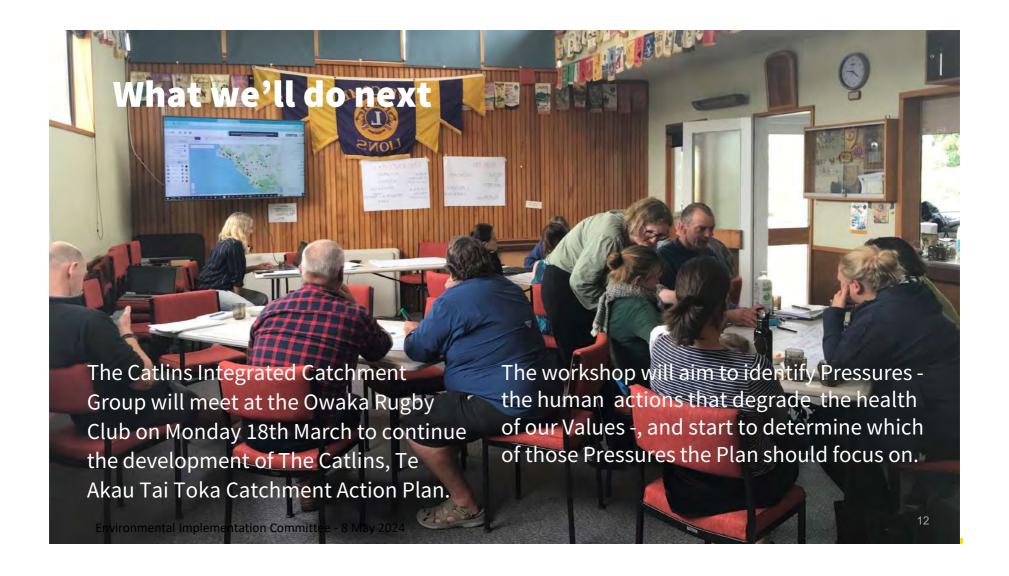












### 5 April 2024

# CATLIN'S CATCHMENT ACTION PLAN PROJECT EVALUATION PLAN

### **Background**

Integrated Catchment Management (ICM) takes a catchment perspective on natural resource management. The importance of ICM is signaled in the Otago Regional Council's 2021-2031 Long-Term Plan requiring ORC to lead "the development, implementation, and review of integrated Catchment Plans in collaboration with iwi and community" (ORC, 2021, p. 17). An ICM Working Group (ICMWG) is overseeing a pilot of the Catchment Action Plan (CAP) process in the Catlins Freshwater Management Unit (FMU). A CAP is a long-term management plan that builds on community, mana whenua and local government work to protect and manage the catchment as well as new actions and projects. A CAP is not solely focused on freshwater outcomes but the whole catchment including biodiversity, land, water (fresh and salt), ecosystem services and human well-being values (including mahika kai², wāhi tupuna³ and livelihoods)⁴.

As part of the Catlins CAP pilot project (October 2023 - October 2024), the ORC ICM Team will work with mana whenua and community to:

- Foster effective collaboration to ensure the CAP is 'owned' and strongly supported by a broad consensus among:
  - o Community representing interests including farming, biodiversity, tourism and forestry
  - o Mana whenua
  - Key stakeholders including the ORC, the Clutha District Council and the Department of Conservation
- Along with the above, develop a focused and adaptive CAP for the Catlins FMU that builds on the best available knowledge
- Enable accountability within the CAP monitoring progress and impacts
- Deliver a CAP development process and CAP that aligns with ORC plans and policies.

The ORC ICM Team will provide advice, administration, and facilitation support to the Catlins Integrated Catchment Group (CICG).

The ORC ICM Team has commissioned Emergence Hub to complete an external evaluation of the Catlins CAP development process to determine:

- The fitness for purpose of the processes used to develop the Catlins CAP (see quality criteria)
- The extent to which the CAP captures available knowledge<sup>5</sup> and strategies that represent the
  concerns, values, and interests of mana whenua, community, and stakeholders.

<sup>3</sup> Sites and areas of significance to Māori.

<sup>&</sup>lt;sup>1</sup> For more information about Integrated Catchment Management see - <a href="https://www.orc.govt.nz/managing-our-environment/integrated-catchment-management">https://www.orc.govt.nz/managing-our-environment/integrated-catchment-management</a>

<sup>&</sup>lt;sup>2</sup> Food gathering area.

<sup>&</sup>lt;sup>4</sup> For more information about the Catlins Integrated Catchment Group who will work with mana whenua and community to develop a Catchment Action Plan for the Catlins, see - <a href="https://www.orc.govt.nz/managing-our-environment/integrated-catchment-management/catlins-integrated-catchment-group">https://www.orc.govt.nz/managing-our-environment/integrated-catchment-management/catlins-integrated-catchment-group</a>

<sup>&</sup>lt;sup>5</sup> We recognise that there are different ways of knowing about ecosystems that are held by community, mana whenua and Western scientists.

The evaluation does not consider CAP effectiveness given that there is a significant lag between CAP activities and medium to long-term outcomes, and progress towards the CAP targets is a part of the CAP implementation process.

### **Evaluation purpose and use**

The evaluation will assess the adequacy of the planning and processes used to develop the Catlins CAP, and the extent to which mana whenua, community, and stakeholders feel ownership of, and support for, the CAP and its contents once developed. While this evaluation will not focus on the implementation of the CAP, it will enable the ORC to determine the success of the Catlins pilot CAP development process and provide the ICMWG and the ICM Team with information to adapt planning and engagement processes to improve future CAPs. Specifically, this evaluation will help:

- The ICM Team to continually update their practices, learn from their work and develop best practice guidelines
- The ICMWG to advise on improvements to the CAP design process
- Otago Regional Councillors to provide effective governance of the ICM Programme.

Having described the evaluation purpose and use we now turn to a description of the CAP development process as it informs the evaluation focus.

### Describing the system in focus - the CAP development process

ICM is a holistic, natural resource management philosophy that recognises that all the elements of an ecosystem, including the people, are connected. It enables a space for communities and mana whenua to agree on shared values for a catchment, make informed decisions and act collectively to manage natural resources. ICM is collaborative, evidence-informed, focused, accountable and adaptive.

### Establishment of the ORC ICMWG

An ICMWG was established to develop the framework for the CAPs and the collaborative platform for the development of the CAPs. The ICMWG has been meeting since February 2023 and its membership includes ORC Councillors and staff, mana whenua and the community.<sup>6</sup>

### Establishment of the CICG

The CICG is tasked with developing the CAP. The CICG has 15 members and represents diverse interests. It was formed with advice from the ICMWG using the following steps:

- Develop criteria to specify the desired experience, knowledge, sectoral and geographic representation of ICG members.
- Develop an open call for ICG membership based on a term of reference that outlines expectations and commitment.
- Hold a community meeting to explain the ICM and CAP processes to the Catlins community and interested stakeholders.
- Disseminate the call for expressions of interest in joining the CICG.
- Review Expressions of Interest for CICG membership.

<sup>&</sup>lt;sup>6</sup> For the Catlins CAP pilot, contact was made with Aukaha, Te Ao Marama, Otago Catchment Community Inc (OCC), Catlins Coast Inc, and the Owaka Catchment Group. All expressed an interest in being involved in the ICMWG in principle. Letters were sent to each group asking them to nominate a representative.

 Recommend appointments to ORC based on an assessment of all applicants against the desired skills and experience.

### Development of the CAP

The ICM team and CICG will meet monthly between October 2023 and October 2024 to develop the Catlins CAP. The ICM team will use the Conservation Standards (<a href="https://conservationstandards.org/about/">https://conservationstandards.org/about/</a>) and Miradi (<a href="https://www.miradishare.org/ux/home">https://www.miradishare.org/ux/home</a>) to develop the CAP with the CICG through a series of workshops. The Conservation Standards are an internationally developed set of principles and practices that provide a framework for developing focused and effective conservation plans with communities.

### Assumptions and external influences

This section clarifies assumptions and external influences. Assumptions are those circumstances that must be 'true' to ensure quality criteria are met. External influences are those factors that can have a positive or negative impact on the ability to meet quality criteria (see Table 1).

#### Assumptions

Assumptions related to the quality criteria being realised include:

### Selection of CICG members

- There are effective outreach and communication strategies in place to ensure that all potential stakeholders are aware of and can participate in the selection process.
- Inclusivity and accessibility in the selection process lead to better decision-making and outcomes because of the diverse inputs.
- The community values inclusivity and is willing to engage in a process that might be more timeconsuming and complex to ensure broad representation.

### Governance and decision-making

- There are established mechanisms (e.g., workshops, public forums, online platforms) that facilitate effective communication and participation.
- Stakeholders are willing to engage in a constructive dialogue and compromise when necessary.
- Effective governance and decision-making processes are recognised as foundational for the success of the CAP.

### CAP development processes (inclusive and meaningful engagement)

- Engaging stakeholders in a meaningful way leads to more effective and sustainable outcomes.
- Participants are motivated by the opportunity to contribute to environmental and community well-being.
- The process is designed to be accessible and accommodating to the needs of all participants, including consideration of language barriers, physical accessibility, and timing of meetings.

### Completed CAP

- Integrating diverse knowledge systems leads to more comprehensive and effective environmental management solutions.
- There is respect and openness among stakeholders to learn from and utilise different types of knowledge.

 Mechanisms are in place to accurately translate and incorporate traditional and local knowledge into the planning process alongside scientific data.

### **External influences**

The ability to meet quality criteria associated with development of the CAP might be affected by the following external influences:

### Positive influences

- Legislation and policies that encourage community involvement in environmental management and provide a supportive framework for CAP development.
- Adequate funding and resources allocated for CAP development can enable thorough engagement processes and ensure that the plan is comprehensive and well-informed.
- Active local networks and community organisations can facilitate broader participation and ensure that local and te ao Māori knowledge is effectively incorporated into the CAP.

### Negative Influences

- Shifts in political priorities or leadership can affect the continuity and support for CAP initiatives, potentially undermining the process and its outcomes.
- Economic downturns or budget cuts can limit the resources available for CAP development, reducing the scope of engagement activities and the quality of the plan.
- Pre-existing social or cultural tensions within a community can hinder participation and collaboration, particularly if segments of the community feel marginalised or distrustful of the process.
- Natural disasters or the broader impacts of climate change can shift focus and resources away from long-term planning initiatives like CAPs to more immediate disaster response and recovery efforts
- If the public is not adequately informed about the importance of catchment management or does not perceive it as a priority, engagement in the CAP development process may be low.

### **Evaluation schema**

Table 1 on the next page provides an evaluation schema that sets out quality criteria and evaluation questions to guide the evaluation<sup>7</sup> (contextualised to evaluation purpose and use), and the data collection methods (to ensure robust findings). A project timeline is then presented.

The schema is indicative only, but used as a tool to help focus the evaluation. The schema's key evaluation questions will shape the questions asked of specific stakeholders and mana whenua at mid and end point of the CAP development processes. These interview questions will be included in the interview guides which will be reviewed and tested to ensure suitability of questions and accessibility by potential interviewees.

<sup>&</sup>lt;sup>7</sup> The evaluation criteria and questions were derived from the evaluation team's own experience and research, documents provided by the ORC ICM team and discussions between the evaluation team and ICM team in developing the Evaluation Plan.

Table 1: Evaluation schema

Quality Criteria 1 - Recruitment and selection process			Met	hods	
The recruitment and selection processes are transparent, inclusive, and strategically designed to attract and identify candidates who not only possess a diverse range of necessary technical skills, experience, and local knowledge but also reflect the community affected by the CAP. There is clear communication of roles, expected contributions, and selection criteria, as well as mechanisms to		Document review <sup>8</sup>	Online interview ICMWG members (n=up to 3)	Online interview ICM team (n= up to 3)	Online interview CICG members (n=up to 15) <sup>9</sup>
ensure diversity and process. <b>Key evaluation</b>	inclusivity in the selection  Evaluation questions				
question How effectively did the recruitment and selection process identify and onboard CICG members with the	How effective were channels and methods used to put out a call for an Expression of Interest (EOI) for CICG membership in reaching mana whenua, community, and stakeholders?			V	٧
diverse skills, experiences, and knowledge necessary for the comprehensive	How effective was messaging about the purpose of the CICG and roles and responsibilities of CICG members?	٧	٧	٧	٧
development of the Catlins Catchment Plan (CAP)?	How well did selection criteria and processes ensure that selection of CICG members was transparent and equitable?	٧	٧	٧	٧
	How well did the initial composition of the CICG reflect a balance of technical expertise, local knowledge, and stakeholder and mana whenua representation necessary for CAP development?		٧	٧	V

 $<sup>^8</sup>$  The ORC ICM Team will provide documents which are relevant to the evaluation questions (e.g., meeting minutes, reports, or policies) to the evaluation team. A guide for document collection is attached as Appendix A. <sup>9</sup> There will be an option of face-to-face interviews if necessary.

Quality Criteria 2	- Decision-making		Met	hods	
The decision-making	g processes of the ORC ICM	Document	Online	Online	Online
team facilitate clear	team facilitate clear, efficient, and effective		interview	interview	interview
communication and	collaboration among CICG		ICMWG	ICM team	CICG
members. There are	e defined roles and		members	(n= up to	members
responsibilities, and	transparent decision-making		(n=up to 3)	3)	(n=up to
protocols that encor	urage consensus-building, and				15) <sup>10</sup>
the presence of effe	ctive conflict resolution				
mechanisms that en	sure all voices are heard and				
valued. High quality	decision making is critical to				
good governance.					
Key evaluation	Evaluation questions				
question	How well defined and			٧	٧
How well did the	understood were roles and				
decision-making	responsibilities of the ICM				
processes within	team and CICG members by				
the CICG foster	CICG members?				
efficiency,	How well did the processes	√	٧	V	V
transparency, and	used in developing the CAP				
inclusiveness in	ensure that decision-making				
the CAP	was participatory,				
development	transparent, based on				
process?	consensus or informed				
	agreement and reflected local				
	priorities and broader				
	legalisation and planning				
	instruments?				
	How well did processes used	√	٧	√	V
	address disagreements or any				
	conflicts, if any, within the				
	CICG?				
	To what extent did the	√	٧	√	٧
	processes used in developing				
	the CAP build on existing				
	environmental work and				
	leverage ORC science				
	expertise?				

 $<sup>^{\</sup>rm 10}$  There will be an option of face-to-face interviews if necessary.

Quality Criteria 3 - CAP development			Met	hods	
processes and too	processes and tools				
The development processes and tools enable and enhance productive collaboration, engagement, and information sharing among all CICG members. This encompasses the suitability, accessibility, and usability of tools and methodologies to support a collaborative environment, facilitate effective communication, and ensure the CAP development process is agile and responsive to emerging insights and CICG member feedback.		Document review	Online interview ICMWG members (n=up to 3)	Online interview ICM team (n= up to 3)	Online interview CICG members (n=up to 15) <sup>11</sup>
Key evaluation	Evaluation questions				
question How well did the development processes and the methods used to facilitate meaningful engagement and collaboration among CICG members, lead to steady progress in	How well did processes used for developing the CAP allow CICG members to contribute their diverse skills, experiences, and knowledges?  What tools were employed to support the CAP development process, and how effective were they in addressing bottlenecks to the CAP's development?	٧		V	٧
the CAP's development?	Were there any tools that were difficult to use and did not support the CAP development process. How did this affect the CAP development process in terms of timing, quality, and confidence in outputs?	٧		٧	٧

 $<sup>^{\</sup>rm 11}\, {\rm There}$  will be an option of face-to-face interviews if necessary.

Quality Criteria 4 - The developed Catlins CAP		Methods			
The completed CAP comprehensively reflects the values, concerns, and aspirations of a wide range of stakeholders, mana whenua, and community members representing a balanced consideration of diverse perspectives and interests. This includes a demonstrable integration of stakeholder and mana whenua input throughout the CAP document, clear responsiveness to identified issues and solutions, and evidence of efforts to reconcile differing viewpoints in a manner that respects and values		Document review	Online interview ICMWG members (n=up to 3)	Online interview ICM team (n= up to 3)	Online interview CICG members (n=up to 15) <sup>12</sup>
community and envi	ironmental well-being.  Evaluation questions				
question To what extent does the completed CAP accurately reflect the broad spectrum of values, issues, and potential solutions identified as	How effectively does the CAP address the key concerns and priorities identified by participants throughout the CAP development process?  Were stakeholder, mana whenua, and community feedback and contributions appropriately incorporated into the final CAP?	V	٧	V	V
important by stakeholders, mana whenua, and community	How effectively does the CAP incorporate and reflect mana whenua values traditional knowledge, and interests?	٧	٧	٧	٧
members involved in the CAP development process?	To what extent are the limitations of the CAP understood and documented?	٧	٧	٧	٧

 $<sup>^{\</sup>rm 12}$  There will be an option of face-to-face interviews if necessary.

# **Evaluation activities timeline**

Evaluation activities	Who	When 2024
Attend a CICG meeting to gain an appreciation of context, introduce the evaluation, and encourage participation in interviews	Evaluation team members (up to 3)	29 April
Review documents	ICM Team provide documents to the evaluation team (see Appendix B)	6 May (documents to date)
Interview:     CICG members (up to 15)     ICM Team (up to 3)	Evaluation team develops fieldwork documents such as the consent form, information sheet, and interview guides for sign off by the ORC ICM team	12 April
ICMWG (up to 3)	ORC ICM team provides feedback on fieldwork documents	19 April
	Evaluation team makes any revisions	26 April
	Evaluation team contacts potential interviewees, books interviews and provides information sheet and consent form	1 - 3 May
	Evaluation team completes interviews, analyses data, and includes findings in Mid Evaluation Report	7 - 28 May
Mid Evaluation Report due	Draft report provided to the ORC ICM team	17 June
	ORC ICM team provides feedback	24 June
	Evaluation team finalises the report	27 June
Attend a CICG meeting	Evaluation team members (up to 3)	September
Review documents	ICM Team provide documents to the evaluation team (see Appendix B). Documents from 9 May to final documentation associated with the development of the CAP	October (after final CICG meeting)
Interview:	Evaluation team completes interviews, analyses	October -
<ul><li>CICG members (up to 15)</li><li>ICM Team (up to 3)</li></ul>	data, and includes findings in draft Evaluation Report	November
	Draft report provided to the ORC ICM team	6 December
	ORC ICM Team provides feedback	13 December
Final Evaluation Report due	Evaluation team finalises the report	20 December

# **KEY CONTACT**

Dr Andrea Clark, Managing Director and Senior Consultant, Emergence Hub Email: <a href="mailto:andrea@emergencehub.co.nz">andrea@emergencehub.co.nz</a>

Mobile: 021 224 5855

#### **APPENDIX A**

# Document collection guide

This document sets out the types of documents that the evaluation team would like the ORC ICM team to provide for review as part of the Catlins CAP evaluation<sup>13</sup>. Documents are listed under headings associated with key evaluation criteria from the Evaluation Plan for this project. Document collection processes are then outlined.

#### **Documents**

#### A. Selection of CICG Members

#### Documents:

- Call for participation notices and advertisements
- Selection criteria documentation
- Applications or expressions of interest received
- Meeting minutes or records detailing decision-making processes for member selection
- Communications materials (emails, newsletters) regarding member recruitment.

#### B. Governance and decision making

#### Documents:

- · Governance structure documentation, including the terms of reference, roles and responsibilities
- Meeting agendas and minutes documenting discussions around key decisions and the key decisions itself
- Reports or updates provided to CICG members and stakeholders

# C. CAP development processes and tools

#### Documents:

- Workshop summaries etc
- Assessments of engagement activities (e.g., notes taken by facilitators).

# D. The developed Catlins CAP

# Documents:

- Drafts and final versions of the CAP, highlighting sections where mātauranga Māori, local community knowledge, and scientific evidence are integrated
- · Contributions or submissions from mana whenua, community groups, and scientific experts
- Meeting records or notes detailing discussions on knowledge integration.

# **Document Collection Guidelines**

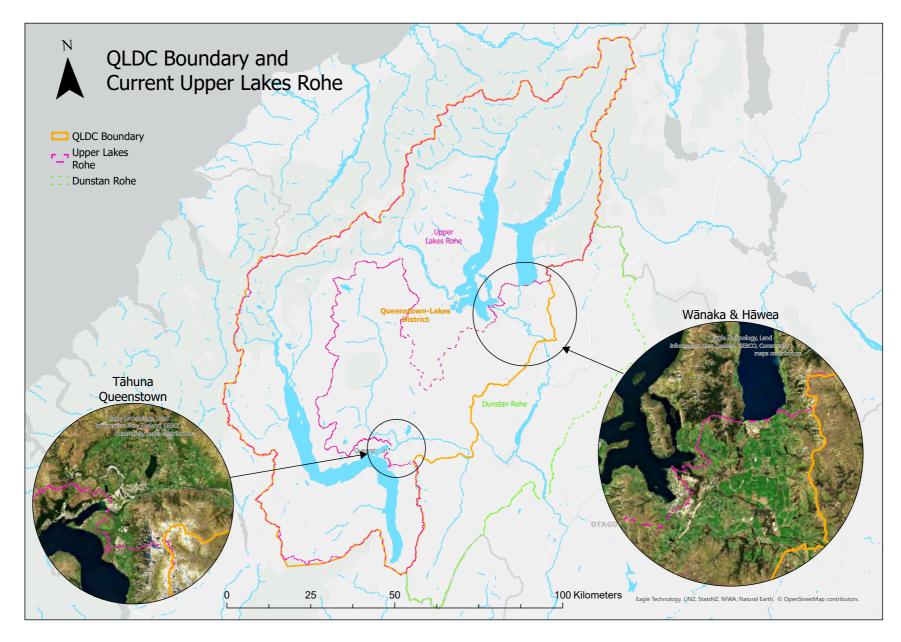
We suggest that the following processes are followed in document collection.

• Organisation: Categorise and label documents according to the relevant evaluation question area (A., B., C., or D. above) to facilitate easy retrieval and review.

<sup>&</sup>lt;sup>13</sup> Please email documents to Dr Andrea Clark (andrea@emergencehub.co.nz).

- Source Identification: Note the source of each document, including the date it was created or received, to assess its relevance and context.
- Confidentiality: Ensure any sensitive information is handled according to ethical guidelines, with appropriate permissions obtained for use<sup>14</sup>.
- Comprehensiveness: Aim to collect a broad range of documents to capture the full scope of activities, decisions, and contributions related to the CAP development.

<sup>&</sup>lt;sup>14</sup> Emergence Hub will store any information provided in a secure password protected platform.



Environmental Implementation Committee - 8 May 2024

# 9.3. Marine Biosecurity

**Prepared for:** Environmental Implementation Committee

Report No. OPS2406

Activity: Governance Report

Sarah Irvine, Team Leader – Environmental Implementation Project

**Author:** Delivery, Duncan Campbell, Biosecurity Specialist – Marine and Freshwater,

Libby Caldwell, Manager – Environmental Implementation

**Endorsed by:** Gavin Palmer, General Manager Operations

**Date:** 8 May 2024

#### **PURPOSE**

[1] To provide an update on progress on the development of an Otago marine biosecurity programme.

#### **EXECUTIVE SUMMARY**

- [2] Invasive marine pest species are a significant potential threat to Otago's marine ecosystems. Once a species is introduced to a region, it is extremely difficult to remove it and the damage could have devastating effect on Otago's native biodiversity, marine industries, water quality, and mahika kai sites. It is therefore important to prevent pest incursion and spread through pathway management, surveillance, and monitoring.
- [3] Regional leadership of marine biosecurity is the responsibility of regional councils under Section 12B of the Biosecurity Act 1993<sup>1</sup>. ORC does not currently have a formal marine biosecurity programme and there is no existing management programme for marine pests in the Otago Regional Pest Management Plan (RPMP)<sup>2</sup>. Informally however work has been undertaken by staff. This work is detailed in the report.
- [4] Connection with iwi and rūnaka representatives has been initiated to explore opportunities for development of a marine biosecurity programme in Partnership with Kāi Tahu. A scoping exercise has also been undertaken to investigate roles and responsibilities in the marine biosecurity space, develop actions required to build foundations for marine biosecurity and pathway management in Otago, and provide preliminary recommendations for future actions to develop an effective marine biosecurity programme for Otago to reduce marine pest threats and risks.
- [5] This paper provides an update of the scoping exercise and actions completed to date.

#### **RECOMMENDATION**

<sup>&</sup>lt;sup>1</sup> Biosecurity Act 1993. 12B Regional council provides leadership regionally. (1) A regional council provides leadership in activities that prevent, reduce, or eliminate adverse effects from harmful organisms that are present in New Zealand (*pest management*) in its region. (2) The ways in which the regional council provides leadership in the region include—(a) promoting the alignment of pest management in the region: (b) facilitating the development and alignment of regional pest management plans and regional pathway management plans in the region: (c) promoting public support for pest management: d) facilitating communication and co-operation among those involved in pest management to enhance effectiveness, efficiency, and equity of programmes. (3) A regional council also provides leadership by promoting co-ordination of pest management between regions.

<sup>&</sup>lt;sup>2</sup> There are eight marine pest species identified as Organisms of Interest in the RPMP. An Organism of Interest is a species that is capable of causing adverse effects, particularly to biosecurity values. It warrants being watch-listed for ongoing surveillance or future control opportunities, but has not been given the status of pest in the RPMP.

That the Environmental Implementation Committee:

1) **Notes** this report.

# **BACKGROUND**

The Otago Coastal Marine Area (CMA)/ Te Tai o Arai Te Uru extends 480km from the Waitaki Fan southward to Wallace Beach, extending 12 nautical miles (22.2km) from shore to the boundary of the territorial sea. This area includes significant ecological zones, taoka species, mahika kai sites, threatened ecological communities, and various proposed marine reserves, mātaitai and taiāpure customary reserves. There are five coastal development areas including a major port that has significant international and national commercial and recreational vessel traffic (>100 vessels per year) (Figure 1).

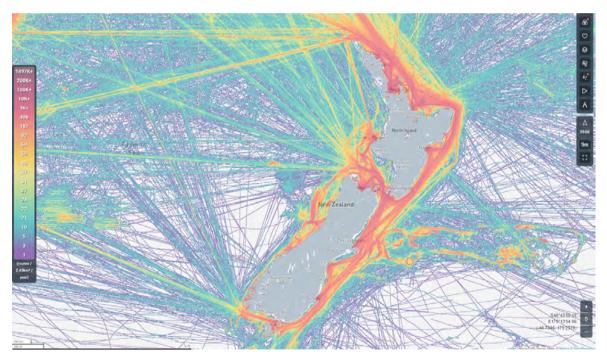


Figure 1. The Otago Coastal Marine Area including sites of interest to marine biosecurity.

[7] Invasive marine pest species are a significant potential threat to Otago's marine ecosystems. Invasion and spread of marine pests can cause negative biodiversity impacts, including predation and outcompeting native marine species for habitat and food resources; introducing and spreading diseases and parasites that can affect native

species and aquaculture; and causing physical damage, such as blocking pipework. Once marine pests become established, it is nearly impossible to eradicate them and the damage could have devastating effect on Otago's native biodiversity, marine industries, water quality, and mahika kai sites. The most cost-effective process is exclusion as marine pest invasion is likely to result in significant costs in terms of industry, infrastructure and through long-term management<sup>3</sup>.

- [8] Regional leadership of marine biosecurity is the responsibility of regional councils under Section 12B of the Biosecurity Act 1993<sup>4</sup>. This includes risk mitigation and threat management once harmful organisms, already present in New Zealand, arrive in a new region.
- [9] Maritime transport is a major pathway for marine pests to invade and spread throughout the Otago CMA, primarily through biofouling and ballast water discharge. Otago's CMA observes a significant amount of international and national commercial and recreational vessel traffic (>100 vessels per year)<sup>5</sup> from large harbours such as Marsden Point, Waitematā Harbour, Picton, Lyttelton and Bluff (Figure 2). Artificial structures, such as pilings and moorings in coastal development areas, such as ports, harbours, marinas, and wharves, are potential incursion sites, providing ideal substrate for marine pests to establish.



<sup>&</sup>lt;sup>3</sup> Economic costs of pests to New Zealand, 2020 Update, Ministry for Primary Industries.

<sup>&</sup>lt;sup>4</sup> Biosecurity Act 1993. 12B Regional council provides leadership regionally. (1) A regional council provides leadership in activities that prevent, reduce, or eliminate adverse effects from harmful organisms that are present in New Zealand (*pest management*) in its region. (2) The ways in which the regional council provides leadership in the region include—(a) promoting the alignment of pest management in the region: (b) facilitating the development and alignment of regional pest management plans and regional pathway management plans in the region: (c) promoting public support for pest management: d) facilitating communication and co-operation among those involved in pest management to enhance effectiveness, efficiency, and equity of programmes. (3) A regional council also provides leadership by promoting co-ordination of pest management between regions.

<sup>&</sup>lt;sup>5</sup> Ministry for Primary Industries. 2009. Vessel Movements within New Zealand. Evaluation of vessel movements from the 24 ports and marinas surveyed through the port baseline survey programmes.

# Figure 2. Shipping route density (routes/2.45km²/year) between domestic and international ports/marinas in New Zealand. Information provided from https://www.marinetraffic.com/

- [10] Other regions across New Zealand have formal marine biosecurity programmes in place. The lack of this being present in Otago could increase the biosecurity risk to other regions. As there is currently minimal surveillance and monitoring of marine pest species within Otago, vessels which enter our waterways may be carried to some of these other areas. A specific example of an area at risk is Fiordland where there is a Fiordland Marine Regional Pathway Management Plan which has been developed by Environment Southland, The Fiordland Marine Guardians, Ministry for Primary Industries, Department of Conservation and Te Rūnanga o Ngāi Tahu. This was adopted in April 2017 with the aim of protecting one of New Zealand's most unique and nationally significant areas. Figure 2 above shows this possible risk through the vessel traffic which comes into Otago and then carries on to Fiordland.
- [11] ORC does not currently have a formal marine biosecurity programme and there is no existing management programme for marine pests in the Otago Regional Pest Management Plan 2019-2029 (RPMP)<sup>6</sup>. Currently, the only marine pest surveillance in Otago is completed as part of the Biosecurity New Zealand (BNZ) National Marine High Risk Site Surveillance (NMHRSS) programme. This programme is restricted to the Port Area of the Otago Harbour, with biannual surveillance primarily targeting pests not yet present in New Zealand. ORC is not aware of any other marine pest surveillance or monitoring currently being undertaken in Otago.
- [12] An initial scoping exercise to determine marine species threats and management approaches was identified as a priority project in the ORC Biosecurity Strategy, 2019 and actions required to progress this were defined (Figure 3).
- [13] The ORC Biosecurity Strategy was predicated on a national pathway plan being developed. At this stage a national pathway plan is not progressing with Biosecurity New Zealand (BNZ) but they have recently advised that they can support development of cross regional pathway plans. Staff are working with BNZ to see what this support would look like in detail.
- [14] Staff believe that a national pathway plan would be beneficial. This would make it clear to all vessels what the rules are that apply across the country. However, in the absence of a national pathway plan, staff are currently working with neighbouring regional Councils (Environment Canterbury and Environment Southland) and are in active discussions about developing -regional marine pathway plans which are aligned. The benefits of a bottom of the south pathway plan are that some of the detail within this can be specific to the South Island as some of these may be unique or different to those faced by the North Island.

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<sup>&</sup>lt;sup>6</sup> There are eight marine pest species identified as Organisms of Interest in the RPMP. An Organism of Interest is a species that is capable of causing adverse effects, particularly to biosecurity values. It warrants being watch-listed for ongoing surveillance or future control opportunities, but has not been given the status of pest in the RPMP.

Partner with other regional councils to actively advocate for a national marine pathway management plan to minimise the risk of marine pest spread. If a national plan is not instigated:

- look to partner with adjacent councils to develop a sub-national plan;
- or a regional pathway management Plan or a change to the Regional Pest Management Plan.

ORC will undertake an initial scoping exercise to determine marine species threats in the Otago Harbour and the wider Otago area to determine what management approaches may be appropriate in the Pathway Management Plan.

Figure 3. Priority Project Action details, ORC Biosecurity Strategy, 2019

## **DISCUSSION**

- [15] Although there is no formal marine biosecurity programme in Otago currently, informal work has occurred and is detailed in this section.
- [16] Connection with iwi and rūnaka representatives was initiated to explore opportunities for development of a marine biosecurity programme in partnership with Kāi Tahu. In August 2023, ORC staff were invited to attend the East Otago Taiāpure Komiti Hui with members from Kāti Huirapa Rūnaka ki Puketeraki, University of Otago, and representatives of the community. The East Otago Taiāpure Management Committee aims to establish appropriate sustainable management measures and structures to protect the East Otago Taiāpure. There was in principle support for the development of a marine biosecurity programme in Otago provided at this hui.
- [17] A scoping exercise has been undertaken to investigate roles and responsibilities in the marine biosecurity space, develop actions required to build foundations for marine biosecurity and pathway management in Otago, and provide preliminary recommendations for future actions to develop an effective Otago marine biosecurity programme. Details of this exercise are included in the *Otago Marine Biosecurity Action Plan*, 2023 (Appendix 1) and following is a progress update of some of the key actions.
- [18] A Marine Biosecurity Engagement Plan (Appendix 2) was developed to identify key stakeholders in the marine biosecurity space to build relationships and networks, identify opportunities for pathway management, and increase public awareness of marine pests.
- [19] Engagement with other regional councils, the University of Otago, and key agencies, such as BNZ, NIWA, and Department of Conservation (DOC) has been initiated and is ongoing. To date, this has mainly been through individual meetings with each council, agency, and council alliance, such as Top of the North. ORC has also provided representation on the BNZ National Marine Biosecurity Partnership and National Marine Behaviour Change groups, attending regular meetings.
- [20] In 2022, a University of Otago student completed a summer studentship project through ORC, to identify marine pest threats to Otago and identify high-risk pathways. The results of this project identified 15 different marine pest threats to Otago and artificial structures, such as vessels, wharves, and aquaculture operations as high-risk pathways. In addition, the report identified five high-risk potential invasion areas of the Otago coastline and recommended development of a surveillance plan, in collaboration with stakeholder agencies, to monitor these high-risk areas (Appendix 3).

- In 2023, a University of Otago student completed a summer studentship project through ORC, providing a summary of the current known distribution and impacts of an invasive seaweed, Undaria (*Undaria pinnatifida*), along the Otago coastline. The student also conducted surveys of sites from Otago Peninsula to Chaslands where Undaria has not previously been observed, but were areas considered to be at high-risk for invasion. The results of this project did not indicate spread of Undaria into the surveyed high-risk locations. However, it highlighted that there is very limited surveillance for invasive marine species undertaken in Otago, identifying the current national NMHRSS monitoring programme as the only surveillance tool and that it is restricted to the Port Area of the Otago Harbour. The conclusions highlighted that a careful risk assessment, surveillance plan, and response plan is needed for secondary ports and areas of high anchorage used by smaller vessels (Appendix 4).
- To increase knowledge of marine pest species and increase capability within the ORC biosecurity team, staff attended a marine pest species ID workshop hosted by BNZ and NIWA. Following this, ORC staff investigated opportunities to authorise biosecurity staff to undertake marine pest related inspections and collect samples of potential invasive species for identification. Staff have undertaken training to collect samples and authorisation of officers will be progressed. In addition, an ORC Biosecurity Officer attended the annual MHRSS undertaken by NIWA in the Otago Harbour to increase knowledge of surveillance methods and staff have connected with the Harbourmaster to undertake a field trip in the Otago Harbour to explore inter-team coordination and view some potential issues/pathways from the water.
- [23] ORC staff have been advocating for a national marine pathway management plan for at least the last three years. It is understood that BNZ is intending to develop a national marine biosecurity strategy and roadmap to provide guidance for marine biosecurity but, at this stage, is not intending to develop a nationwide pathway management plan. ORC staff have been collaborating with neighbouring regional councils to support development of -regional pathway management plans which are aligned. This is ongoing.
- [24] Increasing public awareness is also important as education and advocacy build community capability. Citizen science opportunities have been identified through the Enviroschools and the Marine Science Studies Centre Marine Metre Squared (MM²) programmes. Development of a communications plan is a proposed action to increase public awareness. In the meantime, existing BNZ marine biosecurity signage has been installed at five sites, including Careys Bay, Deborah Bay, Back Beach, Otago Yacht Club, and Karitane. Additional signage is to be installed at Moeraki and an evaluation will be completed of other potential high-risk sites for future installations.
- [25] Maps identifying potential incursion sites and areas of significant cultural and ecological significance have been developed to guide potential pest surveillance activities (Appendix 5). It is proposed that a surveillance plan is developed for each of the five high-risk incursion sites.
- [26] A Biosecurity Specialist Marine and Freshwater position has been established and employment in this role commenced on the 18<sup>th</sup> March 2024. A key element of this role is to develop and implement ORC's marine biosecurity strategic and operational programmes.

- [27] It is recommended that ORC continue to progress development of a marine biosecurity programme, in partnership with Kāi Tahu, for the Otago region to reduce marine pest threats and risks.
- [28] The draft Long Term Plan 2024-2034 includes funding to develop an Otago Marine Biosecurity programme (Appendix 1). This includes \$50,000 in year one, \$100,000 in year two and \$200,000 in year three with \$200,000 ongoing per annum. This proposed budget sits in the Environmental Implementation Teams Biosecurity work area.

#### **CONSIDERATIONS**

# **Strategic Framework and Policy Considerations**

[29] This paper will need to be considered as part of the Harbour Plan work which is being led by the Strategy team.

#### **Financial Considerations**

- [30] This paper updates progress of marine biosecurity and pathway management actions from the Biosecurity Strategy 2019 and outlines the recommendations for continued development of an Otago marine biosecurity programme. Budget consideration has been provided for in the draft Long-Term Plan 2024-2034. The budget for development of a marine biosecurity programme for Otago that was included is:
  - i. Year 1 (24/25) \$50,000
  - ii. Year 2(25/26) \$100,000
  - iii. Year 3(26/27) and ongoing for duration of the plan \$200,000

# **Significance and Engagement**

[31] This paper does not trigger ORC's policy on Significance and Engagement.

# **Legislative and Risk Considerations**

[32] Actions to date and the recommendations fulfil the actions of the ORC Biosecurity Strategy 2019 and ORC responsibilities under the Biosecurity Act, 1993.

## **Climate Change Considerations**

[33] Impacts of climate change, such as marine heatwaves, sea level rise, salinity stresses, and changes in ocean chemistry may favour population growth and range expansion of marine pests increasing the threat of marine pest species in Otago, and pre-disposing native species to increased predation and competition from invasive species. (Otago Climate Change Risk Assessment, 2021).

#### **Communications Considerations**

[34] Networking with other Regional Councils and agencies will continue to develop and the marine biosecurity engagement plan (Appendix 2) will be implemented.

#### **NEXT STEPS**

- [35] Further engagement with mana whenua partners will commence immediately and an approach will be developed over the next six months.
- [36] Following this, further engagement with key stakeholders will occur to inform the development of a marine biosecurity programme for Otago.

- [37] Implementation of the marine biosecurity engagement plan (Appendix 2) will commence immediately.
- [38] Staff will continue to attend and be involved in national marine biosecurity programmes.
- [39] Discussion will continue with BNZ staff to see what support Otago is able to obtain via funding, tools and capability to support increasing ORC's presence in the marine biosecurity space.
- [40] Once a marine biosecurity programme is drafted it will be brought back to the Environmental Implementation Committee for further discussion and endorsement.

# **ATTACHMENTS**

- 1. Appendix 1 Otago Marine Biosecurity Action Plan 2023 [9.3.1 8 pages]
- 2. Appendix 2 Marine Biosecurity Engagement Plan 2023 [9.3.2 7 pages]
- 3. Appendix 3 Summer Studentship 2022 Marine Pest Threats [9.3.3 45 pages]
- 4. Appendix 4 Summer Studentship 2023 Undaria [9.3.4 32 pages]
- 5. Appendix 5 Marine Biosecurity Maps 2024 [9.3.5 5 pages]



# **Otago Marine Biosecurity**

# Action Plan, 2023

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# Purpose

An initial scoping exercise to determine marine species threats and determine management approaches was identified as a priority project in the ORC Biosecurity Strategy, 2019. The purpose of this document is to outline roles and responsibilities in the marine biosecurity space, actions required to undertake this scoping exercise, and provide recommendations for future actions to develop an effective Otago marine biosecurity programme.

This document will be updated as progression is made towards development of a marine biosecurity programme.

# Introduction

The Otago Coastal Marine Area (CMA) / Te Tai o Arai Te Uru extends 480 km from the Waitaki Fan southward to Wallace Beach, extending 12 nautical miles (22.2 km) from shore to the boundary of the territorial sea (Figure 1).



Figure 1. The Otago Coastal Marine Area (CMA) including sites of interest to marine biosecurity.

This area includes significant ecological zones, taoka species, mahika kai sites, threatened ecological communities, and various marine reserves including mātaitai and taiāpure customary reserves. There are five coastal development areas including a major port that has significant international and national commercial and recreational vessel traffic (>100 vessels per year)¹. These vessels are predominantly from large harbours such as Marsden Point, Waitematā Harbour, Picton, Lyttelton, and Bluff.

Maritime transport is a major pathway for marine pests to invade and spread to, and throughout, the Otago CMA, primarily through biofouling and ballast water discharge. Artificial structures, such as pilings and moorings in coastal development areas, such as ports, harbours, marinas, and wharves, are ideal potential incursion sites providing substrate for marine pests to establish.

Otago Harbour is also an important stopover location for vessels intending to visit southern locations (e.g., Fiordland, Stewart Island, Sub-Antarctic islands<sup>2</sup>) which have high marine biodiversity values and it is desirable to minimise the risk of spread of marine pests there.

# Roles and Responsibilities

#### **National Marine Biosecurity Framework**

Under the Biosecurity Act 1993, Biosecurity New Zealand (BNZ) administers the national biosecurity framework. BNZ manages biosecurity risks throughout the system including pre- border, border, and post-border interventions<sup>3</sup>. BNZ manages and implements the NMHRSS programme in 12 of New Zealand's busiest international shipping ports and marinas, including Port Otago.

BNZ has recently established a new national marine biosecurity education and advocacy programme, similar to Check, Clean, Dry, to facilitate public behaviour change to prevent spread of marine pest species. It is intended that BNZ will lead the development of this programme during 2023-24 in collaboration with Regional Councils.

BNZ intends to investigate potential development of a national marine biosecurity strategy and roadmap to provide good practise guidance for marine biosecurity. This would likely involve a request for support to 'pilot' a pathway plan for the Top of the North area. This proposed joint regional pathway plan would ensure consistency of approach with regards to standards, guidelines as well as authorisation of inspections and enforcement.

BNZ has some funding available to support regional councils to build capability in the marine biosecurity space.

# **Regional Marine Biosecurity Framework**

Regional leadership of marine biosecurity is the responsibility of regional councils under Section 12B of the Biosecurity Act 1993<sup>4</sup>. This includes risk mitigation and threat management once harmful organisms, already present in New Zealand, arrive in a new region.

There is provision for regional councils to list specific marine pests, that require regulation and a long-term work programme, through their respective Regional Pest Management Plans.

If a marine pest is identified after the RPMP has been established, regional councils can manage the pest through development of a five-year Small Scale Management Programme under section 100V of the Biosecurity Act 1993.

<sup>&</sup>lt;sup>1</sup> Ministry for Primary Industries, 2009. Vessel Movements within New Zealand. Evaluation of vessel movements from the 24 ports and marinas surveyed through the port baseline survey programmes.

<sup>&</sup>lt;sup>2</sup> Department of Conservation, 2017. Regional Coastal Plan. Kermadec and Subantarctic Islands. DOC administer the coastal plan for the Subantarctic islands.

<sup>&</sup>lt;sup>3</sup> MPI's role in Biosecurity. https://www.mpi.govt.nz/biosecurity/about-biosecurity-in-new-zealand/mpis-role-in-biosecurity/

<sup>&</sup>lt;sup>4</sup> Biosecurity Act 1993. 12B Regional council provides leadership regionally. (1) A regional council provides leadership in activities that prevent, reduce, or eliminate adverse effects from harmful organisms that are present in New Zealand (pest management) in its region. (2) The ways in which the regional council provides leadership in the region include—(a) promoting the alignment of pest management in the region: (b) facilitating the development and alignment of regional pest management plans and regional pathway management plans in the region: (c) promoting public support for pest management: d) facilitating communication and co-operation among those involved in pest management to enhance effectiveness, efficiency, and equity of programmes. (3) A regional council also provides leadership by promoting co-ordination of pest management between regions.

The BNZ Pest Management National Plan of Action<sup>5</sup> outlines regional council leadership responsibilities in the marine area related to

- o Population management of pests.
- o Pathway/vector management of pests.
- o Site/place management to protect values.

The Resource Management Act (RMA) 1991 provides the guidelines for central government and local authorities to manage the adverse effects of coastal activities through the development of policy statements and plans. The New Zealand Coastal Policy Statement 2010 (under the RMA 1991) guides regional policy statements and plans about harmful aquatic organisms<sup>6</sup>. The Otago Regional Policy Statement<sup>7</sup> (RPS) Policy 3.1.5 on coastal water provides direction on the management of pest species in the Otago CMA.

## Otago Regional Council (ORC) and Marine Biosecurity

As above, regional leadership of marine biosecurity is the responsibility of regional councils under Section 12B of the Biosecurity Act 1993<sup>8</sup>. This includes risk mitigation and threat management once harmful organisms, already present in New Zealand, arrive in a new region.

An initial scoping exercise to determine marine species threats and determine management approaches was identified as a priority project in the *ORC Biosecurity Strategy, 2019* and actions required to progress this were defined (Figure 2).

Partner with other regional councils to actively advocate for a national marine pathway management plan to minimise the risk of marine pest spread. If a national plan is not instigated:

- look to partner with adjacent councils to develop a sub-national plan;
- or a regional pathway management Plan or a change to the Regional Pest Management Plan.

ORC will undertake an initial scoping exercise to determine marine species threats in the Otago Harbour and the wider Otago area to determine what management approaches may be appropriate in the Pathway Management Plan.

Figure 2. Priority Project Action details, ORC Biosecurity Strategy, 2019

The Otago CMA does not currently have a marine biosecurity programme and there is no existing management programme for marine pests in the Otago Regional Pest Management Plan 2019-2029 (RPMP)<sup>9</sup>.

The only marine pest surveillance currently undertaken in Otago is completed as part of the Biosecurity New Zealand (BNZ) National Marine High Risk Site Surveillance (NMHRSS) programme. This programme is restricted to the Port Area of the Otago Harbour, with biannual surveillance primarily targeting pests not yet present in New Zealand.

<sup>&</sup>lt;sup>5</sup> MAF Biosecurity New Zealand. 2011. Pest Management National Plan of Action. https://www.mpi.govt.nz/dmsdocument/7087-Pest-Management-National-Plan-of-Action. This was agreed to and supported by the collective regional council Chief Executives at the time.

<sup>&</sup>lt;sup>6</sup> The New Zealand Coastal Policy Statement – Policy 12 Harmful aquatic organisms. Provide in regional policy statements and in plans, as far as practicable, for the control of activities in or near the coastal marine area that could have adverse effects on the coastal environment by causing harmful aquatic organisms to be released or otherwise spread, and include conditions in resource consents, where relevant, to assist with managing the risk of such effects occurring. Recognise that activities relevant to (1) include: the introduction of structures likely to be contaminated with harmful aquatic organisms; the discharge or disposal of organic material from dredging, or from vessels and structures, whether during maintenance, cleaning or otherwise; and whether in the coastal marine area or on land; (i) the provision and ongoing maintenance of moorings, marina berths, jetties, and wharves; and (ii) the establishment and relocation of equipment and stock required for or associated with aquaculture.

<sup>&</sup>lt;sup>7</sup> Otago Regional Policy Statement 2019 (Partially Operative) – Policy 3.1.5 Coastal Water e) Manage coastal water to control the adverse effects of pest species. Prevent their introduction and reduce their spread.

Biosecurity Act 1993. 12B Regional council provides leadership regionally. (1) A regional council provides leadership in activities that prevent, reduce, or eliminate adverse effects from harmful organisms that are present in New Zealand (pest management) in its region. (2) The ways in which the regional council provides leadership in the region include—(a) promoting the alignment of pest management in the region: (b) facilitating the development and alignment of regional pest management plans and regional pathway management plans in the region: (c) promoting public support for pest management: d) facilitating communication and co-operation among those involved in pest management to enhance effectiveness, efficiency, and equity of programmes. (3) A regional council also provides leadership by promoting co-ordination of pest management between regions.

<sup>&</sup>lt;sup>9</sup> There are eight marine pest species identified as Organisms of Interest in the RPMP. An Organism of Interest is a species that is capable of causing adverse effects, particularly to biosecurity values. It warrants being watch-listed for ongoing surveillance or future control opportunities but has not been given the status of pest in the RPMP.

The ORC has been advocating for a national marine pathway management plan to minimise the likelihood of marine pests being spread throughout the CMA and between regions (Biosecurity Strategy 2019).

Chapter 13 of the Otago Coastal Plan<sup>10</sup> guides the policies, rules, plans and methods for the ORC to utilize in relation to delivering marine exotic plant management in the Otago CMA in conjunction with Kāi Tahu.

# **Proposed Actions**

Over recent years ORC has increased it's level of activity in biosecurity and has made decisions about prioritising pests. This has included focussing on feral rabbits, wilding conifers, lagarosiphon, Bennett's wallaby and the exclusion pest programme.

ORC is not currently fulfilling its responsibilities for marine biosecurity in the Otago region, or between regions, as required under Section 12B of the Biosecurity Act 1993. Nor is ORC delivering on the National Plan of Action role. Therefore, it is imperative that a plan is developed to undertake activities to display regional leadership in the marine biosecurity space in Otago.

ORC biosecurity staff have minimal experience in marine biosecurity so will need to build internal capability and working relationships with others who are more experienced in this area.

<sup>&</sup>lt;sup>10</sup> Otago Regional Council. 2012. Regional Plan: Coast for Otago. Chapter 13: Exotic Plants

The following steps are recommended to initiate development of marine biosecurity activities and scope an Otago marine biosecurity programme:

Stage 1 – Scoping Exercise: Building foundations for marine biosecurity in Otago	(2023-24)
Activity	Progress
Engage with mana whenua to understand their concerns and expectations. Develop and implement a marine biosecurity programme in partnership with mana whenua <sup>11</sup> .	Invited to attend the East Otago Taiāpure Komiti Hui. Members supported the concept of an Otago Marine Biosecurity Plan in principle.  Met with representatives of Te Rūnanga o Ngāi Tahu, Kāti Huirapa Rūnaka ki Puketeraki, and the University of Otago to discuss partnership opportunities and potential collaboration with the Kāi Tahu dive team.
Advocate for a national marine pathway management plan to minimise the likelihood of marine pests being spread throughout the CMA and between regions.	ORC has been advocating for a national marine pathway management plan. BNZ is intending to develop a roadmap to provide guidance for marine biosecurity and supports development of regional pathway management plans. Staff will work with Environment Southland and Environment Canterbury staff to ensure that regional pathway management plans are aligned. BNZ do not have a national pathway management plan in their workplan for 2023/24.
Increase the biosecurity team's knowledge and understanding of marine biosecurity in Otago by:  - Attending MHRSS surveys  - Attending Marine Pest ID Workshops  - Attending existing marine biosecurity partnership meetings  - Collaborating with other teams (Science, Harbourmaster, Policy, Consents, and Port Otago)  - Collaborate with BNZ and other regional councils.  - Document current state of knowledge of marine pests in the region and within the harbour	<ul> <li>ORC Environmental Implementation and Science team staff attended a marine pest species ID workshop hosted by BNZ and NIWA to increase knowledge of marine pest species identification knowledge across the team.</li> <li>ORC Biosecurity Officer attended the annual national Marine High Risk Site Surveillance (MHRSS) of the Otago Harbour with NIWA in winter 2023.</li> <li>Collaboration has occurred with the Science team, Harbourmaster, Consents, and Policy teams.</li> <li>Collaboration has been undertaken with BNZ and other regional councils to establish what other councils are implementing in the marine biosecurity space, including attendance of the Top of the North Marine Biosecurity Meeting.</li> <li>ORC representation has been established on the BNZ National Marine Biosecurity Partnership and National Marine Bahaviour Change groups and regular meetings are now being attended.</li> </ul>

<sup>11</sup> Section 7A of the Marine and Coastal Area (Takutai Moana) Act 2011 promotes the participation of affected iwi, hapū, and whānau in the specified conservation processes relating to the common marine and coastal area.

Develop and implement a marine biosecurity engagement and communications plan to increase public awareness and support increased understanding of marine pests and how to reduce their spread. Investigate involvement with BNZ's National Behaviour Change Programme.	ORC marine biosecurity engagement plan has been developed. BNZ Marine Biosecurity signage has been installed at high-risk areas along the Otago Coast. ORC has provided representation on BNZ's National Behaviour Change Programme.
Investigate development of student marine biosecurity projects with the University of Otago using the ORC summer studentship programme.	Two marine biosecurity focused summer studentships have been completed.
Explore feasibility of engaging with the NZ Marine Studies Centre Marine Metre Squared (MM²) project to increase education and advocacy in the marine biosecurity space and support citizen science.	
Investigate requirements for biosecurity officers to become authorized to remove samples from privately owned vessels or structures to send to NIWA for identification.	This has been investigated and authorization will be obtained if required to facilitate a marine biosecurity programme in Otago.
Establish a protocol for collecting samples and sending to NIWA for identification purposes.	Connected with BNZ to acquire sample collection kits and required training for hazardous substances has been undertaken by biosecurity staff so these kits can be stored and used.

The following steps are recommended to initiate development of a marine biosecurity programme for Otago:

Stage 2 – Initial Development of an Otago Marine Biosecurity Programme (2024-25)			
Activity	Progress		
Develop a marine biosecurity regional surveillance plan in Partnership with mana whenua to support the MHRSS. Surveillance options could potentially include undertaking snorkel/dive surveys at secondary highrisk port and anchorage sites and hosting marine pest ID workshops in high- risk areas.  The surveillance plan should be peer reviewed by NIWA and BNZ.			
Work with Environment Canterbury (ECan) and Environment Southland (ES) to establish a Bottom of the South alliance and establish and regional pathway management plans that are aligned. This could potentially lead to working together with Top of the South to create a South Island marine biosecurity alliance.	Connection has been established with Environment Canterbury and Environment Southland in the marine biosecurity space. These councils are keen to collaborate in development of regional pathway management plans to ensure these are aligned where possible. BNZ have funding available to support the development of this plan.		
Consider additional options for implementing marine biosecurity in the Otago CMA and determine what can be achieved in the short/medium/longer term.			
Engage with BNZ and/or other regional councils (Environment Southland or the Top of the South) to support baseline training for ORC staff involved in marine biosecurity or incident response, compliance, organism recognition, vessel inspections, and education and advocacy.			
Develop a small-scale management plan for known identified pest species that are present in Otago and require management prior to revision of the RPMP (2029).			

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Commence delivery of the surveillance plan. Surveillance is implemented by other Regional Councils to increase marine biosecurity awareness and facilitate behaviour change.	
Work with the ORC Policy team on the 2026 Otago Coastal Plan review—specifically on harmful aquatic organisms and any future aquaculture operations in the Otago CMA.	
Collect monitoring data to inform the next iteration of the Otago RPMP in 2029.	IRIS Next Generation will have capability to collect marine biosecurity data. This is already being developed for other regional councils with marine biosecurity programmes.
Allocate budget to develop and implement a marine biosecurity programme	Budget consideration has been provided for in the 2024-2034 draft Long-Term Plan.

Activity	Progress
Ongoing implementation of the marine biosecurity programme for Otago.	
Provide recommendations to amend the Otago RPMP to include marine biosecurity provisions. Align with neighbouring council rules in RPMP to ensure consistency across the Bottom of the South, building on the lessons from Top of the North.	
Investigate potential for marinas to implement clean hull requirements for resident and visiting vessels. This could be achieved by adopting the Six or One rule <sup>12</sup> that marinas in the Top of the North follow.	
Document current vessel maintenance facilities for keeping hulls clean and identify any shortfall. If standards are imposed, they can only be enforced if there is capacity for the required vessel cleaning and antifouling. The primary limitation is likely to be the provision of compliant hard stand facilities. In the long term, the ORC needs to investigate addressing these shortfalls.	

<sup>12 &#</sup>x27;Six or One' requirement states that boatowners need to apply either an antifoul within six months, or a lift-and-wash within one month of leaving an area with marine pests. https://www.nrc.govt.nz/maritime/marine-pollution-and-boat-cleaning/visiting-a-northland-marina- this-summer

# Marine Biosecurity Engagement Plan 2023-2025



# 1. Overview of Engagement

#### 1.1 Introduction

The Otago Regional Council (ORC) is currently assessing the possibility of developing a marine biosecurity programme and pathways management plan in partnership with Kāi Tahu, to minimise risk of marine pest invasion or spread throughout the Otago Coastal Marine Area (CMA)/ Te tai o Arai Te Uru, and between regions.

Developing relationships with key partners/ stakeholders to enable the management of marine pest pathways, and increasing public awareness of marine pests, have been identified as beneficial actions to reduce marine biosecurity risk in Otago.

## 1.2 Key Issues

- The Otago CMA hosts many significant ecological areas with a myriad of threatened ecological communities, taoka species, mahika kai sites, various proposed marine reserves, five coastal development areas including a major port, and mātaitai/ taiāpure customary reserves.
- Otago's CMA observes a significant number of international and national commercial and recreational vessel
  traffic (> 100 vessels per year) from large harbours such as Marsden Point, Waitematā Harbour, Picton,
  Lyttelton and Bluff. The port area of Otago Harbour is identified as a significant potential pathway for marine
  pests to invade and spread, particularly through ballast water and hull biofouling.
- Otago Harbour is also an important stopover location for vessels intending to visit southern locations (e.g.
  Fiordland, Stewart Island, Sub-Antarctic islands) which have high marine biodiversity values and it is
  desirable to minimise the risk of spread of marine pests there.
- The ORC has limited experience in marine biosecurity, therefore will look to build internal capability and working relationships with other councils and agencies.

#### 1.3 Approach

The approach for a marine biosecurity engagement programme is to:

- Identify key stakeholders in marine biosecurity and build relationships and networks.
- Identify audience for marine biosecurity education and advocacy.
- Develop key messaging for consistency across the region and align with Biosecurity New Zealand's (BNZ)
  national behaviour change programme as it is developed.
- Develop a communications plan to present key messages using a variety of communication channels and align with the BNZ national behaviour change programme as it is developed.
- Identify key roles and responsibilities for programme team members.

These points are described in more detail in this plan.

# 1.5 Key Messaging

Key messages will be developed around the following points:

- Provisions to prevent the spread of marine pests within/between regions for example, clean boat hulls regularly and help identify marine pests and report them (citizen science)
- Impacts of marine pests on various ecosystem values for example, outcompetes native species including those considered taoka and important for mahika kai.
- Impacts on boat efficiencies for example, hull-fouling reduces fuel-efficiency on boats.

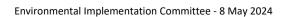
# 2. Partners/Stakeholders

# 2.1 Classifications

# **Partnership**

Kāi Tahu (including Te Rūnaka o Ōtākou, Kāti Huirapa Rūnaka ki Puketeraki, Hokonui Rūnaka, Te Rūnaka o Moeraki, Awarua Rūnaka)

Treaty partners who exercise rangatirataka over areas of the Otago CMA, are involved in decision-making, notified of incursion-response, and are equipped with a dive-team experienced in marine pest management. Engagement thus far has been through Aukaha, meeting with Tangata Tiaki/Kaitiaki of Kāi Tahu and attendance at the East Otago Taiāpure Komiti Hui.



Group	Group Description	Partners/Stakeholders
Provider	Groups/organisations who will be asked to provide inputs and services to the marine biosecurity programme.  Essentially, who will help develop the marine biosecurity programme?	Kāi Tahu and ORC  Peer review: Biosecurity NZ (MPI) – Pest Management Team, NIWA, and University of Otago
Related Projects	Related projects and change activities that can inform this project.	Biosecurity NZ (MPI) – Engagement Programmes Team coordinating National Behaviour Change Programme  NIWA  Other regional councils  ORC Staff reviewing Coastal Plan
Outcome Impacted	Individuals/groups/organisations/related projects who will be affected by the achievement of the project's outcomes.  Who do we need to make aware of the marine biosecurity programme and request feedback?	<ul> <li>Kāi Tahu and coastal rūnaka</li> <li>Recreational Marine Operators</li> <li>Commercial Marine Operators</li> <li>Neighbouring Regional Councils</li> <li>Port Otago</li> <li>ORC Harbourmaster Team</li> <li>Department of Conservation (DOC)</li> <li>Territorial Authorities</li> </ul>
Output Utilisation	Groups/organisations who will be required to implement and utilise the project's outputs to enable the achievements of the project's outcomes.  Whose endorsement is required / desired?	<ul> <li>Kāi Tahu and coastal rūnaka</li> <li>Recreational Marine Operators</li> <li>Commercial Marine Operators</li> <li>Neighbouring Regional Councils</li> <li>Port Otago</li> <li>ORC Harbourmaster Team</li> <li>Enviroschools</li> <li>Territorial Authorities</li> </ul>
Review	Groups/organisations who need to review (or audit) the project and its outputs/outcomes.	<ul> <li>Kāi Tahu and ORC</li> <li>Biosecurity NZ (MPI) – Pest Management Team</li> <li>NIWA</li> <li>University of Otago</li> <li>DOC</li> </ul>
Outcome Accountable	Groups who are the owners/sponsors of the project, supporting the achievement of project outputs and outcomes.	Kāi Tahu and ORC

# 2.2 Partners/Stakeholder Analysis

A stakeholder analysis will ensure collaboration is comprehensive. An initial but not exhaustive list of stakeholders and their contributions to the process follows:

Doute analain	KEI Tahii and ODC	December of the discolar contestion of according
Partnership	Kāi Tahu and ORC	Development and implementation of marine biosecurity programme for Otago.
	Manager - Environmental Implementation	Oversight of programme development and implementation
	Team Leader – Environmental Implementation Project Delivery	Oversight of programme development and implementation     Technical advisory committee member on the National Marine Biosecurity Behaviour Change Programme     Developing networks and maintaining relationships with stakeholders
	Biosecurity Specialist – Marine and Freshwater	<ul> <li>Developing networks and maintaining relationships with stakeholders</li> <li>Programme planning</li> <li>Development and implementation of monitoring and surveillance</li> <li>Coordinating contractors</li> <li>Incursion responses</li> </ul>
Internal Stakeholders	Community Coordinator – Biosecurity Coastal	Education and advocacy     Event planning     Communications
	Comms Team	Deliver comms plan and provide public with marine biosecurity information through social media, pesthub and other communication pathways.      Develop marine biosecurity collateral.
	Science Team	Technical advice and support
	Harbourmaster Team	Support biosecurity team to identify key marine operators and provide information on marine biosecurity provisions.
	Enviroschools	Support development and implementation of citizen science projects, such as iNaturalist and Marine Metre Squared (MM²)
	Biosecurity New Zealand (BNZ)  – Ministry of Primary Industries	Pest Management Team – support in the development and implementation of a marine biosecurity pathways management plan.  Engagement Programmes Team –support to ensure marine biosecurity communications is consistent between regions as part of the Marine Biosecurity National Behaviour Change programme (akin to the freshwater Check, Clean, Dry programme).  Technical advice

	NIWA	•	Undertake bi-annual surveys for marine pests in Otago Harbour under contract from MPI as part of the National Marine High-Risk Site Surveillance programme and offer a Marine Invasives Taxonomic Service (MITS) to aid in marine pest identification.  Technical advice
	University of Otago	•	Have previously provided the ORC with marine biosecurity research in the form of summer-studentships.  Technical advice
External Stakeholders	Other Regional Councils	•	Provide support in the development and implementation of a marine biosecurity pathways management plan. Specifically, by potentially providing trainings in marine biosecurity enforcement and potentially in incursion response.  Ensuring we have consistent marine biosecurity provisions in place throughout the South Island will likely yield the best outcomes in mitigating the spread of marine pests and will be more cost-effective.
	Port Otago	•	Most substantial commercial maritime operator in the Otago CMA, have previously commissioned a delimiting survey for <i>Sabella spallanzanii</i> (Mediteranean Fanworm; Unwanted Organism) in response to an incursion detected in Port Chalmers by NIWA in 2019.
	Department of Conservation	•	Responsible for managing the proposed marine protected areas (MPAs) in the Otago CMA.
	Recreational Maritime Operators	•	Includes boaties, fishermen, divers, swimmers and other recreational users of Otago's marine environment. These are likely represented through yacht clubs, dive clubs and various other organisations/committees.
	Commercial Maritime Operators	•	Includes marine construction operators, fishermen, freight companies and various other commercial users.
	Territorial Authorities (DCC, CDC, WDC)	•	Own and manage various wharfs and moorings that may provide substrate for marine pests.
	Maritime New Zealand	•	Enforce ballast water management guidelines for vessels in New Zealand
	General Public	•	Consultation regarding any potential inclusion of marine species in the RPMP May need to comply with any future marine biosecurity legislation. Can support in marine pest identification and reporting.

#### 2.3 Partner/Stakeholder Database

- Maintained in excel spreadsheet
- Ethics and security
- To be updated with communication evidence regularly

# 3 Communications

# 3.1 Mechanisms

- Develop a communications plan
- Marine biosecurity signage (installed MPI signage on the 7th Aug 2023)
- Additional pest-specific signage could be installed in high-use diving areas (Aramoana mole and Wellers Rock)
- Community engagement Yacht clubs, marina operators, commercial user committee meetings
- Social media Facebook, Instagram, LinkedIn
- Website update PestHub to include marine pests
- Community events NZISF, Wild Dunedin, Conservation Week, Port Chalmers Seafood Festival, A&P Shows
- Surveys of marine users (akin to Check Clean Dry Advocate Work)

# 3.2 Strategies

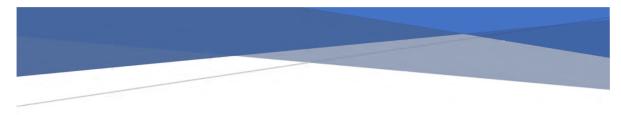
Partner/Stakeholder	Key Messages	Mechanism	Timeframe
Kāi Tahu	Incursion updates, and input at key stages of	Huis with the appropriate Rūnaka. Work with Aukaha	Ongoing
	programme Environmental Advisor		
MPI (Biosecurity NZ)	Project Updates and input to key stages of the programme	Emails and Teams meetings	Monthly updates
NIWA	Taxon identification matters	Attendance at MHRSS Surveys in Otago Harbour	Bi-annual
Neighbouring Regional Councils	Opportunity to collaborate on marine biosecurity matters	Teams Meeting and Southern Alliance in-person catchup.	Bi-annual
Port Otago	Provide with appropriate marine biosecurity messaging	Emails, Team meetings, Marine Pest ID guides, brochures, and other communications material	Ongoing
Recreational Maritime Operators	Provide with appropriate marine biosecurity messaging	Attending committee meetings, Emails, Marine Pest ID guides, brochures, and other communications material	Ongoing
Commercial Maritime Operators	Provide with appropriate marine biosecurity messaging	Emails, Marine Pest ID guides, brochures, and other communications material	Ongoing
DOC	Updates on establishment of marine reserves and Kāi Tahu ranger roles	Emails	Ongoing
Territorial Authorities	Provide with appropriate marine biosecurity messaging	Emails	Ongoing

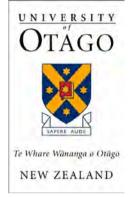
Maritime New Zealand	Engage on how to manage ballast water pathway for pest invasion	Emails	Ongoing
General Public	Provide with appropriate marine biosecurity messaging	Marine Pest ID guides, brochures, and other communications materials	Ongoing
University of Otago	Opportunity to collaborate on marine biosecurity matters – particularly on student projects	Emails and Teams Meetings	Ongoing

# 4 Risk Management Plan

# 4.1 Risk Analysis

Risk	Level of Risk	Mitigation / Contingency Measure
Partners/stakeholders do not have time or willingness to participate in internal processes	Medium	Plan to attend meetings in appropriate locations to reduce travel and timing takes into consideration other workloads.  Project partners allow time for participation in workshops
Difficulty in achieving consensus around appropriate marine biosecurity provisions for Otago	High	ORC staff will continuously monitor partner/stakeholder engagement, feedback and evolution of consensus, consistent with the project's evaluation strategy, and modify the consultation approach where necessary.
Pressure on staff resources	High	Monitor time spent on project. Review (and amend as required) project tasks and resources regularly. Engage a contractor to undertake the implementation of the engagement plan. Recruit an ORC Biosecurity Specialist – Marine
Online resources not well viewed	Medium	Effective engagement strategy – monitor uptake Publicise website extensively and early. Keep website up to date and dynamic. Ensure appropriate people are targeted
Timeframes not met	High	Monitor project tracking and adjust timing if possible.  Keep to core project deliverables







Submitted February 2022 for the Otago Regional Council

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# **Executive summary**

The Otago (Ōtakou) coastal marine area hosts one of the most biodiverse marine regions in Aotearoa New Zealand. In the last few decades, marine pests have threatened native biodiversity in this region due to high vessel traffic, prompting the Otago Regional Council to identify 8 marine organisms of interest to monitor. This surveillance report recommends an additional 7 marine pests that could be added to the organisms of interest category in the Otago regional pest management plan. This report further outlines the key habitats, life histories and negative impacts of the organisms of interest and other unwanted organisms on Otago's marine ecosystems. The review of organisms of interest identified artificial structures such as vessels, wharfs, and aquaculture operations as high-risk pathways to allow the establishment of marine pests. Consequentially, five high risk areas in the Otago coastal marina region were identified to be monitored regularly by the Otago Regional Council.

# In this report I recommend that ORC:

- Establish an annual surveillance plan for marine non-indigenous species listed as
  organisms of interest in the pest management plan as well as for additional unwanted
  organisms listed in this report. This can be done in correspondence with Biosecurity
  New Zealand, NIWA, neighbouring regional councils (particularly Environment
  Southland), Port Otago, and the University of Otago.
- Establish a surveillance programme for marine organisms of interest in high-risk areas
  outside of the Otago Peninsula (already surveyed bi-annually by Biosecurity New
  Zealand) on artificial structures in Oamaru, Moeraki, Karitane and the Catlins.
- Consider putting information boards about marine pests in popular fishing and diving sites in the Otago region so the public can help the council with pest surveillance

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4. Consider removing the Asian paddle crab (*Charybdis japonica*) from the organisms of interest list as spawning of this species only occurs in sea water temperatures much higher than those observed in the Otago coastal marine area.

#### 1. Introduction and objectives

New Zealand/Aotearoa's marine ecosystems contribute an estimated US\$357 billion worth of economic, recreational, and other services annually (MacDiarmid et al. 2013, Woods et al. 2020). The Otago/Ōtakou marine region in the South Island/Te Waipounamu possesses a diverse range of ecologically, economically, and culturally important species. The Otago coastline hosts a variety of marine regions and species that are important to the local iwi, Kāi Tahu, and protected under the Deed of Settlement (1997). These include culturally important areas for Kāi Tahu to practice mahika kai (food-gathering) in tāiapure and mataitai reserves (customary protection areas) and the ability to impose a rāhui (temporary closure) in areas where fisheries stocks are depleted. Examples of mahika kai species found on the Otago coastline include pāua (black foot abalone/Haliotis iris), tuaki (cockles/Austrovenus stutchburyi), karengo (sea lettuce/Pyropia columbina), and Rāwaru (blue cod/Parapercis colias). Tāoka (treasured) species such as kekeno (NZ fur seal), hoiho (yellow eyed penguin/Megadyptes antipodes) and tutumairekurai (Hector's dolphin/Cephalorhynchus hectori) are also found in the Otago marine region. The Otago coastal marine area is only developed in a few places, limited to the Otago Harbour, Oamaru Harbour and some small fishing ports including Karitane, Moeraki and Taieri Mouth. Commercial fishing for a range of fish and shellfish species is extensive along the Otago coast, with Blueskin Bay being a particularly important location for a flatfish and cockle fishery. The Otago coastline is used recreationally for activities such as fishing, boating, sailing, swimming, surfing, and diving (Otago Regional Council 2012).

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Marine pests or non-indigenous species (NIS) can drastically change the structure and function of native biological communities (Fletcher et al. 2017), threatening the ecological, economic and cultural values offered by the marine ecosystems on the Otago coastline.

Marine pests have been found to invade this region due to international and domestic vessel traffic. Specifically, hull biofouling, ballast and bilge water are common vectors associated with vessel traffic that aid the transport of marine pests internationally and domestically (Georgiades et al. 2021). The Otago Regional Council (ORC) have determined a need to create a marine biosecurity plan that will undertake ongoing surveillance and monitoring of major pathways and potential invasion site for NIS in Otago's marine region.

#### 1.1 Current marine biosecurity initiatives in Otago

Although there are existing surveillance initiatives for marine pests in the Otago coastal marine region, the surveys only occur bi-annually and only covers a limited area.

# 1.1.1 Surveillance – Monitoring

The monitoring of incursions of non-indigenous species in the Otago coastline is currently only undertaken by NIWA and Biosecurity NZ with the national Marine High Risk Site Surveillance (MHRSS) programme. The MHRSS programme aims to detects incursion of new or cryptogenic NIS as well as range extensions of extant NIS in 11 high-risk ports and marinas across New Zealand. Survey methods using diver searches, benthic sled tows, crab condo and trap lines, as well as shore searches are undertaken bi-annually (in the summer and winter periods) aiming to monitor non-indigenous organisms listed on the Unwanted Organisms Register in Port Chalmers and in the inner Otago harbour. The survey methods are designed to detect the presence of five primary target NIS (Asterias amurensis, Carcinus maenas, Caulerpa taxifolia, Eriocheir sinensis and Potamocorbula amurensis) and four secondary target NIS (Arcuatula senhousia, Eudistoma elongatum, Sabella spallanzanii and

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Styela clava) (Woods et al. 2020). Other areas in the Otago coastal marine region such as Moeraki harbour, Karitane and the Catlins are not regularly monitored for NIS.

### 1.1.2 Surveillance – Hull inspections

No regular hull inspections (diver surveys of boat hulls) are conducted on vessels within the Otago coastal marine region.

# 1.1.3 Compliance

The Otago regional pest management plan (RPMP) aims to minimise the actual or potential adverse or unintended effects associated with those organisms; and to maximise the effectiveness of individual actions in managing pests through a regionally coordinated approach (Otago Regional Council 2019). However, all marine species that have been listed in this plan are only regarded as 'organisms of interest' meaning that the NIS are to be monitored in a surveillance programme, but no control methods have been implemented.

### 1.2 Statement of problem

There is no surveillance, monitoring and control plan for NIS representative of all the Otago coastal marine area. Only the Otago peninsula (mainly Port Chalmers) is bi-annually monitored for NIS, leaving most of the Otago coastline susceptible to an unknown incursion of a NIS.

## 1.3 Statement of objectives

- Identify habitats and conditions which support species that are organisms of interest under the Otago RPMP
- 2. Identify high risk areas that are recommended for prioritised site investigation of NIS
- Identify NIS not listed in the RPMP that the Otago Regional Council (ORC) could start to investigate

## 1.4 Geographic extent of plan

This marine surveillance plan applies to the Otago coastline which runs for 480km from the Waitaki Fan in the North and to Wallace Beach in the South (*Figure 1*). Further, the plan extends out from the coast to 12 nautical mile (22.2 kilometre), indicating the limits of the territorial sea. The coastline is exposed to several water fronts, including a subantarctic front, resulting in cooler sea water temperatures in the region.

The range of sea surface temperature of high-risk areas in the Otago coastline are as follows:

- Oamaru: 9.2°C (winter) 15.5°C (summer)
- Otago Peninsula: 7-10°C (winter), 12-15°C (summer)
- Catlins: 8-10°C (winter), 12-14°C (summer)



Figure 1: Boundary map of coastal areas (marked with crossed lines) managed by the Otago Regional Council

# 2 Managing invasive marine species

# 2.1 Current and Potential Invasive Marine Species (Organisms of Interest)

Since 2005, Biosecurity New Zealand have found more than 330 NIS in the North and South island, of which half have established populations in New Zealand (Ministry for Primary Industries 2019). NIS are only classified by Biosecurity NZ as "marine pests if they are deemed to pose a significant threat to the ecological, economic, social and cultural values offered by a marine region. There are 11 primary marine pest species targeted by Biosecurity NZ, as indicated on their 'Marine Biosecurity Porthole' website, these include the:

- 1. Northern Pacific Sea star/Asterias amurensis (not known to be in NZ)
- 2. European shore crab/Carcinus maenas (not known to be in NZ)
- 3. Chinese mitten crab/Eriocheir sinensis (not known to be in NZ)
- 4. Asian clam/Potamocorbula amurensis (not known to be in NZ)
- Aquarium Caulerpa/Caulerpa taxifolia (not known to be in NZ, similar species Caulerpa brachypus found in one region in NZ)
- 6. Mediterraean fanworm/Sabella spallanzanii (present in some areas of NZ)
- 7. Australian droplet tunicate/Eudistoma elongatum (present in some areas of NZ)
- 8. Clubbed tunicate/Styela clava (present in some areas of NZ)
- 9. Asian date mussel/Arcuatula senhousia (present in some areas of NZ)
- 10. Asian paddle crab/Charybdis japonica (present in some areas of NZ)
- 11. Wakame Asian Kelp/Undaria pinnatifida (present in some areas of NZ)

The marine pests targeted for surveillance by Biosecurity NZ often differ from the marine pests targeted in RPMPs created by regional councils. This is likely due to the different regions of New Zealand observing different abiotic conditions (i.e., water temperature, salinity, climatic conditions) and severities of marine pest invasions. In the Otago marine region, a 2006 baseline study of marine species in Port Otago (Inglis et al. 2006) indicated there were 18 NIS present in the area. Since then, there have been many more NIS detected in the Port Otago area during the bi-annual MHRSS surveys. In the Otago RPMP, there are 8

marine NIS classified as 'organisms of interest' based on the species' biology and life history. The species are:

- 1. Asian paddle crab/Charybdis japonica
- 2. Mediterranean fanworm/Sabella spallanzanii
- 3. Sea couch/ Agropyron pungens
- 4. Clubbed tunicate/Styela clava
- 5. Australian droplet tunicate/Eudistoma elongatum
- 6. Australian cunjevoi /Pyura dopplegangera
- 7. Carpet sea squirt/Didemnum vexillum
- 8. Wakame Asian Kelp/Undaria pinnatifida

The organisms of interest indicated by the Otago RPMP includes 5 of the marine pests targeted by Biosecurity NZ and 3 additional NIS. Additional to the organisms of interest indicated in the RPMP, there are 7 additional NIS which have been identified for potential investigation by the ORC. Additionally, Appendix 1 outlines all NIS that have been established or at risk of invasion in Otago.

## 2.2 Identified as Organisms of Interest:

### 2.2.1 Wakame Asian Kelp (Undaria pinnatifida)

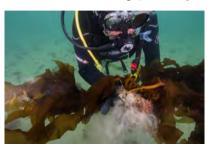


Figure 2: (above) A diver with Undaria Pinnatifida in Stewart Island (credit: Toby Dickson, iNaturalist), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/search-forspecies/

**Description:** Undaria is a golden-brown seaweed which grows 1-2m tall and is characterised by a distinct mid-rib.



**Geographic range:** Native to the cold temperate waters of Japan, China, and Korea. It was first documented in New Zealand in 1987 (Wellington harbour) and observed in the Otago harbour in 1990 (Russell et al. 2008). It likely invaded New Zealand through ballast water.

**Life history:** In New Zealand (where temperature ranges are narrower), it has been found that the species displays a bi-annual life cycles with overlapping generations of sporophytes and gametophytes (two types of reproductive lifestyles). The gametophyte stage is likely to facilitate the introduction of the species to new areas and can delay their development like AAseeds in terrestrial plants (Murphy et al. 2017).

Habitat: Shallow rocky reefs in sheltered coastline (Arnold et al. 2016)

**Impact:** Colonises substrates that do not usually contain dense canopies of seaweed. Due to its high density, *Undaria* can competitively exclude canopy species such as *Macrocystis pyrifera* and other subcanopy seaweed species (Stuart 2004).

### 2.2.2 Sea couch (Agropyron pungens)



Figure 3: (above) Agropyron pungens (credit: Robin Stott), and (right) its distribution in New Zealand. Created on QGIS.

**Description:** Sea couch is a rhizomatous perennial grass (similar to marram grass) with a blue-grey colour and is able to grow to 125cm tall. Taxonomically sea couch



(Agropyron pungens) is also known as Elymus pungens, Agropyron pungens, Elytrigia atherica, Elymus pycnanthus, Agropyron littorale and Elymus athericus

**Geographic range:** Sea couch is native to Western and Southern Europe. In New Zealand it is found in both the North and South islands.

**Life history:** Reproduction is completed through vegetative spread from long-running rhizomes, seeds are also produced (Shaw and Allen 2003)

**Habitat:** Sea couch occupies waste land on the foreshore, stable sand behind beaches, and intertidal mudflats.

**Impact:** Likely forms dense swards on sand dunes where marram grass is not dominant, negatively impacting the structure and function of native ecosystems such as saltmarsh ecosystems. These impacts include sediment accumulation, displacement of flora and destruction of feeding and roosting grounds of native birds (Shaw and Allen 2003).

### 2.2.3 Clubbed tunicate (Styella clava)



Figure 4: (above) Styela clava specimens (credit: Jeannine Fischer, MPI), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/search-for-species/

**Description:** The tunicate has a long, tough,



leathery skinned cylindrical form attached to holdfast. It has a yellow to brown colour and can grow up to 16cm long.

**Geographic range:** The native range of the clubbed tunicate is between the Sea of Okhotsk to Shanghai, China. It likely first invaded New Zealand in 2002 through biofouling of vessels and equipment (Wong et al. 2011).

**Life history:** *S.clava* is a simultaneous hermaphrodite with both male and female gonads present at the same time. The reproductive cycle of the tunicate follows a regular seasonal cycle, with spawning occurring during late summer and early autumn, when sea surface temperatures first reach 15°C (Wong et al. 2011).

**Habitat:** The tunicate is found on both natural and artificial substrate in low intertidal and subtidal regions down to a depth of 40m.

**Impact:** The clubbed tunicate is an aggressive competitor for food and space having damaging environmental and economic impacts on native biodiversity and aquaculture (Clarke and Therriault 2007).

## 2.2.4 Carpet sea squirt (Didemnum vexillum)



Figure 5: (above) Didemnum vexillum specimens (credit: Xavier Turon, CEAB-CSIC), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/search-for-presied/



Description: Is a yellow-orange colonial

tunicate which can form encrusting mats with small or large lobes.

**Geographic range:** The carpet sea squirt is potentially native to Japan and was first detected in New Zealand in 2001 in Whangamata harbour but is now present as far south as Dunedin.

**Life history:** The sea squirt is reproductive (sexually and asexually) for 9 months in the year and display no larval recruitment in temperatures below 12°C (Knorek et al. 2020). In the Mediterranean it reaches its highest abundance in spring, but has high plasticity in invaded areas which can result in changes to the sea squirt's biological cycle (Ordóñez et al. 2015).

**Habitat:** Populations are found on artificial structures but are also abundant on natural cobble reefs in deep offshore waters (40-65m).

**Impact:** The sea squirt has been found to smother native species, aquaculture operations and fisheries species (Fletcher et al. 2013).

## 2.2.5 Asian paddle crab (Charybdis japonica)



Figure 6: (above) Charybdis japonica (credit: Kelvin Perrie, iNaturalist), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/search-for-species/

Description: The Asian paddle crab is a

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green-brown swimming crab with paddle-like hind legs.

**Geographic range:** The Asian paddle crab is indigenous to China, Korea, Malaysia, Japan and Taiwan, it was first observed in New Zealand in the Auckland harbour in 2000 (Hilliam 2020). It currently only occurs in North Island, with a sub-tropical distribution.

**Life history:** In its native range the crab spawns in sea temperatures between 17-22°C (Wong and Sewell 2015), warmer than Otago waters. Females are able to hatch a brood of up to 415,000 eggs between the austral spring and autumn with a peak in summer (Fowler and McLay 2013).

Habitat: The crab inhabits inlets, harbours and bays with firm sand or muddy sand benthos.

**Impact:** It can have significant impacts on native macroinvertebrate communities (Hilliam 2020) and fishes (Wong and Sewell 2015).

### 2.2.6 Mediterranean fan worm (Sabella



Figure 7: (above) Sabella spallanzanii (credit: Brian Azzopardi), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/search-for-species/



#### spallanzanii)

**Description:** The Mediterranean fan worm has a long leathery, flexible tube that is pale brown in colour and can grow to a length of 10-50cm.

Geographic range: Native to the Mediterranean Sea and parts of the North-Eastern Atlantic Coast. In New Zealand, it was first discovered in Lyttleton harbour in 2008 and has spread as far south as Dunedin. The fan worm invaded New Zealand through the ballast water of a vessel from Australia (Ahyong et al. 2017)

**Life history:** The fan worm is a broadcast spawner, exhibiting intratubular fertilisation, with larvae that can survive for 21 days before settlement. Its spawning coincided with falling sea water temperatures and has reproductive tolerances between 11-22°C making Otago's coastline highly susceptible to invasion (Lee et al. 2018).

**Habitat:** The fan worm is found biofouling on sediment substrate and on artificial surfaces, with higher abundances in eutrophic areas (Ahyong et al. 2017).

**Impact:** It has negative impacts on soft sediment benthic habitats due to its physical presence and biological activities, particularly suspension feeding and bio-deposition. It also outcompetes native and aquaculture species for food and space (Atalah et al. 2019).

## 2.2.7 Australian droplet tunicate (Eudistoma elongatum)



Figure 8: Figure 7: (above) Eudistoma elongatum (credit: Sean Handley), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/search-forspecies

**Description:** The tunicate looks like clusters of white or creamed coloured tubes that are generally 5-30cm long.



**Geographic range:** The Australian droplet tunicate is native to Australia and was first observed in New Zealand in 2005 (Northland, where it has since established), likely through ballast water.

**Life history:** Colonies were reproductive for nine months of the year (from October through to June) and embryos were present in zooids at water temperatures above 14°C, embryos also remain viable as low as 10°C (Page et al. 2011).

**Habitat:** The tunicate occupies a wide range of habitats in sheltered bays, colonising natural and artificial substrata (particularly aquaculture equipment) (Smith et al. 2007)

**Impact:** This tunicate species outcompetes native species for both food and space, as well as fouling oyster aquaculture operations (Page et al. 2011).

## 2.2.8 Australian cunjevoi (Pyura dopplegangera)



Figure 9: (above) Pyura dopplegangera (credit: Brian Azzopardi), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/searchfor-species



**Description:** The Pyura sea squirt is brown coloured with a sack-like body which can grow up to 15cm long and can form large colonies.

**Geographic range:** The Australian cunjevoi is native to Australia but has been in New Zealand since 2007 and has travelled as far south as Nelson.

**Life history:** Little is known about the reproductive biology of the tunicate, however it has been noted that larvae can only spend a maximum of 12 hours in the water column and there are high levels of larval retention at the parent site (Davis and Hepburn 2020).

**Habitat:** The tunicate is usually found in rock platforms down to depths of 12m.

**Impact:** The tunicate is an invasive ecosystem engineer that can threaten to competitively exclude bivalves such as *Perna canaliculus* from their native habitat (Davis et al. 2018). On the contrary, a recent study in Northland has determined that the Australian cunjevoi is not an aggressive competitor as once thought and is not a threat to native communities (Atalah et al. 2021).

## 2.3 Potential organisms of interest (unwanted organisms)

### 2.3.1 Aquarium caulerpa (Caulerpa brachypus)



Figure 10: (above) Caulerpa brachypus (credit: Laboratory of Scientific Projects, Saint Petersburg), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/searchfor-species

**Description:** Aquarium caulerpa is bright green with feather-like fronds and



flattened with a smooth midrib and branchlets.

**Geographic range:** *C.brachypus* is native to the Indo-Pacific region but was found in Aotea (Great Barrier) island in 2021.

**Life history:** The caulerpa seaweed reproduces by vegetative fragmentation, with fragments as small as 4mm being able to survive and attach to substrata within two days (Walters 2009). A similar seaweed in the same genus *Caulerpa taxifolia* was found to have peak reproductive activity occurring in February/March (Phillips 2009).

**Habitat:** The species has a cold tolerance between 9-11°C and grows between the tideline at 6-10 metres depth on both hard surfaces and in sandy areas (Chisholm et al. 2000)

**Impact:** In favourable conditions Caulerpa seaweeds can spread rapidly, forming vast dense beds, negatively impacting native seaweeds (Luigi et al. 2001).

## 2.3.2 Northern Pacific seastar (Asterias amurensis)



Figure 11: Asterias amurensis (credit: Serena Cox, NIWA)

### **NOT PRESENT IN NZ YET**

**Description:** The Northern Pacific Sea generally has five arms each up to 40-60mm long, with topside of the sea star generally yellow with purple markings.

**Geographic range:** The Northern Pacific Sea star is native to the Northern Pacific (Japan and Russia) and is invasive in Australia.

**Life history:** The sea star reproduces both sexually and asexually, spawning between July and October, with female sea stars carrying up to 20 million eggs (Byrne et al. 1997).

**Habitat:** It is found in shallow waters of protected coasts, preferring water temperatures between 7-10°C, making Otago waters susceptible to invasion.

**Impact:** It has observed negative impacts on native benthic assemblages, fisheries, and aquaculture operations (Ross 2001).

## 2.3.3 European shore crab (Carcinus maenus)



Figure 12: Carconus maenus (credit: MIchael Marmach)

### NOT IN NEW ZEALAND YET

**Description:** The European shore crab has varying colour ranging from green on top to yellow underneath, to red above and orange beneath. The adult carapace is up to 8cm wide and they are characterised by three rounded lobes between the eyes.

**Geographic range:** The European shore crab is native to the Eastern coast of the Atlantic (from Norway to Mauritania) and is an unwanted organism in New Zealand.

**Life history:** Ovarian development of the females occurs biannually with a primary winter cycle in which larger crabs reproduced and a secondary summer cycle when smaller crabs reproduced (Lyons et al. 2012).

**Habitat:** The crab survives in temperatures between -2°C to 33°C and inhabits shallow, protected bays to exposed shores (up to 60m deep).

**Impact:** They are aggressive predators that can displace native and fisheries species, with additional impacts on aquaculture operations (Gregory et al. 2002)

# 2.3.4 Asian clam (Potamocorbula amurensis)



Figure 13: Potamocorbula amurensis (credit: YHshells, Hao Yang)

### NOT IN NEW ZEALAND YET

**Description:** The shell of an Asian clam can be yellow, tan or dirty white with brown staining up to 3cm in length, there is also a distinctive 'overbite' in shells.

**Geographic range:** The Asian clam is native to eastern Russia and Japan and is an unwanted organism in New Zealand.

**Life history:** They spawn throughout the year in invaded areas, with larvae that are euryhaline (2 to 30 PSU) resulting in invasion success (Nicolini and Penry 2000).

**Habitat:** They occur in sand, mud and clay sediments within subtidal and intertidal environments.

**Impact:** They can grow to high densities and reduce the concentration of plankton in the water available for native species (Miller et al. 2014).

## 2.3.5 Bonnemaisonia seaweed (Bonnemaisonia hamifera)



Figure 14: (above) Bonnemaisonia hamifera (credit: David J. Garbary), and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/search-for-



**Description:** *B.hamifera* is a red alga that forms feathery fronds and grows to a length of 35cm.

**Geographic range:** The seaweed is native to Japan and has become widespread in the North Atlantic where it is common on temperate coasts of both Europe and North America. It was first recorded in Karitane, in the South Island of New Zealand in 2019.

**Life history:** This seaweed displays both gametophytic and sporophyte stage life cycle. In New Zealand, the *B.hamifera* population spans seasons and in different habitats due to its filamentous stage, similar to other invasive seaweeds (Garbary et al. 2020).

Habitat: Sandy substrate in low intertidal zones.

**Impact:** Changes native community composition, and forms blooms showing growth as balls (Garbary et al. 2020).

## 2.3.6 Asian date mussel (Arcuatula senhousia)



Figure 15: Figure 15: (above) Arcuatula senhousia (credit: Olivia Johnstone) and (right) its distribution in New Zealand. Viewed on 15/02/2022 at https://marinebiosecurity.org.nz/se arch-for-species



**Description:** The Asian date mussel is a greenish colour with zigzag markings on its shell, it can grow as big as 3cm in length.

**Geographic range:** The mussel is native to the Pacific Ocean from Siberia to Singapore, but arrived in Auckland's Waitemata estuary in the 1970s (Hayward et al. 2008).

**Life history:** The mussel is observed to spawn in austral autumn and has the lowest abundance during the summer anoxia period (Mistri 2002).

Habitat: The mussel inhabits intertidal and subtidal zones to a depth of 20 meters.

**Impact:** Has negative impacts on benthic communities as they outcompete native species for food and space (Lourenço et al. 2018).

## 2.3.7 Chinese mitten crab (Eriocheir sinensis)



Figure 16: Eriocheir sinensis (credit: University of Valencia)

### NOT IN NEW ZEALAND YET

**Description:** The Chinese mitten crab is characterised by a light brown to olive green carapace and a hairy 'mitten' with white tips on its front claws.

**Geographic range:** Its native range is between Vladivostok (eastern Russia) and South China, including Japan and Taiwan.

**Life history:** The mitten crab spawns in the summer months in the brackish water or saltwater areas of estuaries, and offspring migrate up to brackish or freshwater for rearing. Larvae are able to survive and grow in temperature ranges between 15-18 °C (Veldhuizen and Stanish 2002)

**Habitat:** The crabs are found brackish water and in muddy riverbanks at varying developmental stages

**Impact:** The crab can form dense colonies that can disrupt native ecosystems and fisheries species due to excessive burrowing (Rudnick et al. 2000)

### 2.4 High risk sites structures and pathways

### 2.4.1 Pathways in Otago

The human-mediated invasion of NIS into new marine regions in New Zealand can be mainly attributed to vessel traffic and aquaculture activities, specifically through ballast water, hull biofouling, and sea chests (water intake recesses in the hull) (Dodgshun et al. 2007). In Port Otago (an international seaport) approximately 83 % (15 of 18 species) of NIS are likely to have been introduced in hull fouling assemblages, 6 % via ballast (one species) water and 11 % (two species) could have been introduced by either ballast water or hull fouling vectors (NIWA, 2005). Although international vessel traffic is a significant vector for the transport of NIS into New Zealand, domestic vessel movements (such as fishing boats) aid in the dispersal of NIS between and within marine regions in New Zealand. Biofouling of NIS is enhanced on static artificial structures (Hopkins et al. 2021), these can include moorings, moored vessels and fishing equipment. Although Otago does not have marine aquaculture operations, it is perhaps also worth noting that anthropogenic marine debris from aquaculture facilities such as plastics ropes also enhance the spread of NIS (Campbell et al. 2017). The risk of invasion of NIS to high value areas such as kelp forest ecosystems which are ecologically, culturally and recreationally important, are heightened with recreational vessel traffic (Iacarella et al. 2020).

## 2.4.2 Sites and structures in Otago

As highlighted above, vessels and artificial structures greatly enhance the establishment of NIS, therefore it is imperative to monitor ports, harbours, wharfs, moorings, and other artificial structures in the Otago marine region. The MHRSS programme already monitors artificial structures in the Otago Peninsula bi-annually, particularly sites near Port Otago, reducing the need for the ORC to monitor these areas. However, it is still important that the

ORC corresponds with Biosecurity NZ and NIWA regarding areas within the peninsula that potentially need additional monitoring. Although intertidal and subtidal zones are also high-risk areas where NIS can be detected, due to the abundance of coastline in the Otago region it would be cost-ineffective to monitor these areas. Rather, it could be beneficial to include photos and information about marine pests in popular estuaries and beaches where many burrowing NIS such as the Asian Mitten Crab can be found.

## High risk areas in the Otago coastal marine region:



Figure 17: HIgh risk areas in the Otago coastal marine region; sites include Oamaru harbour, Moeraki, Karitane, Otago Peninsula, and the Catlins (in order from top to bottom)

- Oamaru/Te Oha-a-Maru Harbour wharfs, vessels, moorings, fishing equipment, and other artificial structures
- 2. Moeraki wharfs, vessels, moorings, fishing equipment, and other artificial structures
- **3. Karitane** wharfs, vessels, moorings, fishing equipment, and other artificial structures

- Otago Harbour wharfs, boating clubs, vessels, moorings, and other artificial structures
- 5. Catlins Boating clubs, vessels, and other artificial structures

### Regions to include information boards regarding marine pests:

- 1. Estuaries Kakanui, Shag, Waikouaiti, Kaikorai, Taieri, Tokomairiro and Catlins
- 2. Beaches Saint Clair, Moeraki, Warrington and other popular beaches
- Fishing and diving areas Aramoana mole, Blueskin Bay and other popular fishing and diving spots

### 2.5 Methods for surveillance in Otago

### 2.5.1 Monitoring for marine pests

Surveys methods undertaken by the MHRSS programme includes diver searches, benthic sleds, crab condos and crab traps (Woods et al. 2020). Additional to the bi-annual MHRSS diver surveys (in winter and summer), it could be beneficial to undertake diver surveys in some of the high-risk areas (particularly in the Otago Harbour) other seasons (particularly spring) with the help of the scientific divers from the University of Otago. The ORC should consider contacting the Biosecurity NZ and NIWA for specialised NIS surveillance tools such as crab traps. The ORC should also continue to monitor future NIS monitoring methods such as using eDNA monitoring (Ellis et al. 2021) and using settlement plates (Tait et al. 2018).

# 2.5.2 Hull inspections for marine pests

Regular hull inspections for commercial and recreational vessels should be considered in the Otago region to detect new NIS or range extensions of existing NIS. Inspections of older, out-of-service vessels that possess greater levels of biofouling should be prioritized (Coutts

and Taylor 2004). Further, a pathway management plan could be established with passes for 'clean' vessels such as the one established in Fiordland (Cunningham et al. 2019) to reduce biofouling and NIS spread on fishing vessels. Yachts should also be monitored as they are also deemed to be high risk for marine biosecurity and can aid in the transfer of NIS through bilge water (Fletcher et al. 2021).

## 3. Conclusions

The Otago coastal marine area provides an array of valuable ecosystem services to the Otago community. The diverse and rich biodiversity found in the Otago marine realm provides the region with tourism and other economic benefits. Unfortunately, due to heavy vessel traffic and other transport vectors, the marine ecosystems in Otago are threatened by invasions by marine pests. Marine pests often have deleterious effects on native marine communities which in turn will reduce the economic, cultural, and recreational benefits provided by the Otago coastal region. Because of this, continual monitoring of marine pests in the Otago coastline is pivotal to maintaining the health of our coastlines for future generations to come.

## 4. Recommendations for the Otago Regional Council:

- Establish a marine biosecurity plan for marine non-indigenous species listed as
  organisms of interest in the pest management plan as well as for additional unwanted
  organisms listed in this report. This should be done in correspondence with
  Biosecurity New Zealand, NIWA, neighbouring regional councils (particularly
  Environment Southland), Port Otago, and the University of Otago.
- Establish a surveillance programme for marine organisms of interest in high-risk areas
  outside of the Otago Peninsula (already surveyed bi-annually by Biosecurity New
  Zealand) on artificial structures in Oamaru, Moeraki, Karitane and the Catlins.

- Consider putting information boards about marine pests in popular fishing and diving sites in the Otago region so the general public can help the council with pest surveillance
- 4. Consider removing the Asian paddle crab (*Charybdis japonica*) from the organisms of interest list as spawning of this species only occurs in sea water temperatures much higher than those observed in the Otago coastal marine area.
- 5. Consider adding the seven non-indigenous species listed in section 2.3 of this report to the list of organisms of interest in the regional pest management plan

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## 1 Appendix 1

- 2 Table 1: List of marine non-indigenous specie (NIS)s that have established or are at risk of invasion to the Otago coastal marine region based on
- 3 species monitored in the Otago Regional Pest Management Plan (BOLD) and from the MHRSS programme (since 2015 surveillance report).
- 4 Information about marine NIS was mainly obtained from the Invasive Species Compendium from the Centre of Agriculture and Biosciences
- 5 International (CABI). P/A indicates whether the species is present (P) or absent (A) in New Zealand (NZ) and Otago (OTA).

Species	Common name	Pathway	Impact	Habitat	Temp/Salinity/Depth range	P/A NZ (OTA)
Charybdis japonica	Asian paddle crab	Ballast water, vessel biofouling	Opportunistic predator of benthic invertebrates	In intertidal regions including inlets, harbours and bays with firm sand or muddy sand benthos	-1-34 °C, 4-34 PSU, 1-15m	P(A)
Sabella spallanzanii	Mediterranean fanworm	Ballast water vessel biofouling and aquaculture biofouling, artificial marine structures	Outcompetes native species for food and space, fouls aquaculture operations	In subtidal regions on artificial structures, natural reef, and soft sediment habitats	4-29 °C, 26-38 PSU, 1-30m	P (P)
Agropyron pungens	Sea couch	Vegetative (rhizome) spread	Outcompetes native species and impacts dune ecosystem function	Beaches and intertidal mudflats	N/A	P (P)

Styela clava	Clubbed tunicate	Ballast water, vessel and aquaculture biofouling, kelp rafts	Outcompetes native species for food and space, fouls aquaculture and fishing equipment, negative impacts on human health (indirect)	Subtidal regions on both natural and artificial structures	-2-27 °C, 10-36 PSU, 1-25m	P (P)
Eudistoma elongatum	Australian droplet tunicate	Vessel and aquaculture biofouling	Outcompetes native species for food and space, fouls aquaculture equipment	Intertidal regions in sheltered bays and harbours on natural and artificial substrate	>10 °C, >10 PSU, 1- 2m	P (A)
Pyura doppelgangera	Australian cunjevoi	Vessel biofouling	Outcompetes native species for food and space	Subtidal rocky reefs	>12 °C, >26 PSU, 0- 12m	P (A)
Didemnum vexillum	Carpet sea squirt	Ballast water, vessel, and aquaculture biofouling	Smothers native species, aquaculture operations and fisheries species	Subtidal rocky reefs	1-2 °C, >20-45 PSU, 0-80m	P (P)
Undaria pinnatifida	Wakame Asian kelp	Vessel and aquaculture biofouling, artificial marine structures, drifting sporophytes	Restructuring subtidal communities, fouling	Intertidal and subtidal regions	0.1-30 °C, >18 PSU, 0-15m	P (P)
Asterias amurensis	Northern Pacific seastar	Ballast water, vessel biofouling	Negative impacts on native, fisheries and aquaculture species	Sheltered coasts	0-25 °C, 18.7-41 PSU, 0-220m	A (A)
Caulerpa taxifolia	Killer algae	Aquarium trade and fisheries	Reduces native biodiversity by forming dense beds	Estuaries, harbours, and sheltered bays	9-32.5 °C, > 17 PSU, 3-30m	P (A)

Caulerpa brachypus	Aquarium caulerpa	Aquarium trade and fisheries	Reduces native biodiversity by forming dense beds	Subtidal rocky and sandy regions	9-32.5 °C, > 17 PSU, 6-10m	P (A)
Carcinus maenus	European shore crab	Ballast water, vessel and aquaculture biofouling	Negative impacts on native biodiversity and ecosystem function	Intertidal and subtidal regions	0-33 °C, 1.4-54PSU, 0-60m	A (A)
Potamocorbula amurensis	Asian clam	Ballast water	Outcompetes native species for food and space, negative impact on fisheries/aquaculture operations	Intertidal and subtidal regions	6-23 °C, 0.2-42PSU, 0-30m	A (A)
Grateloupia turuturu	Devil's tongue weed	Ballast water, vessel and aquaculture biofouling	Negative impacts on native biodiversity and ecosystem function	Intertidal and subtidal regions	4-29 °C, 12-52PSU, 0-2.4m	P (P)
Botrylloides diegensis	San Diego sea squirt	Ballast water, vessel and aquaculture biofouling	Outcompetes native species for food and space, negative impact on fisheries/aquaculture operations	Rock reefs	>15 °C, >25 PSU, 1- 170m	P (P)
Ascidiella aspersa	European sea squirt	Ballast water and vessel biofouling	Negative impacts on native biodiversity and ecosystem function	Subtidal regions	N/A, 18-40 PSU,0- 30-0m	P (P)
Ciona savignyi	Pacific transparent sea squirt	Ballast water vessel biofouling and aquaculture biofouling	Outcompetes native species for food and space, negative impact on fisheries/aquaculture operations	Rocks and substrate in subtidal regions	-1.7-27 °C, 24-37 PSU, 1-100m	P (P)
Ciona intestinalis	Sea vase	Ballast water vessel biofouling	Outcompetes native species for food and space, negative impact on	Rocks and substrate in	-1-30°C, 34-42 PSU, 1-100m	P (P)

		and aquaculture biofouling	fisheries/aquaculture operations	subtidal regions		
Caprella mutica	Japanese skeleton shrimp	Vessel and aquaculture biofouling	Reduces native biodiversity and modifies benthic communities	Subtidal regions attached to substrate	-1-25°C, 10-42 PSU, 0.5-20m	P (P)
Diplosoma listerianum	Unnamed sea squirt	Live seafood, ballast water and vessel biofouling	Reduces native biodiversity and modifies benthic communities	Subtidal and intertidal regions	0-28°C, 25-34 PSU, 0-15m	P (P)
Polyandrocarpa zorritensis	Unnamed sea squirt	Ballast water, vessel biofouling and aquaculture biofouling	Negative impacts on native biodiversity and ecosystem function	Hard substrate in shallow water	8-30°C, 35-39 PSU, 0.5-5m	P (A)
Apocorophium acutum	Unnamed amphipod	Vessel and aquaculture biofouling	Negative impacts on native biodiversity and ecosystem function	Marine sediments in intertidal regions	N/A	P (P)
Botrylloides giganteum	Unnamed sea squirt	Vessel biofouling	Outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)
Clavelina lepadiformis	Light bulb sea squirt	Ballast water, vessel biofouling and aquaculture biofouling	Outcompetes native species for food and space	Substrate in subtidal regions	>12°C, 14-35 PSU, 0- 50m	P (A)
Thecacera pennigera	Winged thecacera	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)
Thalamoporella californica	Unnamed bryozoan	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)

Omobranchus anolius	Oyster blenny	Ballast water	Likely outcompetes native species for food and space	Shallow estuarine waters	N/A	P (A)
Pachymeniopsis lanceolata	Unnamed red algae	Vessel biofouling and aquaculture biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)
Polysiphonia brodiei	Unnamed red algae	Vessel biofouling and aquaculture biofouling	Reduces native biodiversity and modifies benthic communities	Substrate in subtidal regions	>0°C, N/A, 0-8m	P (A)
Lissoclinum perforatum	Unnamed sea squirt	Likely ballast water, vessel biofouling and aquaculture biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)
Bugulina flabellata	Unnamed bryozoan	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)
Celleporaria nodulosa	Unnamed bryozoan	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	<27°C, N/A, N/A	P (A)
Tricellaria inopinata	Unnamed bryozoan	Vessel biofouling and aquaculture biofouling	Negative impacts on native biodiversity and ecosystem function	Substrate in intertidal and subtidal regions	3-34°C, 20-35 PSU, N/A	P (A)
Watersipora subatra	Red ripple bryozoan	Likely vessel biofouling	Outcompetes native species for food and space, negative impact on aquaculture operations	Substrate in subtidal regions	N/A	P (A)
Amphilectus fucorum	Shredded carrot sponge	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in intertidal and subtidal regions	N/A	P (A)

Ectopleura crocea	Tubular hydroid	Likely vessel biofouling	Outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)
Neosiphonia sertularioides	Unnamed red algae	Likely ballast water, vessel and aquaculture biofouling	Likely has negative impacts on native biodiversity and ecosystem function	Intertidal and subtidal regions	N/A	P (A)
Celleporaria umbonatoidea	Unnamed bryozoan	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)
Goniodoris meracula	Unnamed sea slug	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in intertidal and subtidal regions	N/A, N/A, 0-10m	P (A)
Jassa slatteryi	Unnamed amphipod	Likely vessel biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)
Ulva tanneri	Unnamed green algae	Ballast water	Modification of natural benthic communities	Intertidal and subtidal regions	N/A	P (A)
Bugula neritina	Brown bryozoan	Ballast water and vessel biofouling	Negative impacts on aquaculture and fisheries operations	Hard substrate in intertidal and subtidal regions	N/A, 18-30 PSU, 0- 5m	P (A)
Baseodiscus delineatus	Unnamed nemertean	Likely vessel biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)
Megabalanus coccopoma	Titan acorn barnacle	Vessel biofouling	Negative impacts on aquaculture and fisheries operations	Hard substrate in intertidal and	N/A, N/A, <100m	P (A)

				subtidal regions		
Hydroclathrus tilesii	Unnamed brown algae	Likely ballast water, vessel and aquaculture biofouling	Likely has negative impacts on native biodiversity and ecosystem function	Intertidal and subtidal regions	N/A	P (A)
Clathrina procumbens	Unnamed sponge	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in intertidal and subtidal regions	N/A	P (A)
Hypnea cervicornis	Unnamed red algae	Live seafood and vessel biofouling	Negative impacts on native biodiversity and ecosystem function	Hard substrate in intertidal and subtidal regions	N/A	P (A)
Hypnea corona	Unnamed red algae	Live seafood and vessel biofouling	Negative impacts on native biodiversity and ecosystem function	Hard substrate in intertidal and subtidal regions	N/A	P (A)
Polysiphonia morrowii	Unnamed red algae	Likely vessel biofouling	Outcompetes native species for food and space	Intertidal and subtidal regions	6-25°C, N/A, N/A	P (A)
Arcuatula senhousia	Asian date mussel	Ballast water, vessel biofouling and aquaculture biofouling	Negative impacts on native biodiversity and ecosystem function	Intertidal and subtidal regions	0.8-31.1°C, 18-35.5 PSU, 0-20m	P (A)
Caprella scauroides	Unnamed amphipod	Vessel and aquaculture biofouling	Likely reduces native biodiversity and modifies benthic communities	Subtidal regions attached to substrate	N/A	P (A)

Phoronis ijimai	Horsehoe worm	Likely vessel and aquaculture biofouling	Likely outcompetes native species for food and space	Hard substrate in subtidal regions	N/A	P (A)
Lysmata californica	Red rock shrimp	Likely vessel and aquaculture biofouling	Likely outcompetes native species for food and space	Subtidal regions	10-20°C, N/A, 0-60m	P (A)
Grateloupia subpectinata	Unnamed algae	Likely ballast water, vessel, and aquaculture biofouling	Likely has negative impacts on native biodiversity and ecosystem function	Intertidal and subtidal regions	N/A	P (A)
Fushitsunagia catenata	Unnamed algae	Likely ballast water, vessel and aquaculture biofouling	Negative impacts on native biodiversity and ecosystem function	Intertidal and subtidal regions	N/A	P (A)
Schizymenia apoda	Unnamed algae	Likely ballast water, vessel and aquaculture biofouling	Negative impacts on native biodiversity and ecosystem function	Intertidal and subtidal regions	N/A	P (A)
Ectopleura larynx	Ringed tubularia	Likely vessel biofouling	Negative impacts on native biodiversity and aquaculture operations	Hard substrate in subtidal regions	N/A, N/A, 10-30m	P (A)
Pennaria disticha	Unnamed hydroid	Likely ballast water, vessel biofouling and aquaculture biofouling	Likely outcompetes native species for food and space	Hard substrate in subtidal regions	N/A, N/A, 0-29m	P (A)
Melibe australis	Unnamed sea slug	Likely vessel biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)

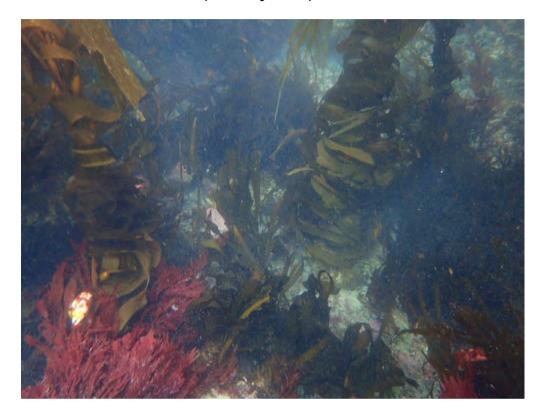
Paraheteropia ijimai	Unnamed sponge	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in intertidal and subtidal regions	N/A	P (A)
Nevianipora pulcherrima	Unnamed bryozoa	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)
Arenigobius bifrenatus	Bridled goby	Likely ballast water	Likely outcompetes native species for food and space	Shallow estuarine waters	N/A	P (A)
Bonnemaisonia hamifera	Unnamed algae	Likely ballast water, vessel and aquaculture biofouling	Negative impacts on native biodiversity	Intertidal regions	-1-29°C, 11-35 PSU, N/A	P (P)
Schizymenia dubyi	Unnamed algae	Likely ballast water, vessel and aquaculture biofouling	Likely outcompetes native species for food and space	Intertidal regions	N/A	P (A)
Chromadorina tangaroa*	Unnamed nematode	Vessel biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)
Polycera hedgpethi	Unnamed sea slug	Vessel biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)
Striaria attenuata	Unnamed algae	Likely ballast water, vessel, and aquaculture biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	<31.9°C, N/A, N/A	P (A)
Amathia chimonidesi	Unnamed bryozoan	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)

Chaetomorpha linum	Unnamed algae	Likely ballast water, vessel, and aquaculture biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)
Cladophora vagabunda	Unnamed algae	Likely ballast water, vessel, and aquaculture biofouling	Outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)
Acentrogobius pflaumii	Unnamed fish	Ballast water	Modification of natural benthic communities	Estuarine intertidal regions	>8°C, N/A, N/A	P (A)
Polycera fujitai	Unnamed sea slug	Vessel biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)
Magallana gigas	Unnamed bivalve	Ballast water and vessel biofouling	Negative impacts on native biodiversity and ecosystem function	Substrate in subtidal regions	3-35°C, 5-45 PSU, N/A	P (A)
Oratosquilla oratoria	Japanese mantis shrimp	Likely vessel biofouling	Likely outcompetes native species for food and space	Estuarine intertidal and subtidal regions	N/A	P (A)
Clavelina oblonga	Unnamed ascidian	Likely ballast water, vessel biofouling and aquaculture biofouling	Negative impacts on native biodiversity	Substrate in subtidal regions	N/A	P (A)
Tritia burchardi	Australian dog whelk	Likely vessel biofouling	Likely outcompetes native species for food and space	Intertidal regions	N/A	P (A)
Okenia pellucida	Unnamed sea slug	Likely vessel biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)

Paralepidonotus ampulliferu	Unnamed annelid	Likely vessel and aquaculture biofouling	Likely outcompetes native species for food and space	Hard substrate in subtidal regions	N/A	P (A)
Symplegma brakenhielmi	Unnamed sea squirt	Likely ballast water, vessel biofouling and aquaculture biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A	P (A)
Amathia verticillata	Spaghetti bryozoan	Likely vessel biofouling	Negative impacts on aquaculture and fisheries operations	Substrate in intertidal and subtidal regions	N/A	P (A)
Halisarca dujardini	Unnamed sponge	Likely vessel biofouling	Likely outcompetes native species for food and space	Substrate in subtidal regions	N/A, N/A, 10-50m	P (A)
Caprella penantis	Unnamed amphipod	Vessel and aquaculture biofouling	Likely reduces native biodiversity and modifies benthic communities	Substrate in intertidal and subtidal regions	N/A	P (A)
Chironemus maculosus	Unnamed fish	Ballast water	Modification of natural benthic communities	Estuarine intertidal regions	N/A	P (A)
Botrylloides leachi	Unnamed sea squirt	Ballast water, vessel, and aquaculture biofouling	Outcompetes native species for food and space, negative impact on fisheries/aquaculture operations	Rocky reefs	N/A	P (A)
Stictyosiphon soriferus	Unnamed algae	Likely ballast water, vessel, and aquaculture biofouling	Likely outcompetes native species for food and space	Intertidal and subtidal regions	N/A	P (A)

Conopeum	Unnamed	Likely vessel	Likely outcompetes native	Substrate in	N/A	P (A)
seurati	sponge	biofouling	species for food and space	subtidal		
				regions		
Watersipora	Unnamed	Likely vessel	Likely outcompetes native	Substrate in	N/A	P (A)
subatra	sponge	biofouling	species for food and space	subtidal		
				regions		
Distaplia viridis	Unnamed sea	Likely ballast	Likely outcompetes native	Substrate in	N/A	P (A)
-	squirt	water, vessel	species for food and space	subtidal		
	•	biofouling and	•	regions		
		aquaculture				
		biofouling				

# Distribution of *Undaria pinnatifida* along the Otago coast (January 2023).



Report produced for the Otago Regional Council

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#### **Executive Summary**

The kelp *Undaria pinnatifida* (Wakame) a marine invasive species originating from Japan and Korea is now widely distributed in temperate ecosystems in all major oceans. It arrived in New Zealand in 1987 most likely as a result of hull fouling of ships. *Undaria pinnatifida* arrived in Otago Harbour in 1991 and several studies have described its distribution and effects on natural ecosystems. This report synthesizes past research on *U. pinnatifida* and describes the extent of *U. pinnatifida* along the Otago coast. As the distribution of *U. pinnatifida* north of Otago Harbour has been relatively well documented, additional surveys at 17 sites along the south coast (from Taiaroa Head to Slope Point) were conducted during January 2023.

Past research from 2005 - 2022, indicates that *U. pinnatifida* is well established from Oamaru to Dunedin. These studies included visual surveys, manual removals, and ecosystem function experiments. High densities have been recorded in Moeraki, Otago Harbour, and the East Otago Taiāpure. *U. pinnatifida* has been previously observed at Taiaroa Head and in and near the entrances of Papanui and Hoopers Inlet but it has not been found further south in the Otago region. The range of *U. pinnatifida* has continued to increase and *U. pinnatifida* can grow on a wide range of surfaces including invertebrates and other algae species. *Undaria pinnatifida* can reach high densities and does not provide the same habitat values of native species. However, manual removal has been found effective at reducing biomass.

In this study, an established population was only found at Hoopers Inlet. However, at both ends of Wickliffe Bay, *U. pinnatifida* was found floating in the water column near the reef substrate. It appears that there has been no further southward range expansion since this area was surveyed in 2005. While *U. pinnatifida* has yet to be observed from Hoopers Inlet to Waikawa in the south, it is well established in the rest of the Otago region. The highest risk location on the south coast are good weather anchorages such as the inside of Okaihea (Green Island) and the more sheltered area to the east of Moturata (Taieri Island) where vessels wait to cross the Taieri bar. The wharf area at Taieri Mouth is likely less susceptible due to lowered salinity from the influence of the Taieri River. For the management of *Undaria*, surveillance of high value areas and supporting control programs should be a high priority.

The spread of *Undaria* provides a case study for what might happen if other marine invasive species reach Otago. Currently national monitoring for invasive species focuses on Otago Harbour, the region's major port. Secondary ports and areas of high anchorage used by smaller vessels are currently not surveyed where invasive species such as the Mediterranean fan worm (*Sabella spallanzanii*), invasive *Caulerpa* sp., could become or already be established without detection. Vessels like yachts that use smaller ports are a likely vector for establishment of a marine invasive species in the Otago region. Secondary port monitoring would allow early detection and rapid response, reducing potential damage and the likelihood of invasive species becoming established and dominating important and valuable coastal ecosystems in Otago like *U. pinnatifida* has. A careful risk assessment and response plan for different potential marine invasives in the Otago region is needed. Secondary port and anchorage surveillance is likely key. Only with a rapid response and a clear species specific action plan is effective management of a new incursion of an invasive species possible.

#### Introduction

Invasive species can displace native species, and change to community structure/food webs and changes to nutrient cycling and sedimentation (Hobbs 2000). This in turn, can result in economic damage through the diminishment of valuable native species, costs of mitigation, and damage to artificial structures (Molnar et al. 2008, Pimentel et al. 2000). Marine macroalgae are an ecosystem engineer profoundly changing the environment win which they establish, therefore invasive algae that often possess different traits to native species could affect many native species, reduce biodiversity and significantly change habitat dynamics (Lawton and Jones 1995).

Undaria pinnatifida is a successful invasive kelp species originating from the Northwest Pacific. Undaria pinnatifida has plastic growth (meaning both microscopic and adult life stages can tolerate broad ranges of temperature and salinity (Henkel and Hofmann 2008, Bollen et al. 2016). It also has the ability to disperse over stances up to 100 m via microscopic zoospores and larger distances via floating sporophytes (Forest et al. 2000) and to attach to many different substrates (both natural and artificial (Russell et al. 2008)). Undaria pinnatifida has rapid growth and high reproductive output (Casas et al. 2008, Primo et al. 2010) and efficient photosynthetic performance (Desmond et al. 2019) and nutrient uptake (Dean and Hurd, 2007) compared to other laminarians. Undaria pinnatifida prefers sheltered areas with lower disturbance, but its plasticity has allowed it establish populations in wave exposed environments (Brown and Lamare 1994, Russell et al. 2008) and it is now a dominant component of wave exposed coastlines in Southern New Zealand (Desmond et al. 2019, Howarth 2022, Keeler-May 2022). Studies have also shown that native kelp communities are less resistant to U. pinnatifida invasion when disturbance events are frequent, as this reduces the cover of the native algae canopy, facilitating invasion (Valentine and Johnson 2003, Tait and Schiel 2011). These competitive advantages and transportation via anthropogenic processes have allowed *U. pinnatifida* to extend its geographic range throughout the Atlantic and Pacific Oceans, establishing itself in thirteen different countries across four continents (James et al. 2015).

The global dispersal of *U. pinnatifida* is largely facilitated by the transportation via fouling of on ship hulls (Hay & Luckens 1987). *Undaria pinnatifida* was first discovered in New Zealand in 1987 in Wellington Harbour (Hay and Luckens 1987). It has since spread throughout the country (establishing in major ports first), even up to northern parts of New Zealand which were previously thought to be uninhabitable by *U. pinnatifida* (James and Shears 2012). *Undaria pinnatifida* was discovered in Otago Harbour in 1990 (Hay and Villouta 1993), and was found throughout the harbour by 2005 (Russell et al. 2008). This source population has enabled dispersal up the coast. Densities along the North Otago coast have significantly increased and saw a 12 km northward range expansion within a six-year period (1999-2005) and expansion form secondary ports in Oamaru and Moeraki was also observed (Russell et al. 2008).

#### Undaria pinnatifida in the Otago Region

A number of projects have worked on the distribution of *U. pinnatifida* in the lower South Island. Here we summarise the main findings of these studies. Based on these studies, the distribution of *U. pinnatifida* along the Otago coast is also provided in Figure 1.

Russell et al (2008) documented the range expansion of *U. pinnatifida* in Otago Harbour from 1990 to 2004 and the geographic range of *U. pinnatifida* on the coastline of the southern South Island. The range of *U. pinnatifida* in Otago harbour expanded from Port Chalmers and increased substantially between surveys from 1997 to 2004. Most locations around the perimeter of the harbour support patches of *U. pinnatifida*. The range expansion of *U. pinnatifida* outside of the harbour was limited to the north coast. *U. pinnatifida* was absent form large stretches of coastline south of Otago harbour. Founding populations were found to start in the intertidal zone. *Undaria pinnatifida* was found to be capable of invading native communities in wave exposed areas with sporophytes found amongst bull kelp species. Indicating that disturbance events are not needed for invasion. There was little range expansion form Bluff harbour. This was likely due to a monthly manual eradication from port structures. However, the funding for this stopped in 2004.

Richards (2009) documented an increase in *U. pinnatifida* distribution north since the work by Russell et al (2008). Similarly wave exposure had no effect on *U. pinnatifida* density. *Undaria pinnatifida* was also found growing as an understory algae in kelp forests which may exclude native understory species. Richards (2009) also conducted experiments on the photosynthetic rate of *U. pinnatifida* and native macroalgae communities. Density of *U. pinnatifida* (ranging from 5 to 25 individuals per m²) did not decrease photosynthetic rate indicating that *U. pinnatifida* performs well in dense strands. Richards (2009) also simulating disturbance by providing new space in shallow subtidal native macroalgae communities. It was found that the native communities that are present in Otago take a long time to form (greater than 14 months). The photosynthetic rate and productivity of these communities was directly affected by the variety and amount of algae.

The ecological function of *U. pinnatifida* was studied from 2011 – 2014 by Rocío Suárez Jiménez for her PhD and subsequently published in Suárez Jiménez et al. 2015, 2017a and b). *Undaria pinnatifida* was found to be an abundant but inconsistent resource in Otago, comprising up to 75 % of macroalgae assemblages in December but less than 10 % in April. During food preference experiments with invertebrates such as pāua (*Haliotis iris*), sand hopper (*Bellorchestia quoyana*), and Cook's turban (*Cookia sulcata*), *U. pinnatifida* was found to be consumed, but not preferred. The role of *U. pinnatifida* as habitat was also investigated. *Undaria* was found to host only a quarter of the density of invertebrates compared to native species such as *Carpophyllum* spp, *Cystophora* spp., and *Sargasium* spp. This was because of *U. pinnatifida* has lower morphological complexity than these native species. The work by Suárez Jiménez et al. indicates that *U. pinnatifida* can provide an ecological role in the form of food and habitat but at a lesser extent than native species due to its season lifecycle and simple morphology.

The focus of Howarth (2021) was the depth distribution and settlement surface of *U. pinnatifida* introduced to a new environment. *Undaria pinnatifida* was found to invade the intertidal, then once established spread deeper. *Undaria pinnatifida* was found to show epiphytic behaviour growing on several species such as: mussels, tunicates, ascidians, *Adamsiella chauvinii*, *Corallina spp.*, *Aspargopsis armata*, ducks bill limpet and pāua. Over 49 sites surveyed in the southern South Island, 19 % of Undaria was epiphytic. Epiphytic attachment was 16 % in Otago Harbour and 8 % in Moeraki. The distribution range of *U. pinnatifida* was also found to

increase since Richards (2008) with *U. pinnatifida* present at all sites surveyed in the East Otago Taiāpure (Figure 1).

PhD research on the impacts and response of macroalgae communities to the removal of *U. pinnatifida* was conducted from 2019 – 2022 by Gaby Keeler-May. Large scale removal of *U. pinnatifida* was carried out in the East Otago Taiāpure yearly from 2019 to 2021. There was an 80 % decrease in overall biomass at sites with manual removal. Furthermore, there was no short-term negative effects on native species from the manual removal of *U. pinnatifida*. *Undaria pinnatifida* was found to be the most common and dominant species across 44 sites in Otago (Moeraki, Otago Harbour, and the East Otago Taiāpure). A significant negative relationship between native biomass and *U. pinnatifida* biomass in shallow (0 - 2 m) and intermediate depths (3 - 5 m) was found. The work by Keeler-May (2022) re-emphasises that marine species can be difficult to eradicate but that manual removal can be effective at reducing *U. pinnatifida* biomass in important sites (high value or likely areas for transport to new sites).

The general conclusions of this research are:

- 1. The range and biomass of *U. pinnatifida* has continued to increase in the Otago region.
- 2. *Undaria pinnatifida* can reach high densities and doesn't provide the same habitat values of native species.
- 3. *U. pinnatifida* can grow on a wide range of surfaces including invertebrates and other algae species.
- 4. The manual removal of *U. pinnatifida* can be effective in reducing biomass.

Due to the extent of *U. pinnatifida* in the South Island and the potential to damage natural ecosystems, Te Rūnanga o Ngāi Tahu have developed an *Undaria* Control Programme supported by LINZ Jobs for Nature funding and the University of Otago. This program trains divers and then uses manual removal to reduce the biomass of *U. pinnatifida*.

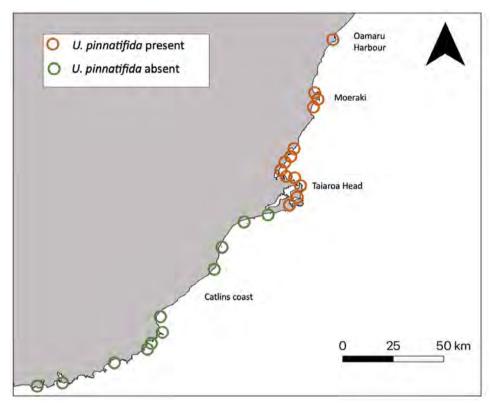


Figure 1: Presence and absence of *Undaria pinnatifida* on the coastline of the lower eastern South Island, New Zealand based on research in the area from 2005 - 2021 (Russell et al. 2008, Richards 2009, Suárez Jiménez 2014, Howarth 2021, Keeler-May 2022). While not marked on the map, a well-established population has been in the Otago Harbour since 1990 (Russell et al. 2008).

## Study Aim

As the distribution of *U. pinnatifida* north of Otago harbour has been relatively well documented we carried out additional surveys at 17 sites along the south coast (from Taiaroa Head to Slope Point). A description of the macroalgae community and a visual risk assessment of *U. pinnatifida* invasion for each site is provided.

#### Methods

This survey was an observational study, undertaken in January 2023. Sites sampled were from Taiaroa Head to Slope Point. Sites from Taiaroa Head to Taieri Island were surveyed from boat (RV Naiad 6.3 m), whereas sites from Bull Creek to Slope Point were surveyed from the shore. At each site, three freedivers searched in the area for the presence of *U. pinnatifida*. The search pattern varied at each site, predominantly consisting of a methodical pattern with a set distance between each of the divers following a reference point (e.g., the low tide mark). Pictures, videos, and GPS coordinates were taken at each site. Pictures were taken of the dominant kelp species, *U. pinnatifida* (if present), general underwater terrain and landscape out of the water. Sites were determined by looking at likely places *U. pinnatifida* would settle,

with most of them sheltered from the southerly swell. We also revisited surveyed in 2005 by reported in Russell et al 2008 Some sites could not be surveyed as they were inaccessible by car or were not divable due to large swells/poor visibility.

After the data was collected, sites were given an *U. pinnatifida* invasion risk level. This was based on wave-exposure, available substrate, space availability, algae diversity, presence of *U. pinnatifida* nearby, and any other unusual factors.

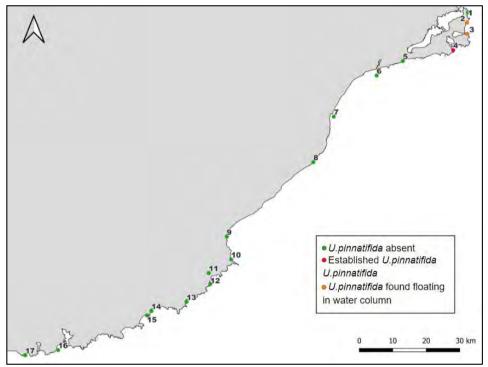


Figure 2. Distribution of *Undaria pinnatifida* along the South Otago coast based on surveys conducted in January, 2023. Sites are represented by the respective numbers: Taiaroa Head (1), Wickliffe Bay (2), Papanui Inlet (3), Hoopers Inlet (4), Saint Clair (5), Green Island (6), Taieri Island (7), Bull Creek (8), Kaka Point Beach (9), Fishing Station (10), Owaka (11), Jacks Bay (12), Purakaunui (13), Papatowai (14), Tautuku (15), Waikawa (16), Slope Point (17).

#### Results

#### Taiaroa Head

The area surveyed was the point of the northernmost sandy beach at the head. The area is sheltered from the north but is exposed to high wave exposure from southerly and easterly swells. The reef consisted of a steep rock wall with large boulders. Algal diversity was moderately low with *Durvillaea antarctica* found in the intertidal zone (Figure 2C). In the subtidal zone, *Marginariella boryana* was the most prevalent, with various Rhodophyta species also present (Figure 2B). Many of the boulders had large beds of sea tulips (*Boltenia pachydermatina*) (Figure 2A). Although no *Undaria* was observed in this survey, it is known to be well established in the area since the early 2000s (Chris Hepburn personal observation).

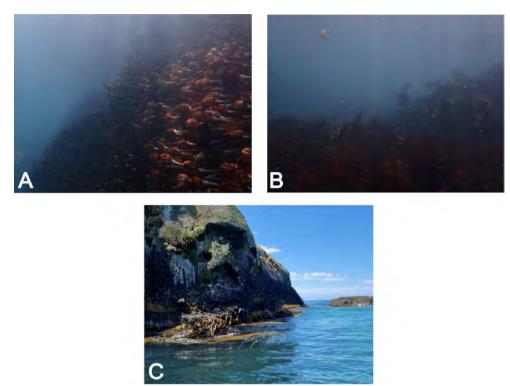


Figure 2. Taiaroa Head. A - Large bed of *Boltenia pachydermatina* along the rock wall. B - *Durvillaea willana* in the background with *Marginariella boryana* in the foreground growing on large boulders. C - Steep cliff face along the southern end of the point with *Durvillaea antarctica* growing from the rock structure located at the surface.

# Wickliffe Bay

This site is situated on the north end of Wickliffe Bay. The point offers protection from the north but is still exposed to large swells from the east and south. The substrate was similar to Taiaroa Head, with large boulders that progress onto a sandy bottom. *Durvillaea antarctica* was found in the intertidal zone, with *Durvillaea willana*, *Durvillaea poha* and *Marginariella boryana* prevalent in the shallow subtidal. *Chaetomorpha spp.*, *Boltenia pachydermatina* (sea tulips) and various Rhodophyta species (mainly *Curdiea flabellata*) were also found throughout. Space availability was moderate, with some suitable substrate for *U. pinnatifida* to settle on but *U. pinnatifida* was not observed attached to the reef or as an epiphyte. Whole *U. pinnatifida* individuals were found floating in the water column (Figure 3A), but not established on the reef. This is likely that these individuals are from the Papanui Inlet population (which is less than 5km away). Although this site sees high wave-exposure, the proximity to established populations and available substrate make this sight a high risk of for *U. pinnatifida* and further surveys will likely find small established populations.

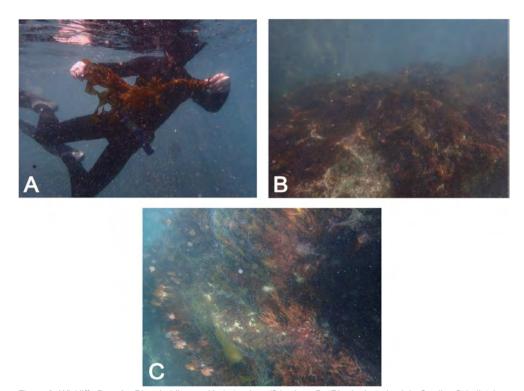


Figure 3. Wickliffe Bay, A - Diver holding an *Undaria pinnatifida* plant. B - Rhodophyta (mainly *Curdiea flabellata*) attached to rock reef. C - Various Rhodophyta species on the side of a boulder.

#### Papanui inlet

This site is located on the southern end of Wickliffe Bay, at the mouth of Papanui Inlet. The area of interest was the rocky beach south of the mouth. Although Cape Saunders provides shelter from the southerly swell, this site still sees high wave exposure from the east and north. The substrate progressed from a steep rocky beach to a sandy bottom with scattered rocky outcrops. On the limited rocks that were present; *Durvillaea antarctica*, *Durvillaea willana*, *Durvillaea spp.* and *Marginariella boryana* were the most prevalent algal species. *Chaetomorpha spp.*, *Ulva spp.*, various Rhodophyta and *Perna canaliculus* (green-lipped mussels) occupied the rest of the available substrate. The substrate would be suitable for *U. pinnatifida*, however, the limited space availability may present a barrier to entry. *Undaria pinnatifida* was also found floating in this area, but not established (Figure 4B). There is an existing *U. pinnatifida* population inside the inlet (Russell et al 2008), which is where these individuals most likely came from. Despite the high wave exposure and lack of space availability, this site should be considered a high invasion risk level due to the close proximity to an established *U. pinnatifida* population and patchy populations may have established in the area.

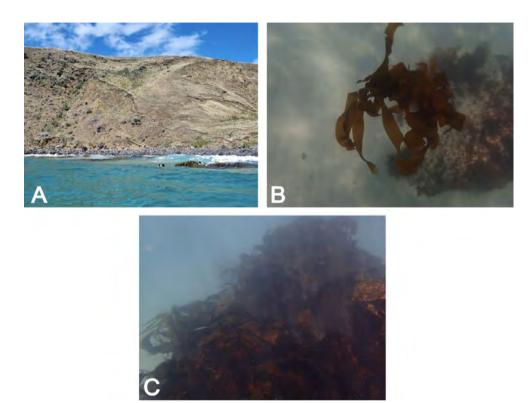


Figure 4. Papanui Inlet. A - Steep farmland with a rocky shoreline and large patches of *Durvillaea* spp. within the intertidal. B - *Undaria pinnatifida* floating above a sandy bottom and Rhodophyta species attached to a rocky outcrop. C - A large mass of *Durvillaea spp*.

## **Hoopers Inlet**

The area sampled was the southern point, close to the entrance of Hoopers Inlet. At the site, the reef followed the contour of the coastline with a distinctive algae line onto sand. A significant *Undaria* population was present in this area (Figure 5B). *Durvillaea spp.* was found in the intertidal, *Macrocystis pyrifera* and a few Rhodophyta species in the subtidal zone. *U. pinnatifida* was seen exhibiting epiphytic behaviour on some of the *M. pyrifera* individuals (Figure 5A & 5B). This site has high wave exposure, but has some shelter from the southerly and easterly swells. Space availability on the reef was moderate. As well as growing on the reef, *U. pinnatifida* was also growing on small rocks completely smothered by sediment, making it appear as if it was growing directly out of the sand (Figure 5C & 5D). There is a well-established population within Hoopers Inlet (Russell et al. 2008)

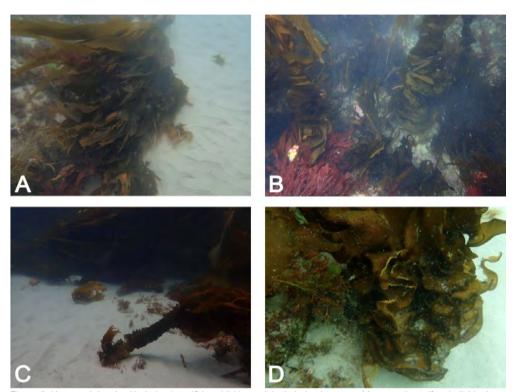


Figure 5. Hoopers Inlet. A - *Undaria pinnatifida* exhibiting epiphytic behaviour on a *Macrocystis pyrifera* individual along the reef edge. B - *Undaria pinnatifida* growing within *Macrocystis pyrifera* and various Rhodophyta species. C - *U. pinnatifida* growing out of the sand beyond the weed edge. D - Large *Undaria pinnatifida* individual attached to the sand along the reef edge.

#### Saint Clair

Saint Clair is a popular surf beach with high wave exposure. The area sampled was the fringing reef on the southern end of the beach. The reef was covered with sediment with *Durvillaea willana* in the intertidal/shallow subtidal zone. In the subtidal zone, *Ulva spp., Chaetomorpha coliformis, Caulerpa brownii* and many Rhodophyta dominated (Figure 6B). The most prevalent Rhodophyta were *Gymnogongrus spp., Curdiea flabella.* and *Adamsiella angustifolium.* There was little space availability for *U. pinnatifida* to settle and a reasonable distance from established populations. Saint Clair would therefore be considered a low invasion risk site.

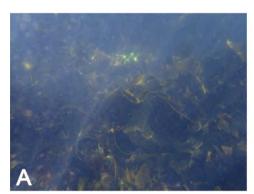




Figure 6. Saint Clair. A - Bed of *Durvillaea willana* with Rhodophyta species underneath. B - Rocky reef covered in sediment with *Chaetomorpha coliformis*, *Cystophora torulosa* and Rhodophyta species growing through.

## Okaihe (Green Island)

The area surveyed was in the more sheltered inshore western side of the island. Around the Island, the reef gradually drops into deep water. The intertidal zone was thick with *Durvillaea spp.*. Below the *Durvillaea spp.*, *Lessonia variegata*, *Marginariella boryana* and *Cystophora retroflexa* dominated (Figure 7B & 7D). There was little space availability, with the only viable place for *U. pinnatifida* to settle being in between the *Durvillaea* and *Lessonia/Marginariella/Cystophora* canopy. Wave exposure around the island is high, especially on the southern and eastern sides. Green Island is sometimes an area that boats anchor during good weather and the habitat near potential vectors makes this a moderate risk area for establishment on the landward/western side of the Island.

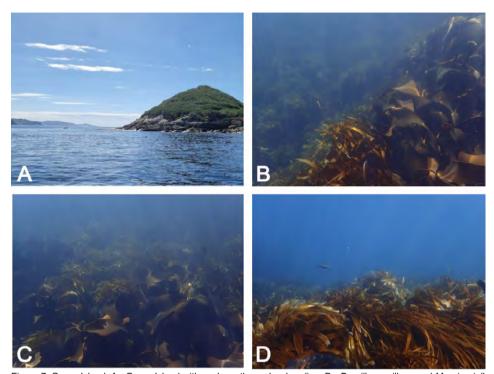


Figure 7. Green Island. A - Green Island with seals on the rocky shoreline. B - *Durvillaea willana* and *Marginariella boryana* in the foreground with *Cystophora retroflexa* in the background. C - *Durvillaea willana* and *Marginariella boryana* forest. D - Patch of *Marginariella boryana* and *Lessonia variegata*.

## Moturata (Taieri Island)

The west side of Moturata is a common anchorage for boats waiting to cross the Taieri bar. In this area, there is a fringing reef which is dominated by *Ulva spp., Spatoglossum chapmanii* and *Halopteris spp.* (Figure 8C). Further towards the southern point of the island, the reef becomes larger and much more diverse. Species such as *Xiphophora gladiata, Durvillaea spp., Marginariella boryana* and *Lessonia variegata* are more prevalent (Figure 8B). There is a relatively low space availability on both sections of reef. This area endures reasonable wave-exposure, but is sheltered from both northerly and easterly swells. The Taieri River emits large volumes of freshwater, causing a brackish layer and variable salinity. Although Taieri Island is far from established *U. pinnatifida* populations and there is significant wave exposure the chance of transport via recreational and commercial vessels makes establishment from these vectors a moderate risk. The wharf area at Taieri Mouth is likely less susceptible due to lowered salinity from the influence of the Taieri River. However, certainty around this lowered risk isn't high as *Undaria* is known to tolerate low salinity (Bollen et al. 2016) and has been observed quite far up estuaries, such as Hoopers Inlet (Russell et al. 2008).

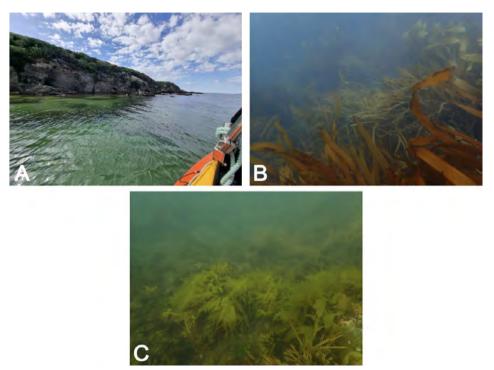


Figure 8. Taieri Island. A - Western side of Taieri Island with large boulders close to shore. B - Patches of Marginariella boryana, Xiphophora gladiata and Lessonia variegata. C - Area dominated by Spatoglossum chapmanii and Ulva spp., some Xiphophora gladiata present.

## **Bull Creek**

The area surveyed was the middle point within the Bull Creek township. During the sampling period this area was exposed to large swells, making it dangerous to enter the water. From the surface, we could see *Durvillaea antarctica* and *Macrocystis pyrifera* (Figure 9A & 9B). The reef looked to drop to sand quickly, with little space availability or suitable substrate for *U. pinnatifida* to settle. There is a large distance between established *U. pinnatifida* populations and the area is highly exposed to waves. Bull Creek would be a low invasion risk site.





Figure 9. Bull Creek. A - Surge along the shoreline dominated by *Durvillaea antarctica*, B - Rocky points that lead towards a sandy beach with the rock structure being dominated by *Durvillaea antarctica*.

#### Kaka Point Beach

The southern end of Kaka Point Beach is a fringing reef, consisting of many smooth, small boulders. The most prevalent algal species observed were *Durvillaea spp., Xiphophora gladiata, Halopteris spp., Spatoglossum chapmanii* and a few Rhodophyta (most prevalent being *Gymnogongrus furcatus*) (Figure 10C & 10D). Space availability was moderate with plenty of suitable substrate for *U. pinnatifida* to settle (Figure 10B). Although somewhat sheltered from the southerly swell, wave exposure is still high. The site is situated far from established *U. pinnatifida* populations and should be considered a low invasion risk area.

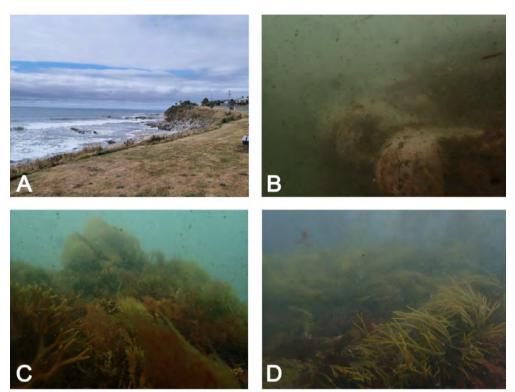


Figure 10. Kaka Point beach. A - Rocky, wave-exposed shoreline. Submerged reef with *Durvillaea spp.* on the surface. B - Suspended algae debris floating over smooth rocks with lots of space availability. C - Various Rhodophyta species, *Gymnogongrus furcatus* seen in the bottom left. D - Patch of *Xiphophora gladiata* with some Rhodophyta species present and *Spatoglossum chapmanii* in the background.

#### **Fishing Station**

Fishing Station is located just north of Nugget Point and is near the southern boundary of the Punawai o Toriki Mātaitai. It consists of an artificial concrete groyne extending perpendicular to the shore with a natural fringing reef on the right-hand side. The reef is surrounded by a sandy bay. Algae on the reef predominantly consisted of *Durvillaea spp., Xiphophora gladiata, Marginariella boryana, Cystophora retroflexa, Ulva spp.* and various species of Rhodophyta (Figure 11B & 11C). Space availability was moderate, with preferable substrate for *U. pinnatifida* to settle. Underneath the thick *Durvillaea spp.* canopies there was high space availability, but growth of other species is likely limited by light availability. Although somewhat sheltered from the southerly swell, this site is exposed to high wave-exposure. Fishing Station is far from *U. pinnatifida* populations and should be considered a low invasion risk area.

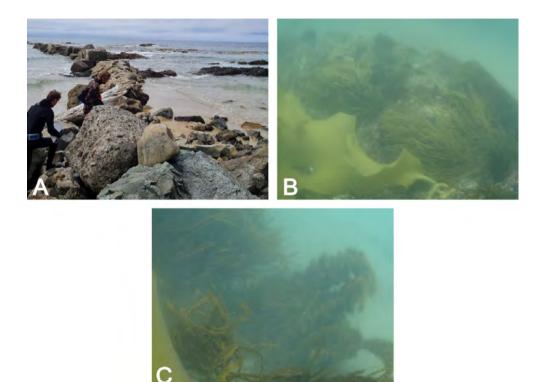


Figure 11. Fishing Station. A - Artificial concrete groyne with reef on each side and *Durvillaea poha* attached. B - *Durvillaea spp.* and *Xiphophora gladiata* with small Rhodophyta species attached to the rocks. C - *Marginariella boryana* and *Cystophora retroflexa*.

#### Owaka

This site was situated within the estuary fed by the Catlins and Owaka rivers. The area of interest was a steep artificial rockwall next to the main channel. There was a low diversity of algae, with the most prevalent species being *Ulva spp., Macrocystis pyrifera* and some Rhodophyta species (Figure 12B & 12C). Rocks were covered in *Ostrea chilensis* (rock oysters), but overall space availability was high. This area has low wave exposure and high tidal flow. The large freshwater input also creates substantial fluctuations in salinity, which *U. pinnatifida* has been known to tolerate (Bollen et al. 2016). There is also a boat ramp close to the site. However, this boat ramp is small and would be used for small boats that are stored on land reducing the likelihood of spreading *U. pinnatifida*. Owaka is also far from *U. pinnatifida* populations. For these reasons, Owaka would be classified as a low invasion risk level.

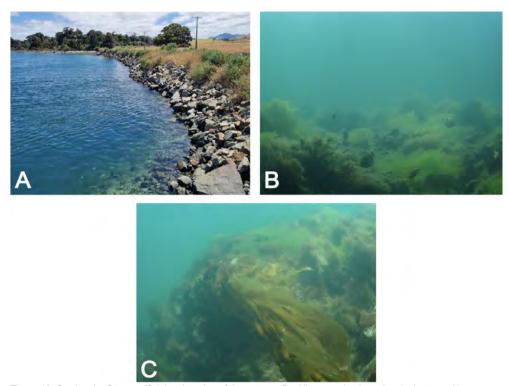


Figure 12. Owaka. A - Steep artificial rocky edge of the estuary. B - *Ulva spp.* dominated rocky bottom with some Rhodophyta species present. C - *Macrocystis pyrifera* plant growing on a rocky substrate covered in *Ulva spp.* And various Rhodophyta.

# Jacks Bay

Jacks Bay is a sandy beach with reefs at each point. We focused on the southern reef, between the shore and Tuhawaiki Island. This site was dominated by *Durvillaea spp.* on the edges. Algae diversity was high, with *Cystophora scalaris, Carpophyllum flexuosum, Marginariella urvilliana, Marginariella boryana, Macrocystis pyrifera* and *Xiphophora gladiata* dominating the reef with *Ulva spp., Caulerpa brownii, Landsburgia quercifolia* and various Rhodophyta species also present (Figure 13B, 13C & 13D). Space availability was relatively low, as was wave exposure (sheltered by Tuhawaiki Island). This site is far away from established *U. pinnatifida* populations. This site is a low invasion risk area.

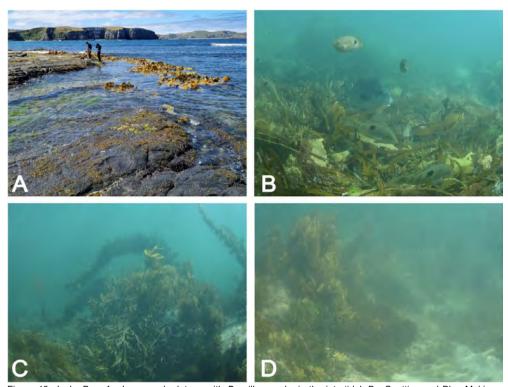


Figure 13. Jacks Bay. A - Large rock plateau with *Durvillaea poha* in the intertidal. B - Spotties and Blue Moki swimming amongst *Marginariella boryana*, *Xiphophora gladiata* and *Marginariella urvilliana*. C - Large *Cystophora retroflexa* behind *Carpophyllum flexuosum* and *Xiphophora gladiata*. D - A patch of *Cystophora retroflexa* with *Ulva spp.*, *Cystophora scalaris*, *Caulerpa brownii*, *Landsburgia quercifolia* present.

# Purakaunui Bay

Purakaunui is a popular campsite and beach. The area of interest was the fringing reef on the southern point. The reef is small and drops onto sand quickly. *Durvillaea spp.* was observed in the intertidal (Figure 14A) with *Adamsiella angustifolium*, *Caulerpa spp.*, *Halopteris spp.* and *Bryopsis spp.* being the most prevalent species in the subtidal zone (Figure 14B). There was low space availability, with *Durvillaea spp.* occupying a large part of the shallows. Purakaunui Bay sees high wave exposure, even though sheltered from the southerly swells. The visibility was poor, with lots of sediment and drift algae in the water column during the sampling period. This site is separated from established *U. pinnatifida* populations and should be considered a low invasion risk site.





Figure 14. Purakanui. A - Steep cliffs that drop down to the ocean with large patches of *Durvillaea spp*. in the intertidal zone. B - *Adamsiella angustifolium, Caulerpa spp*. and *Bryopsis spp*. within the subtidal zone.

#### **Papatowai**

The area sampled was the southern point of Tahakopa Beach, south of the Tahakopa River mouth. On the point, was a fringing small reef that continued around the corner. Despite being sheltered from the south, this area sees reasonable wave exposure. We observed a lot of sediment and drift algae in the water column. The algae on the reef was relatively diverse, with *Durvillaea antarctica* in the intertidal zone and *Durvillaea spp., Xiphophora gladiata, Ulva spp., Halopteris spp.*, and *Bryopsis spp.* in the subtidal zone (Figure 15B, 15C & 15D). There was little space availability, with some ideal substrate for settlement. Papatowai is far from established *U. pinnatifida* populations and should be considered a low invasion risk.

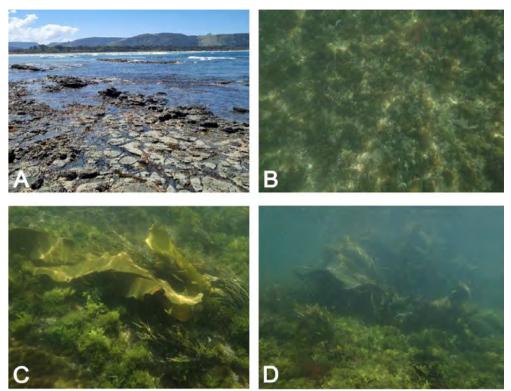


Figure 15. Papatowai. A - Rock plateau with *Durvillaea spp.* attached to the submerged rock structure. B - Sediment covered rock structure with *Halopteris spp.*, various Rhodophyta and settled algae debris. C - *Durvillaea poha, Xiphophora gladiata* and *Bryopsis spp.* within the subtidal. D - Large *Durvillaea poha* patch surrounded by *Bryopsis spp.* and *Xiphophora gladiata*.

#### Tautuku

The area of interest was Oyster Bay on the northern end of Tautuku Bay. Ideally, we would have sampled the southern end as this was a more likely looking settlement location, however, access to this area was too difficult. This area sees high wave-exposure and was not divable due to reasonable swell and poor visibility. From the surface we could see *Durvillaea spp.*, but no other noticeable species (Figure 16A). There looks to be little available substrate for *U. pinnatifida* to settle. Tautuku is far from established *U. pinnatifida* populations and should be considered a low invasion risk zone.



Figure 16. Tautuku. A - Steep cliffs with a rocky shore. Ocean with high wave action.

## Waikawa (Curio Bay)

Curio Bay is a sandy beach with a fringing reef on the southern point. Although Waikawa is outside ORC territory, we thought it would still be appropriate to sample due to popularity with beach goers/campers. This reef showed a high diversity of algae species. *Cystophora scalaris, Xiphophora gladiata, Marginariella boryana, Carpophyllum flexuosum* and *Cystophora torulosa* were the most prevalent species, with *Hormosira banksii, Macrocystis pyrifera, Splachnidum rugosum, Spatoglossum chapmanii* and *Ulva spp.* also present (Figure 17B, 17C & 17D). There was some space availability shown on the reef, with suitable substrate for *U. pinnatifida* to settle. The inside of the reef is also sheltered from southerly swells. The beach is a popular camping and holiday destination which could facilitate the transport of *U. pinnatifida*, but reasonably far from established populations in Waipapa Point. The surrounding sandy beaches present a barrier to entry. For these reasons, Curio Bay should be considered a low invasion risk level.

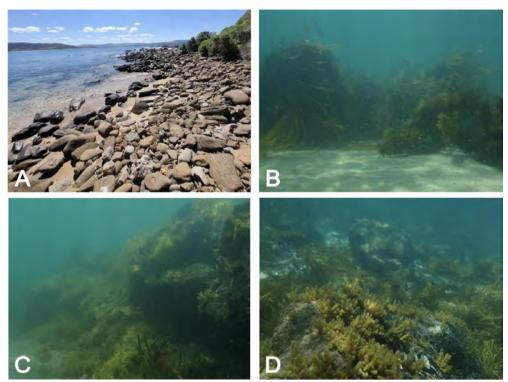


Figure 17. Waikawa. A - Sandy stone covered beach with submerged rock structure. B - Large Marginariella boryana patch on sandy bottom with Cystophora retroflexa present. C - Rock structure covered with Splachnidum rugosum, Spatoglossum chapmanii and Ulva spp. D - Reef covered in Splachnidum rugosum and Xiphophora gladiata.

## Slope Point

Slope Point is situated in an extremely rugged part of the coastline, being exposed to large southerly and easterly swells. Underwater, the site consisted of large boulder substrate. Although this site was not in the ORC region, we thought it would be appropriate to sample due to the proximity to populations at Waipapa Point. The dominant kelp species observed were *Durvillaea antarctica* in the intertidal zone, (Figure 18A) and *Marginariella boryana, Xiphophora gladiata* and *Lessonia variegata* in the subtidal zone (Figure 18C). There was low diversity on this reef with lots of space availability. Slope point is the closest site to established *U. pinnatifida* populations at Waipapa Point. Hydrodynamic processes (Southland Current) favour the transport from Waipapa Point to Slope Point (Sutton 2003). The proximity to the established populations at Waipapa Point and Bluff Harbour but high wave exposure makes this site a medium invasion risk level.

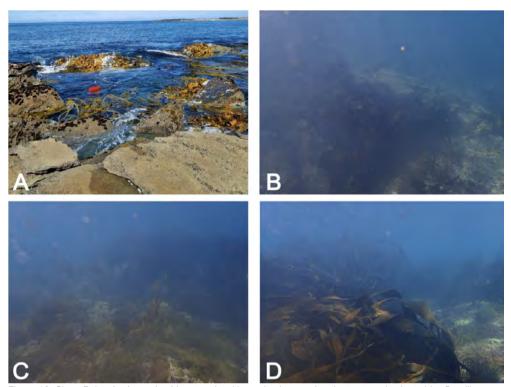


Figure 18. Slope Point. A - Large bouldery terrain with semi submerged rock structure dominated by *Durvillaea* antarctica. B - Large boulder with a patch of *Durvillaea spp.* attached. C - A patch of *Marginariella boryana* and *Xiphophora gladiata* attached to rock structure with *Durvillaea spp.* in the background. D - Large patches of *Durvillaea spp.* attached to rock structure.

## **Discussion**

The aim of this study was to conduct observational surveys of sites along the Otago Coast to determine any range expansion of *U. pinnatifida*, with focus on high risk sites. Of the seventeen sites, only one had *U. pinnatifida* established on the reef, thatg was at the entrance to Hoopers Inlet. Drifting *U. pinnatifida was found at the* entrance of Papanui Inlet and the north end of Wickliffe Bay. From previous surveys, we knew of established *U. pinnatifida* populations in these locations (Russell et al. 2008). Both sites had *Durvillaea spp.* cover in the intertidal zone, with reefs that dropped onto sandy substrate. Hoopers Inlet also had a reasonably healthy *Macrocystis pyrifera* population. The Hoopers Inlet site is subjected to less wave exposure than the two sites at Papanui Inlet. There was significantly more space availability at Hoopers Inlet. Further south, no *U. pinnatifida* was observed. The sites varied in terrain, wave exposure, algal diversity and space availability. The most observed species of algae were: *Macrocystis pyrifera*, *Durvillaea spp.*, *Marginariella boryana*, *Lessonia variegata*, *Cystophora retroflexa*, *Xiphophora gladiata*, *Spatoglossum chapmanii* and various species of Rhodophyta.

The *U. pinnatifida* observed at Hoopers Inlet was growing directly on the reef, but also appeared to be growing out of soft sediment habitat. After a closer inspection, individuals were attached to a hard substrate and had since been buried in sediment. Although hard substrates are preferred, *U. pinnatifida* has the ability to settle on unfavourable substrates (Thompson 2004). *Undaria pinnatifida* has also been known to exhibit epiphytic behaviour (Howarth 2022), which limits the light availability of host individuals (Smith 1982). In some cases, this can result in mortality and gaps within the canopy cover for new *U. pinnatifida* individuals to invade (Howarth 2022). At Hoopers inlet, we observed *U. pinnatifida* displaying epiphytic behaviour on many *M. pyrifera* individuals. If left unattended, the *U. pinnatifida* could outcompete *M. pyrifera* individuals and colonise the whole reef. We also observed these individuals during their summer senescence. During winter, the reef would most likely have greater *U. pinnatifida* densities (Morita et al. 2003).

Understanding connections among populations is important un guiding control and survelliance programmes for invasive species (Franzén & Nilsson, 2013). The populations inside Hoopers and Papanui Inlets are most likely sources to the small populations on surrounding open coast. Despite *U. pinnatifida* being present in high densities in Hoopers and Papanui since at least 2005 (Russell et al. 2008), there hasn't been a range expansion far from the entrances of these inlets (less then 100 metres). Drifting individuals were found but no established populations suggesting that establishment rather than dispersal is the issue. This indicates that areas exposed to full southern swells do not provide good habitat for *U. pinnatifida*. From north Aramoana north there is some shelter from southerly swells provided by the Otago Peninsula where *U. pinnatifida* is abundant on the open coast (Russell et al. 2008, Desmond et al. 2019). As such, semi-sheltered areas protected by headlands and other features are at a higher risk of *U. pinnatifida* becoming established.

Undaria pinnatifida has a short dispersal distance via zoospores. The principal vector enabling the long distance spread of *U. pinnatifida* along open coastlines is drift of mature, fertile sporophytes (Forest et al. 2000). These grow in sheltered sites where they are transported by wave action and currents, allowing for the dispersal to rough waters (Russell et al. 2008). Due to the Southland Current, the majority of water movement is northward (Sutton 2003). There is also local upwelling and eddies which replace the water column at least once a tidal cycle (Russell and Vennell 2017). However, this water is also heading north and back towards the coast around Blueskin Bay (Murdoch et al. 1990). We observed drifting mature sporophytes around Papanui Inlet (Both sites in Wickliffe Bay). Even though we observed little space availability for *U. pinnatifida*, their epiphytic behaviour may allow them to invade these reefs. Although these sites are close to established populations and considered high risk, the fact that *U. pinnatifida* has not established dense populations indicates it has a low impact on this areas and that management would not be of high value

At many sites, we observed dense *Durvillaea spp*. growth in the intertidal and shallow subtidal zones. Initially, it was thought *U. pinnatifida* invades the intertidal zone first, then propagates deeper (Forrest et al. 2000). However, studies on the North Otago coast have shown that in areas with high wave exposure, *U. pinnatifida* will first settle below the *Durvillaea spp*. With this, they escape the large surge and the whiplash of *Durvillaea spp*. blades. *Undaria pinnatifida* is as resistant to wave exposure as *Lessonia variegata* and *Marginariella spp*. (both of which were frequently observed at sites in this study) (Russell et al. 2008). Stressors on *Durvillaea spp*. can also influence the recruitment of *U. pinnatifida* to new areas. In the event

of a marine heatwave, where a local extinction of *Durvillaea spp.* has occurred, *U. pinnatifida* has been shown to replace native kelp (Thomsen et al. 2019). This follows the competitive release of *Durvillaea*, reducing the canopy and allowing *U. pinnatifida* to occupy this niche (Taylor & Schiel 2005, Arkema et al. 2009). With oceanic temperatures rising and the frequency of marine heat waves increasing, this could be a major threat to *Durvillaea*, making them unable to recolonise an area after an extinction event. (Taylor & Schiel 2003).

Through primary literature, we know that if *U. pinnatifida* could reach many sites within this study, it is capable of invasion. This study was limited to one point in time in summer when *U. pinnatifida* densities are lowest due to its annual lifecycle. As we did not find *U. pinnatifida* in areas it has been reported before (Taiaroa Head) a more appropriate time of year survey would be spring when *U. pinnatifida* would be at its densest. Another limitation of this study was the number of sites and site selection. Ideally more sites would be surveyed, and sites would be more targeted to high-risk areas. This would involve more planning and knowledge of the area to target sheltered anchorage sites.

#### **Management Implications**

Undaria is present along a considerable length of the Otago coastline (Figure 1). However, the spread of *U. pinnatifida* south of Otago Harbour is limited (Figure 2). We did not find *U. pinnatifida* in the Catlins area. However, identifying areas of high risk in areas where *Undaria* has yet to establish and surveying them at appropriate times would be beneficial. These would be areas with low water motion and areas where small vessels would anchor. Identifying even rarely used anchorages in the broader Otago region would allow us to understand where establishment is likely for other potentially invasive species outside of Otago Harbour.

As *U. pinnatifida* is well established in much of Otago, future management of *U. pinnatifida* should focus on surveillance at high value areas where *Undaria* has yet to establish and supporting well designed and carefully managed control programs that can reduce densities. Although there may be value in commercialising *U. pinnatifida*, this provides risks and these opportunities should only be provided using waste from well designed and monitored control programmes. Ineffective control of these operations may result in farming *U. pinnatifida* on natural reefs and increase its density and range and as a result damaging valuable ecosystems.

While the eradication of *U. pinnatifida* in Otago in unlikely. Actions can be taken to avoid other invasive species establishing in Otago and then Otago Regional Council should consider how to complement existing surveillance by the Ministry of Primary Industries. Secondary ports (e.g. Oamaru, Moeraki, Waikouaiti Estuary) are a significant risk and if monitoring is not taking place it is likely that invasive species have already established and could be spreading. The observation of *Bonnemaisonia hamifera*, which was first seen in Waikouaiti Estuary (Garbary et al. 2020), provides an example of this issue. Vessel traffic to secondary ports and anchorages allows for the introduction of invasive species and appropriate secondary port and anchorage monitoring should allow a rapid response to new threats (e.g. Mediterranean fan worm (*Sabella spallanzanii*), and the invasive *Caulerpa* sp.) and thus reduce eventual costs and likelihood of success of any incursion response.

#### Conclusion

The objective of this report was to provide a synthesise of research on *U. pinnatifida in Otago* and undertake observational surveys at multiple sites along the Otago coast. *U. pinnatifida* provides an example of how other invasive marine species could spread and impact of ecosystems in the Otago region. Range expansion has occurred primarily out of Otago Harbour and secondary ports in Oamaru and in particular Moeraki (Russell et al. 2008). The profound impacts and dominance of *Undaria pinnatifida* today, a species that established 30 years ago in this region, is only now becoming clear. A careful risk assessment and response plan for different potential invasives in the Otago region is needed. Secondary port and anchorage surveillance is likely key. Only with a rapid response to new incursions and a clear plan is success possible. Without this expensive control and eradication programmes could be required.

## Acknowledgements

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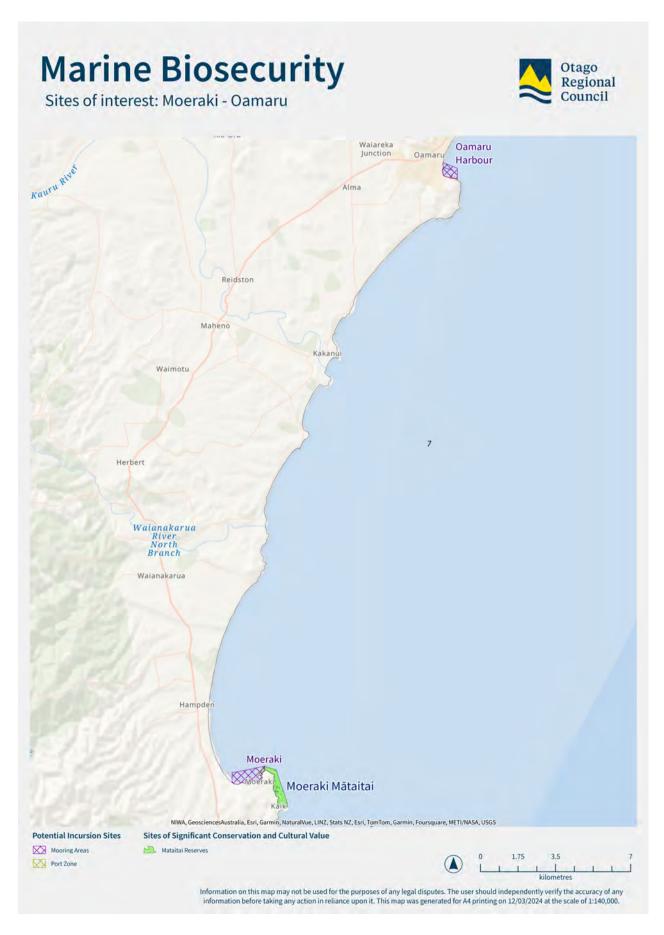
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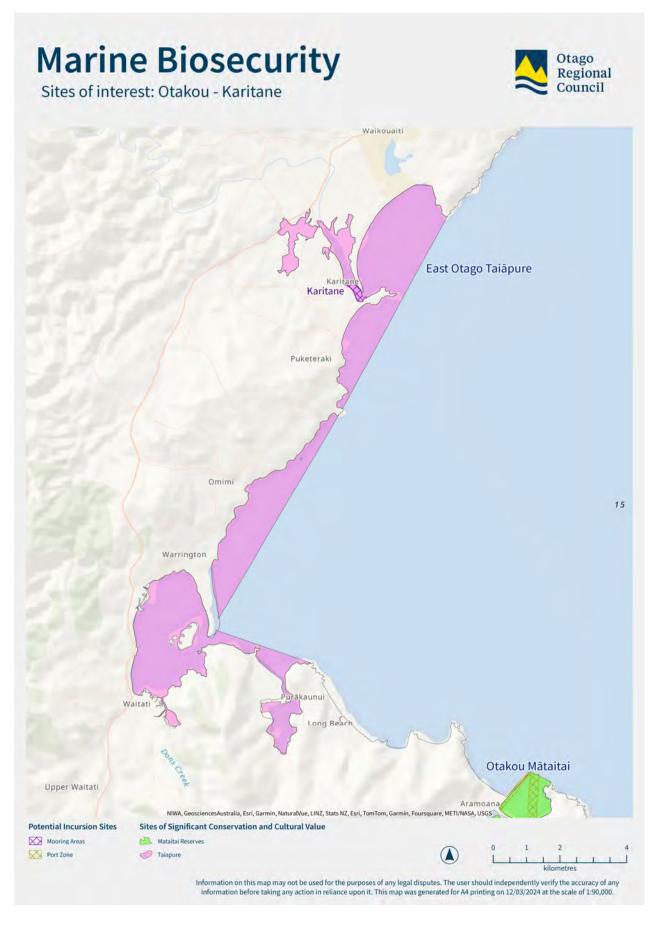
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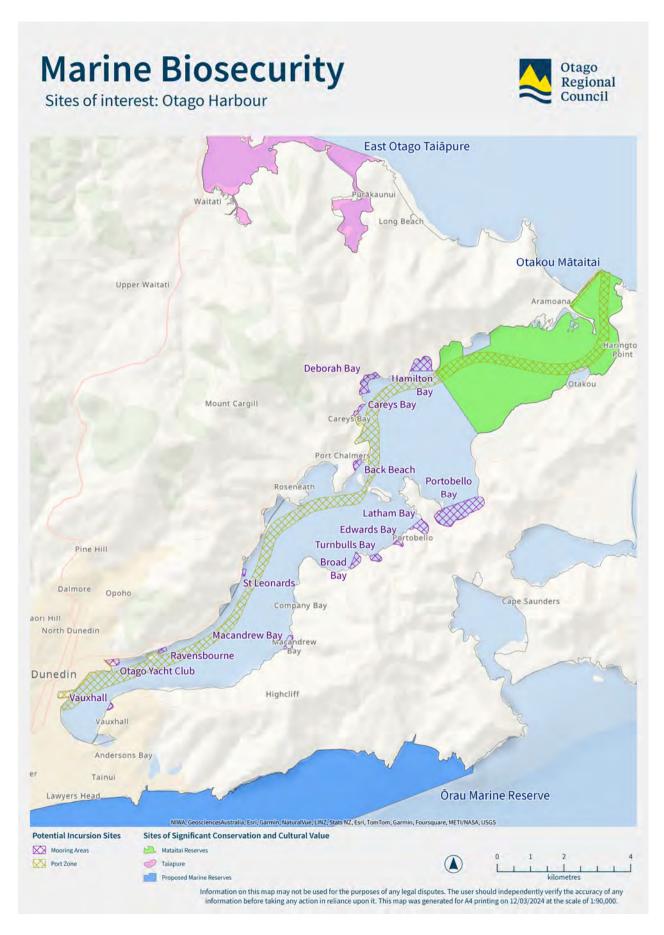
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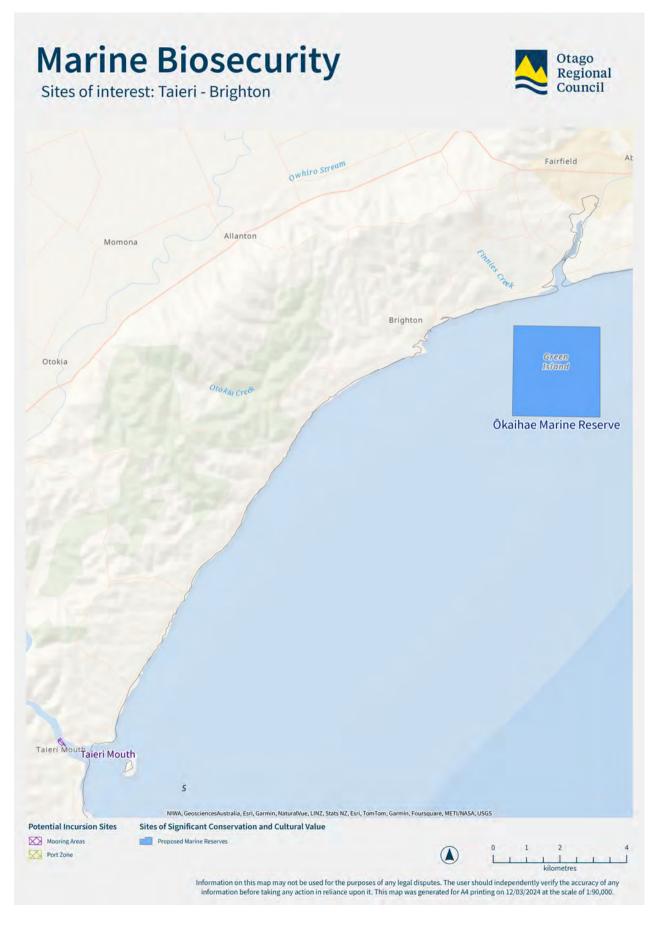
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# 9.4. Freshwater Improvement Projects Update

**Prepared for:** Environmental Implementation Committee

Report No. OPS2409

Activity: Governance Report

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**Endorsed by:** Gavin Palmer, General Manager Operations

**Date:** 8 May 2024

## **PURPOSE**

[1] This report provides an update on the three ORC priority water quality projects: Tomahawk Lagoon, Lake Tuakitoto and Lake Hayes. It provides an update on the Ministry for the Environment (MfE) funded Toitū Te Hakapupu/Pleasant River Catchment Restoration project. It also provides an update on the Site-Led freshwater pest management programme for Lagarosiphon.

## **EXECUTIVE SUMMARY**

[2] The Otago Regional Council Long Term Plan 2021-2031 details that key projects for delivery under environmental enhancement are the priority site specific projects of Lake Hayes, Tomahawk Lagoon and Lake Tuakitoto (Figure 1).

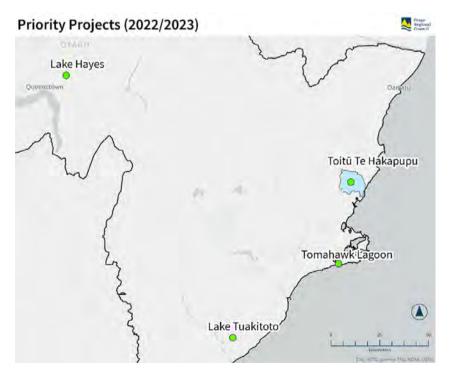


Figure 1: Locations of priority site specific projects and the Toitū Te Hakapupu Essential Freshwater Fund (EFF) project

- [3] Implementation plans based on the Ecological Report for Lake Tuakitoto and Tomahawk Lagoon have been drafted by staff (Appendix 1 and Appendix 2).
- [4] A Stormwater Education programme has been developed and delivered for the Tomahawk Lagoon catchment.
- [5] The Mill Creek (Arrow River water) augmentation works are nearing completion. The physical pipe infrastructure is all in place and built-up sediment around the structure discharging to Mill Creek is to be undertaken prior to commissioning the pipe.
- [6] The works downstream of the existing Lake Hayes culvert within Hayes Creek have been successfully completed.
- [7] The Toitū Te Hakapupu project is funded through Ministry for the Environment (MfE) Essential Fresh Water Fund (EFF). MfE have assigned nearly \$4 million. ORC will contribute \$786,000 as an in-kind contribution. Landowners must contribute 25% of the value of the works on their property. The MfE spend sits at \$1,280,387 as at end March 2024.
- [8] The ORC project team has worked successfully with partners Kāti Huirapa Rūnaka ki Puketeraki to deliver a project that reflects that partnership wherever possible.
- [9] The Toitū Te Hakapupu project has to date supported landowners to erect 7.5 km of fencing and plant 22,750 native plants.
- [10] There are currently fifteen active planting and fencing sites and 25 landowners have been engaged with.
- [11] Integrated Catchment Management work is underway. The work on freshwater projects as detailed in this report support and inform this work programme.

# **RECOMMENDATION**

That the Environmental Implementation Committee:

- 1) **Notes** this report.
- Notes the progress of implementation activities that are occurring on the water quality projects delivered by ORC, partners and the community as detailed in this report.
- 3) **Recommends to Council to endorse** the implementation plans for Tomahawk Lagoon and Lake Tuakitoto (Appendix 1 and Appendix 3).
- 4) **Notes** the Cultural Values Statement Waiwhakaata (Appendix 6) and theNgāi Tahu ki Murihiku Environmental Statement of Expectation Waiwhakaata/Lake Hayes (Appendix 7)
- 5) **Notes** that the Toitū Te Hakapupu project is in its last year of delivery to successfully deliver on all the objectives of the MfE funding deed.
- 6) **Notes** the progress made on the site led programme for Lagarosiphon.

# **Integrated Catchment Management**

Integrated Catchment Management (ICM) work is underway and has commenced in the Catlins Freshwater Management Unit and Upper Lakes rohe. As Catchment Action Plans (CAPs) have not yet been developed in the areas where projects are described

throughout this report, management plans have been developed and these are related to mainly freshwater opportunities. ICM work incorporates a wider sphere of environmental outcomes than freshwater alone. In the future when CAPs are developed these management plans will be able to be incorporated. CAPs, once completed will also provide guidance around future projects that could be led and/or supported by ORC.

#### **Tomahawk Lagoon**

[13] Tomahawk Lagoon is located at the southern end of the Otago Peninsula. It consists of two shallow brackish water lagoons which are joined by a narrow channel and weir/gate structure and share a common sea outlet (refer to Figures 2 and 3). Tomahawk Lagoon is a wildlife refuge of 33 hectares that is managed by the Department of Conservation which contains the threatened plant species *Isolepis basilaris* on the margin of the lagoon. The area is important ecologically as it is defined as a marsh and less than 15% of original marshes remain in Otago.



Figure 2: The catchment for Tomahawk Lagoon



Figure 3: Tomahawk Lagoon

- [14] Tomahawk Lagoon is a regionally significant wetland habitat for waterfowl and waders with a variety of bird species present and is part of a chain of feeding habitats along the coast used by migrating birds. Tomahawk Lagoon is also an important habitat for native fish and eels. Citizen Science water quality monitoring is undertaken by ECOtago monthly. ECOtago are a community group who are working to test and improve water quality within the Tomahawk Lagoon catchment. Their results (found at tomahawkcitizenscience.com) indicate that turbidity, E. coli, nitrates and phosphate levels are all exceeding national guidelines. Cyanobacteria is also regularly found within the lagoon over the summer months which is a toxic bacterium which can be harmful to humans and animals.
- The Otago Regional Council Long Term Plan 2021-2031 details Tomahawk Lagoon as a key project for delivery between 2021 to 2024. \$260,000 has been allocated to this project over these three financial years.
- [16] Since 2021 key stakeholder and community meetings have been held to contribute to the development of the management plans for Tomahawk Lagoon (Appendix 2). The management plan includes three priority actions based on community feedback. Community meetings have also been hosted to update them around the findings of the ecological reports which have been delivered by Cawthron Institute in July 2023.
- [17] A Tomahawk Lagoon Management Plan, based on community consultation, was approved by Council in April 2022 (Appendix 2).
- [18] The Management Plan identified three priority actions to commence. For Tomahawk Lagoon this included: the support and formation of a catchment group, an ecological assessment of the catchment is to be undertaken and a permanent water quality monitoring site to be installed. These were the priority actions decided by the community. These actions are all on track to be delivered as detailed below.

- [19] A permanent water quality monitoring site was established within Tomahawk Lagoon in July 2022.
- [20] Cawthron Institute were engaged to deliver an ecological assessment for both Lake Tuakitoto and Tomahawk Lagoon and identify and provide guidance on where action could be delivered for best investment environmental outcomes (Appendix 5).
- [21] Otago Catchments Communities are leading the formation of the Catchment Group for the Tomahawk Lagoon area supported by ORC staff.
- [22] Staff are currently working with ECOtago and Tomahawk-Smaills Beachcare Trust to explore funding opportunities for a riparian planting project and water quality monitoring work within the Tomahawk Lagoon catchment.
- [23] In May 2023, ORC sought proposals from suppliers to develop a Stormwater Education Programme for the Tomahawk Lagoon catchment. ORC contracted 4Sight Consulting to lead this piece of work. The Stormwater Education programme has been developed and was delivered to the Tomahawk Lagoon community on the 17<sup>th</sup> of April 2024. This was slightly delayed as it was originally proposed in January 2024. This was due to community availability and uptake for this event. The work that has been undertaken on this programme will be rolled out to other urban areas of Otago through the Catchments team.
- [24] Following receipt of the Ecological Assessment (Appendix 5) an implementation plan for Tomahawk Lagoon has been drafted by staff. This is included in Appendix 1. The implementation plan is related to the ecological assessment undertaken by Cawthron Institute. This report provided recommendations and therefore an implementation plan has been developed to show what work is planned to be completed within the catchment and what outcomes are sought. The community consultation which initiated the development of the Management Plan for the area and the implementation plan are linked as one of the priority actions to deliver was the ecological assessment. Now that this has been delivered there are other 'Potential projects' within the Management Plan which are listed to commence. This includes fencing and native planting.
- [25] The \$260,000 which has been allocated to this project over the last three financial years is currently underspent. A budget is included in the Implementation Plan (Appendix 1) in section 5 of this document which indicates that some of this funding will be spent in the 2024/25 financial year. The budget collected for Tomahawk Lagoon is from its own reserve so the budget can be transferred forward to allow for this spend and to ensure that ongoing delivery of this project occurs.

# **Lake Tuakitoto**

[26] Lake Tuakitoto is a large lowland lake and adjoining swamp near the coast north of the Clutha River/Mata-Au Mouth (refer to Figure 4 and Figure 5). It is fed from the inflow of Lovells Creek at the northern end of the wetland and is the best remaining example in Otago of a previously widespread wetland type (ORC, 2004).



Figure 4: Map showing the catchment for Lake Tuakitoto

[27] Lake Tuakitoto supports a high diversity of indigenous flora and fauna and an exceptionally high diversity of bird life. It is a regionally significant wetland habitat for nationally and internationally rare or threatened species. It provides a breeding habitat

for the rare Australasian Bittern (*Botaurus poiciloptilus*) and Banded Dotterel (*Charadrius bicinctus bicinctus*). It is also a breeding area for the uncommon Marsh Crake (*Porzana pusilla affinis*), Spotless Crake (*Porzana tabuenis plumbea*) and South Island Fernbird (*Bowdleria punctata punctata*). Habitat is provided for the threatened giant kokopu (*Galaxias argenteus*). The threatened plant species swamp nettle (*Urtica linearifolia*) and *Isolepis basilaris* are present on the swamp margin (ORC, 2004).



Figure 5: Lake Tuakitoto

[28] A diverse mosaic of vegetation types and wildlife habitats exists within the Lake Tuakitoto area. It is considered a regionally and nationally important habitat for

waterfowl, waders and swamp birds which supports a significant proportion of the national population of Mallard (*Anas platyrhynchos*) and New Zealand Shoveller/Kuruwhengi (*Anas rhynchotis variegata*), Grey Teal (*Anas gracilis*) and Black Swan (*Cygnus atratus*). All these species breed here. It is considered nationally important as a freshwater fishery habitat, supporting longfin eel (*Anguilla dieffenbachii*), shortfin eel (*Anguilla australis*), whitebait/inaka (*Galaxias spp.*) and common bully/pako (*Gobiomorphus cotidianus*) populations (ORC, 2004).

- [29] Lake Tuakitoto is highly valued by Kāi Tahu for cultural and spiritual beliefs, values and uses, including mahika kai and waahi taoka. The associated wetland is highly valued by Kāi Tahu for its historical associations and as a traditional food gathering area (ORC, 2004).
- [30] In 2004, ORC constructed a walkway around the lake to improve public access to the lake.
- [31] Lake Tuakitoto provides significant hydrological values including maintaining water quality and low flows or reducing flood flows. Lake Tuakitoto and surrounding wetlands perform a valuable hydrological function. It serves as a flood ponding area and is an integral part of the Lower Clutha Flood Control and Drainage Scheme (ORC, 2004). The lakebed and some of the lake margins are owned by ORC. The opportunity exists for ORC, as a landowner, to enhance its land in the same way other landowners are enhancing theirs.
- [32] The regionally significant Lake Tuakitoto Wetland complex, which includes Robson Lagoon, is located in the Clutha/Mata-Au catchment, approximately 7km northeast of Balclutha, Otago. This project has upgraded flow management structures within Robson lagoon to improve flow during flood events, whilst maintaining sustainable water levels during normal and low flow conditions. This provides a more sustainable habitat for local wildlife, such as native fish, and will protect the cultural values associated with the area.
- [33] The Otago Regional Council Long Term Plan 2021-2031 details Lake Tuakitoto as a key project for delivery between 2021 to 2024. \$260,000 has been allocated to this project over these three financial years.
- [34] Since 2021 key stakeholder and community meetings have been held to contribute to the development of the management plan for Lake Tuakitoto (Appendix 4). The management plan details three priority actions based on community feedback.
- [35] A Lake Tuakitoto Management Plan, based on community consultation, was approved by Council in April 2022 (Appendix 4).
- [36] The Management Plan for Lake Tuakitoto included: an ecological assessment of the catchment, establishment of new water quality monitoring sites and a hydrological assessment. These were the priority actions decided by the community. Two of these actions have been completed and are detailed below. The hydrological assessment has not commenced to date but is proposed to be undertaken next financial year.

- [37] Cawthron Institute were engaged to deliver an ecological assessment for both Lake Tuakitoto and Tomahawk Lagoon and identify and provide guidance on where action could be delivered for best investment environmental outcomes (Appendix 5).
- [38] In June 2023, ORC added two water quality monitoring sites to the Lake Tuakitoto catchment. This brings the total number of monitoring sites in the catchment up to three, with the existing site being Lovells Creek. The two additional sites are at Stony Creek and Frasers Stream. These sites are sampled monthly, and sampling will continue until 1 July 2025.
- [39] Following receipt of the Ecological Assessment (Appendix 5) an implementation plan for Lake Tuakitoto has been drafted by staff. This is included in Appendix 3. The implementation plan is related to the ecological assessment undertaken by Cawthron Institute. This report provided recommendations and therefore an implementation plan has been developed to show what work is planned to be completed within the catchment and what outcomes are sought. The community consultation which initiated the development of the Management Plan for the area and the implementation plan are linked as one of the priority actions to deliver was the ecological assessment. Now that this has been delivered there are other 'Potential projects' within the Management Plan which are listed to commence. This includes fencing and native planting.
- [40] The \$260,000 which has been allocated to this project over the last three financial years is currently underspent. A budget is included in the Implementation Plan (Appendix 3) in section 5 of this document which indicates that some of this funding will be spent in the 2024/25 financial year. The budget collected for Lake Tuakitoto is from its own reserve so the budget can be transferred forward to allow for this spend and to ensure that ongoing delivery of this project occurs.
- [41] Staff have developed a project plan for a wastewater education programme to be delivered in the Lake Tuakitoto catchment. The aim of this project is to raise awareness around Onsite Wastewater Management Systems and the impacts these can have on water quality when they are not maintained appropriately. This project will provide guidance and resources to those within the catchment around best practice management of their systems. Once the resources are finalised this programme will be initiated within the catchment.

#### Lake Hayes/Waiwhakaata

- [42] The Lake Hayes restoration project aims to improve water quality within Lake Hayes and reduce the risk of flooding along the perimeter of the lake. Currently there are flooding impacts to the existing recreational trail which affects public access, negatively impacts on the Crested Grebe habitat, increases runoff of nutrients from flooded land and impacts adversely on native planting which has been established for local biodiversity restoration along the shores of Lake Hayes.
- [43] The Waiwhakaata /Lake Hayes Strategy Group is continuing to support the development of a refreshed strategy. In March 2024 a new chair of the group was appointed Jana Davis. Jana represents Kāi Tahu (Hokanui Rūnaka, Ōraka-Aparima Rūnaka). The group comprises representatives of mana whenua, ORC, Friends of Lake Hayes, Department of Conservation and Queenstown Lakes District Council.

- [44] The Lake Hayes restoration project aims to improve water quality within Lake Hayes and reduce the risk of flooding along the perimeter of the lake. Currently there are flooding impacts to the existing recreational trail which affects public access, negatively impacts on the Crested Grebe habitat, increases runoff of nutrients from flooded land and impacts adversely on native planting which has been established for local biodiversity restoration along the shores of Lake Hayes.
- [45] A Cultural Values Statement Waiwhakaata (Appendix 6) has been completed by Aukaha and the Ngāi Tahu ki Murihiku Environmental Statement of Expectation Waiwhakaata/Lake Hayes (Appendix 7) has been completed by Te Ao Marama (TAMI). These assessments provide a comprehensive summary of mana whenua values and environmental aspirations and will be used to inform the final refreshed strategy (and other planning and strategic processes concerning the Waiwhakaata catchment).
- [46] Work downstream of the existing culvert in Hayes Creek was completed in April 2024 (Figures 6 and 7). This downstream work has been undertaken to support the existing culvert being able to function better, so that hopefully the culvert will not need to be replaced. This work involved vegetation removal and sediment/obstruction removal. Consent has been granted for a new culvert if in the future it is decided that the downstream rehabilitation works were not sufficient to support improvements to the health of Waiwhakaata.



Figure 6: Photo of Hayes Creek post downstream works completed.



Figure 7: Photo of Hayes Creek post downstream works completed.

- [47] The Mill Creek (Arrow River water) augmentation works are nearing completion. The physical pipe infrastructure is all in place and built-up sediment around the structure discharging to Mill Creek is to be undertaken prior to commissioning the pipe. This is to ensure that sediment is not dislodged and discharged downstream when it is first turned on. The sediment removal requires a consent and we are collaborating at the moment with Mana Tahuna to see if we can utilise existing consents that they have for sediment removal within the Mill Creek area. Staff are also working closely with Millbrook who are considering undertaking sediment removal of their own ponds around the same time, while a contractor is on site.
- [48] ORC is establishing a commissioning working group to go through the risks associated with the commissioning process for augmentation and ensure co-ordinated involvement from all stakeholders. The working group will include representatives from the following groups: ORC, Arrow Irrigation Company (AIC), Friends of Lake Hayes (FOLH), Mana Whenua, project consultants (Egis, Mitchell Daysh) and Base Contracting. Millbrook Resort representatives will also be invited.
- [49] The key items for the commissioning working group to consider include the contractual requirements for the physical infrastructure, impact on the immediate environment when flushing begins, and potential mitigation measures, appropriate approvals and blessings from Mana Whenua prior to operating, ongoing monitoring and effectiveness, establishing the operational plan and community communications.
- [50] The Waiwhakaata Strategy Group continues to provide an effective mechanism to bring all parties together to discuss issues of mutual interest and to act as a liaison point

between mana whenua, the community and government agencies. It has facilitated better communication and enabled ORC to quickly engage the views of partners and key stakeholders to ensure acceptable progress is made to deliver the Lake Haye restoration project.

[51] Going forward the group will discuss how to incorporate the cultural values assessments that have been delivered by Aukaha and TAMI and update the terms of reference to reflect a more strategic vision for this group to achieve outcomes which enhance the health of Lake Hayes and the surrounding catchment.

# Toitū Te Hakapupu/Pleasant River

The \$4.0m, Ministry for the Environment funded, Toitū Te Hakapupu/Pleasant River Catchment Restoration Project with the objective of improving/protecting water quality in partnership with Kāti Huirapa Rūnaka ki Puketeraki is progressing. The rivers and estuary of Te Hakapupu have had excess sedimentation and nutrients deposited throughout the catchment which impacts on ecosystem habitat and health, cultural values, as well as reducing recreation and amenity values. These signs include areas of dense algal mats, anoxic water conditions, and muddy sediment deposited in riverbeds and into the estuary. Changing land use in the area, particularly in the upper catchment, over time has contributed to an increase in sediment and nutrients entering the waterways. Erosion, which is associated with land clearance, and weather events have also exacerbated sediment loss to water in the catchment.



Figure 8: Satellite showing catchment boundary (dark blue) and the three main waterways (light blue) leading into the estuary, Te Hakapupu (Pleasant River), Te Owhakaoho (Trotter) and Watkin.

- [53] The purpose of the Toitū Te Hakapupu project is to implement effective interventions to reduce sediment and nutrients and better safeguard the water resources from *ki uta ki tai* (mountains to the sea). The ultimate receiving environment includes the proposed Te Umu Koau marine reserve (D1) and supporting good quality water entering this is important.
- [54] The opportunities through delivery of the project include protecting riparian margins through fencing and planting, protecting wetlands through fencing and enhancement through planting, improving the quality of water to the estuary and coastal environments, actions to address sediment and nutrient laden water, working with the forestry sector to reduce impacts on stream health and biodiversity and fish passage remediation.
- [55] The project has three strands:
  - a. Rural Interventions Programme this involves fencing waterways, planting 75,000 indigenous plants (and maintenance of these plants), supporting and

- implementing good management practices across water quality, biodiversity and biosecurity, restoration/remediation of degraded wetlands and identification and rectification of fish passage barriers.
- b. Forestry Interventions Programme this involves engaging with, and supporting, landowners and forestry companies to develop a Forestry Action Plan and implement practices to minimise impacts on stream health and biodiversity, explore different approaches to prioritise land stewardship and best practices for sustainable harvesting and beyond regulation advice and action.
- c. Community Engagement, Education and Action this involves the development and implementation of a catchment action plan, and the provision of information and opportunity for community to shape and influence project delivery.
- By June 2025, the project will have implemented on-the-ground mitigation activities in line with the funding deed. This is expected to include installing 20km of fencing, planting up to 75,000 native trees, restoring fish passage to three barriers in the catchment, and a range of other potential remediation actions like sediment traps, erosion planting, wetland restoration, and riparian buffers in forestry areas.
- [57] The actions on the ground for this project will be funded by MfE through project funding, not by ORC. The ORC contribution to delivery of the Toitū Te Hakapupu project is in kind.
- [58] ORC have partnered with Kāti Huirapa Rūnaka ki Puketeraki to deliver the Toitū Te Hakapupu project, as stated in the MfE funding deed. A Partnership Group was formed, as discussed and agreed on by ORC and Kāti Huirapa Rūnaka ki Puketeraki.
- [59] The Partnership Group has 7 members and is co-chaired by ORC (2 seats) and Puketeraki (3 seats). It is made up of representatives from ORC, Kāti Huirapa Rūnaka ki Puketeraki and the Community (1 East Otago Catchment Group member, 1 catchment community member).
- [60] Partnership Group meetings are held quarterly, with additional input occasionally sought via email between those meetings.

# **Project tracking**

[61] The project team have been able to track project activities and landowner engagement through a mapping tool. This tracks planting, fencing, landowner engagement and other points of interest that the project is supporting.



Figure 9: Toitū Te Hakapupu dashboard tracking project KPI's planting and fencing. Landowner agreements and other data sit in the layers.



Figure 10: Toitū Te Hakapupu project dashboard showing landowner progress through planting and/or fencing works undertaken/underway.

# **Project Activities**

[62] The Catchment Action Plan is now in draft form and will be shared with Kāti Huirapa Rūnaka ki Puketeraki and East Otago Catchment Group for input and feedback. Key

values for the catchment have been identified based on workshops and discussions with the community and representatives of Kāti Huirapa ki Puketeraki. These values focus on waterways within the catchment, biodiversity, mana whenua values, and the community. Strategies and actions have been identified to support/enhance these values, many of which will be supported by the Toitū Te Hakapupu project.

- [63] Environmental Baselines have been set and results show that Te Hakapupu/Pleasant River estuary has similar characteristics to other estuarine systems in Eastern Otago with similar types and numbers of fish species, including four considered to be mahika kai; kahawai, sand flounder, skate and yellow eyed mullet. Te Hakapupu habitat scores at ten sites were 'poor', 'fair', and 'good' for two, six, and two sites respectively.
- [64] Water quality monitoring is now in year two. Results so far indicate that turbidity (the measure of sediment in the river) exceeded the recommended threshold for ecosystem health. Detailed analysis of the metrics will be undertaken once sufficient samples have been taken.
- [65] There are three AquaWatch waka located in the three tributaries to measure key water quality health indicators in real time data (15-minute updates). This includes measurements of five parameters; dissolved oxygen, turbidity, temperature, pH and conductivity. Technical issues with the original waka have meant that the upgraded waka were installed in January 2024. We await the valuable data to be measured and delivered during rainfall events.





Figure 11: AquaWatch "waka" a community science tool to capture real time water quality data (left). Waka being installed in Te Hakapupu on the Watkin River (right).

[66] The Forestry Action Plan is in draft form and has been circulated to the Forestry Working Group for input. The group have identified a range of potential priority actions such as utilising new riparian areas created as legacy blocks are harvested, investigating coupe

- harvest systems, and enhancing pest control. Confirming the detail around actions for these and other priorities will be the focus of the group's next meeting.
- [67] Sediment hot spots have been identified using NIWA sediment source tracking, risk mapping and erosion mapping. Ground truthing has confirmed a number of hot spot areas. These include stream banks, areas of active erosion and areas of mass movement.
- [68] Sediment mitigation actions and planning are underway, with fencing and planting river margins and wetlands, sediment traps and erosion planting proposed for priority sites.
- [69] Fencing is underway in Te Hakapupu to protect waterways and wetlands. Riparian fencing completed or currently underway is 4.75 km. Wetland fencing to protect Te Hakapupu regionally significant wetland with approximately 3.75 km of fencing proposed to exclude stock from the wetland areas.
  - Fencing completed and underway 8.5 km.
  - Fencing proposed 19 km





Figure 12: Boundary fencing crosses the river at some points (left). Most fencing it is to protect waterways from stock and buffer the effects of pastural activities (right).

- [70] Planting wetlands and stream banks in Te Hakapupu is underway to stabilise stream banks, reduce erosion, provide wildlife corridors, increase habitat and increase biodiversity.
  - Numbers of plants planted 22,750.
  - Numbers of plants proposed for 2024 season 38,650.





Figure 13: Stream bank planting is carried out by the Aukaha planting team with landowners making a contribution usually through assisting with planting.

- [71] Kāti Huirapa Rūnaka ki Puketeraki have involved up to ten rūnaka members directly working on the project at times as well as project coordinator. Activities to date include:
  - The nursery is producing up to 40,000 plants for the project;
  - Whānau have developed a Cultural Health Monitoring Plan and are undertaking ongoing cultural health monitoring;
  - A draft capacity and capability plan has been completed;
  - A video story is being produced to share project achievements and highlights;
  - 20 fish passage barriers were identified in the catchment and all have been assessed for fish passage for native fish species. The outcome was that seven structures are considered priority for replacement or improvement. Three of the seven are high priority for replacement or improvement and the project team are working with landowners to support rectifying these barriers.
- [72] Landowner engagement continues within the catchment. As of early April 2024, the project team has identified 47 landowners with properties that could have water quality improvement works installed (streambank erosion, active erosion, mass movement). Of these the project team have engaged with 41 (87%) landowners. Works are either complete, underway or planned for 29 of those, and engagement is still underway. This is a 71% success rate for landowner engagement.
- [73] A community celebration was held at the Puketeraki marae on February 15<sup>th</sup> 2024 to acknowledge those that had already contributed so much to the success of the project. Those being acknowledged were handed a plaque and personally thanked by the Partnership Group. Councillor Malcolm was in attendance at this event.
- [74] A community planting day was held in September 2023 in Goodwood. Over 50 people, including families and children participated and 1200 plants were planted.

- [75] Schools have been brought into the project through an education day which included planting, stream health study and an introduction to cultural health monitoring.
- [76] A number of communications channels are used to promote the project and its activities:
  - The ORC/Toitū Te Hakapupu website is regularly updated and holds information about project updates and findings.
  - Regular bimonthly newsletter with project updates, new findings from project monitoring/investigation, a science section and a meet the team section. A signup form is available on the website.
  - A media release to promote and advocate for the project and provide an update
    on progress went out late 2023, and the Otago Daily Times published an article on
    24 February 2024 that spoke about the partnership with Puketeraki and an
    interview with Katharina Ruckstuhl, the co-chair for the Partnership Group.
  - Media releases go out following each event which includes planting days, community hui and field days.
  - Sign design confirmed to promote the project on landowner's properties alongside State Highway 1.
- [77] As at Year 3 Quarter 2 (end December 2023), project spend shown below in Table 1. The project is on track for its budget spend, though the ORC contribution will be an overspend.

Table 1: Toitū Te Hakapupu Budget summary

Funding	Total spend end March 2024	Total Budget
MfE funding claimed	\$1,280,387	\$3,904,500
ORC In Kind	\$760,891	\$786,000
Landowner contribution	\$104,925	\$500,000
Total	\$2,246,202	\$5,290,500

[78] For the project to succeed ORC needs to deliver certain KPI's agreed to in the funding deed from MfE. These targets are well underway, with this next calendar year delivering the remainder of these as shown in Table 2 below.

Table 2: Toitū Te Hakapupu - Key Performance Indicators

Focus areas	Proposed new Targets*	Achieved to Date	Planned 2024
Fencing	20 km	8.5 km	19 km
Planting	75,000	22,750	38,650
Ha planted	20	5	10
Site Restoration (cultural/historic significance)	2	1	1
Number of properties with water quality actions	Up to 25	13	19
Landowners engaged with	Up to 75%	80%	Ongoing
Fish passage barriers assessed	5	20	
Fish passage barriers mitigated	3	0	3
Number of people hours worked	20,000	11,500	7,000

Number of people undertaking	9	10	
training			

\* ORC is progressing through a change request with MfE for this project to amend some of the KPIs to reflect more realistic targets. This is due to the effects of inflation, as well as unknowns when the project was established.

Table 3: Toitū Te Hakapupu – planned activity

Activity	Description	Planned time
Community workshops	To deliver community science and foster connections between landowners, forestry industry and our iwi partners and promote project successes.	Forestry field trip 18 April 2024
	Community science sessions – 3 or 4 to be held throughout the next year.	18 May 2024, October 2024, February 2025, April 2025
	Planting day	August 2024
Communications	Newsletter, science web page, comms about events (before and after), media release, video story	Throughout project
Planting and fencing	Continue as the project works toward KPI targets and beyond.	May – November 2024 and May to 30 June 2025.
Sediment traps and erosion planting	For priority properties with active erosion	
Fish passage barriers	3 fish passage barriers to be replaced or improved to enable native fish to travel up and downstream and increase access to habitat.	Summer 2024/2025
Water quality monitoring	To gain an understanding of changes in water quality over time considering seasonal change and storm events	Summer 2024 Summer 2025
Cultural Health Monitoring	Carried out by Kāti Huirapa Rūnaka ki Puketeraki whānau	Ongoing
Catchment Action Plan including Forestry Action Plan	Input from Puketeraki and community and finalised as a living document.	February 2025

[80] Staff will continue to provide up to date reporting to MfE. This includes quarterly reports, annual reports, annual work plans and an independent annual audit.

# **Nature Based Solutions**

- [81] A pilot study is being undertaken in the Te Hakapupu catchment and will look at how nature-based solutions could help lessen the effects of flooding, providing for opportunities Otago-wide.
- [82] This project, the Wai i te reporepo, wai i te wao: Nature-based Solutions Study, is one of 21 nationally to be fully funded by the Ministry for the Environment's (MfE) Essential Freshwater Fund. It will explore the potential of Nature-based Solutions such as restoring wetlands and planting natives to help manage flooding, clean our water and support biodiversity.
- [83] A report detailing the types of solutions that could work in the catchment will be drafted this year. Consultants have been engaged and are supporting the work, combining local Otago knowledge with international best practice to develop recommendations.
- [84] On completion of the report, we're planning to test some of its findings more widely with land users around Otago. An engagement study, looking at perceived barriers and opportunities around people's willingness to adopt these ideas, will be completed in 2025.
- [85] The results of the engagement study will help inform future decision-making and highlight opportunities that could benefit the entire region in regard to how nature-based solutions could be adopted and what opportunities there may be to incentivise this type of work occurring on private land.

#### Site-led programme - Lagarosiphon

- [86] The Site-Led programme is part of the Otago Regional Pest Management Plan 2019-2029 (RPMP) and seeks to manage additional pests to avoid, mitigate or prevent damage to the indigenous ecosystem values at specific sites.
- [87] There are four Site-Led Programmes in Otago. This paper refers to the Site-Led Programme for lagarosiphon management areas (Figure 14). A previous paper to the Environmental Implementation committee on the 8<sup>th</sup> February 2024 provided an update on the three Site-Led terrestrial areas including Otago Peninsula, Quarantine and Goat Island, and West Harbour Mt Cargill.

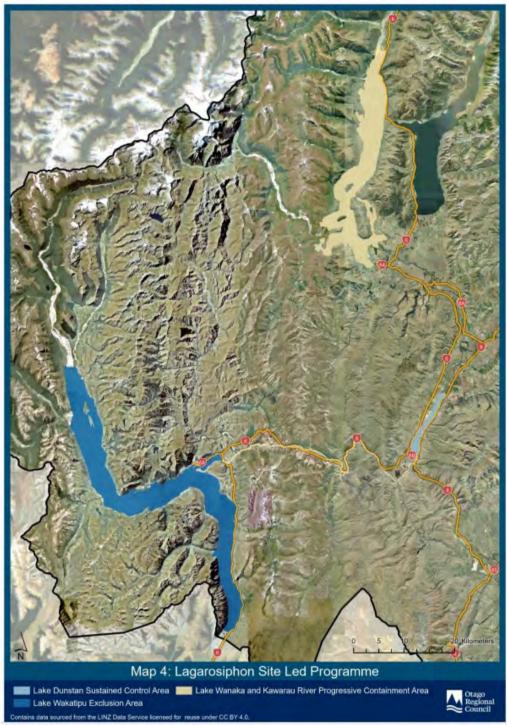


Figure 14: Lagarosiphon Site-Led Programme management areas

[88] Lagarosiphon is a submerged freshwater pest plant (Figure 13). It propagates through stem fragments being carried on water currents, boats, fishing gear, aquarium and pond escapes and deliberate planting. Its vigorous growth means that it can quickly shade out and outcompete native species, affecting ecosystems and the ability for people to swim, boat and use the water for recreation. It can also affect water supply intakes.

Lagarosiphon is known to be present in Lakes Dunstan and Roxburgh and part of Lake Wānaka. It is also present in the Clutha River/ Mata-Au and the Kawarau River. Isolated, individual plants are regularly removed from Frankton Arm in Lake Whakatipu to prevent it spreading.





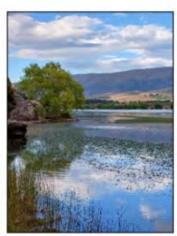


Figure 15. Lagarosiphon

- [89] Most of Otago's lake beds and rivers are administered by Toitū Te Whenua, Land Information New Zealand (LINZ). The Site-Led programme for lagarosiphon management areas is delivered in collaboration with LINZ, Biosecurity New Zealand, and other members of the lagarosiphon management committees including representatives from district council, Fish and Game, Guardians of Lake Wānaka, Contact Energy, and community groups. NIWA provide overall scientific advice to the programme. The current areas of focus for the control of lagarosiphon are Lake Dunstan, Lake Wānaka and Lake Whakatipu.
- [90] ORC's role in the Site-Led Programme for lagarosiphon management areas include:
  - to support joint planning in developing an annual control work programme led by LINZ;
  - advocate and support the continued suppression of lagarosiphon in Otago's lakes and rivers;
  - iii. support LINZ in the development, review, and delivery of 10year Lagarosiphon Management Plans for the control of lagarosiphon in Otago's lakes and rivers;
  - support and participate in Check, Clean and Dry campaigns and advocate for campaign activities to be undertaken in additional areas to further prevent spread of aquatic pests;
  - continue to provide funding to lagarosiphon management where this supports coordinated action, whilst recognising that LINZ is the key agency undertaking management.

# Toitū Te Whenua, Land Information New Zealand lagarosiphon control programme 2023-2024

[91] To meet Otago Regional Pest Management Plan 2019-2029 (RPMP) Objective 6.5.7 a to c (Figure 16), ORC works collaboratively with Toitū Te Whenua, Land Information New Zealand (LINZ) to support the LINZ Otago lagarosiphon control programmes in Lake

Wānaka, Lake Whakatipu, the Kawarau River, and Lake Dunstan. LINZ have supplied a report of the work undertaken to date for the 2023-2024 year (Appendix 8 and 9).

#### Plan Objective 6.5.7

Over the duration of the Plan actively manage lagarosiphon to:

- reduce the extent of lagarosiphon in Lake Wanaka and the Kawarau River (Map 4 in Appendix 3) through progressive containment over the next 10 years;
- implement sustained control of lagarosiphon in Lake Dunstan (Map 4 in Appendix 3);
- prevent the establishment of lagarosiphon in Lake Wakatipu (Map 4 in Appendix 3);
- d) prevent the establishment of lagarosiphon in lakes, rivers and tributaries where it is not already present

to avoid, mitigate or prevent effects on the environment, and amenity and recreational values.

#### Principal measures to be used

Land Information New Zealand will take a lead role in controlling and eradicating lagarosiphon in Otago's lakes and rivers that it administers. Otago Regional Council will work collaboratively with Land Information New Zealand and other partners in the preparation, administration and delivery of 10-year Management Plans for the control of lagarosiphon and in other initiatives to deliver the outcomes in the objectives.

Occupiers will be responsible for eradicating lagarosiphon within private ponds and aquariums.

The requirement to act, service delivery, advocacy, education, and collaboration described in section 5.3 of the Plan, will be used primarily to achieve Plan Objective 6.5.7. How the Otago Regional Council intends to support the delivery of these objectives with Land Information New Zealand is described more fully in Section 3 of the Biosecurity

Figure 16. Plan Objective 6.5.7 of the Otago Regional Pest Management Plan 2019-2029.

[92] Included within the LINZ report (Appendix 8) is a recommendation that ORC provide surveillance funding of \$125,400 at high-risk sites. ORC don't currently have budget allocated for this work and have advised LINZ to provide input through the Long-Term Plan submissions.

Strategy.

- [93] ORC staff will attend and participate in the annual LINZ stakeholder meetings to be held 6-8th May 2024 and are providing feedback on the current review of the ten-year Lake Wānaka Lagarosiphon Management Plan. The ten-year plans for Lake Whakatipu and the Kawarau River, and Lake Dunstan are due to be updated next Financial Year (FY2024/25) and ORC staff will be providing feedback.
- [94] ORC contribute \$50,000 per annum via a funding agreement to LINZ to the lagarosiphon programme. This has been approved in the 2023/34 annual plan and is also included in the draft 2024-2034 Long Term Plan. This contribution goes towards lagarosiphon control in Lake Dunstan to minimize weed impacts of lake users within high-risk areas, for example boat ramps, and also in high-amenity areas, for example recreational areas. Contribution in Lake Dunstan is based on the view that ORC shouldn't reduce the level of existing commitment to lagarosiphon control in this area.

## ORC monitoring and surveillance of non-LINZ managed water bodies 2023-2024

[95] To meet RPMP Objective 6.5.7 ...(d) prevent the establishment of lagarosiphon in lakes, rivers, and tributaries where it is not already present, ORC is the lead agency responsible for preventing lagarosiphon invasion by managing pathways by which lagarosiphon is introduced and by undertaking monitoring and surveillance of additional water bodies to those controlled and monitored by LINZ. In 2023-2024, 11 primary locations were identified for monitoring inspections and an additional 50 secondary locations were

identified for baseline surveillance inspections (Figure 17). Additional lagarosiphon monitoring locations were also identified based on recently discovered public observations.

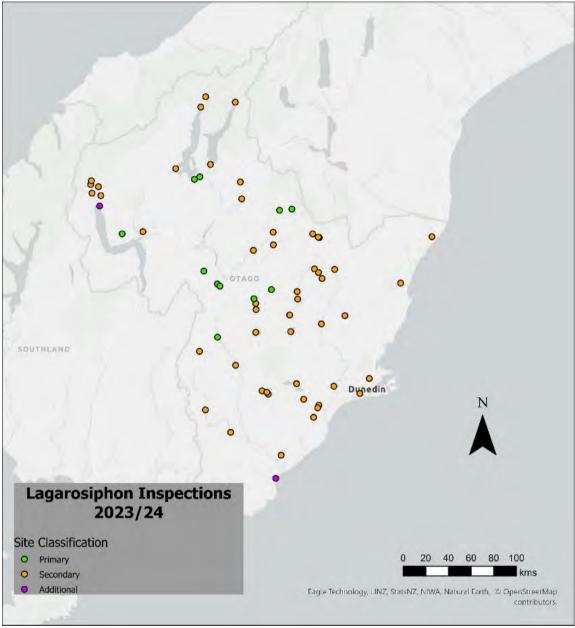


Figure 17. ORC lagarosiphon inspection locations and classifications 2023-2024.

[96] As at April 2024, monitoring inspections have been completed at the 11 primary locations and baseline surveillance inspections completed at 43 of the secondary locations. Seven of the identified locations were found to be inaccessible for this round of surveillance but will be revisited in the future (Figure 18).

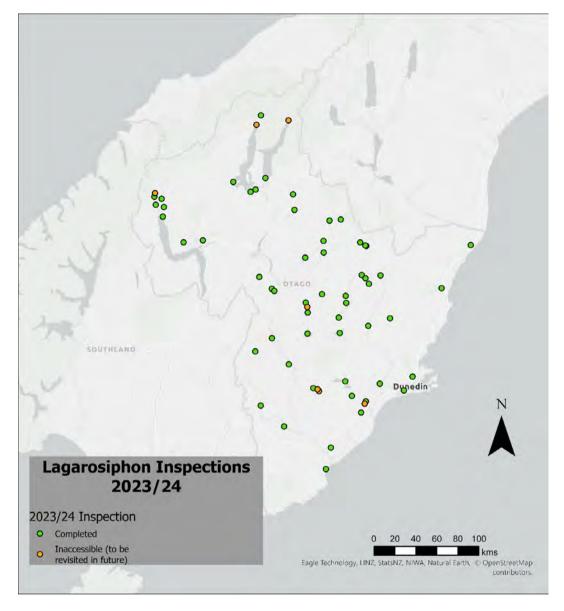


Figure 18. Status of lagarosiphon inspection and monitoring activities as of March 2024

[97] Lagarosiphon infestations were detected in three of the locations: Bullock Creek (Wānaka), Albert Town Stormwater Ponds and the Puerua River, Clutha (Figure 19). The Bullock Creek and Albert Town sites contain existing surface-reaching infestations that are known through historical monitoring and options for management are currently being explored. The Puerua river infestation contains surface-reaching weeds and was not known to ORC as an existing site and has been located near the mouth of the river. Additional surveillance will be undertaken to determine the extent of the infestation upstream and management options will be explored. The 2023-2024 monitoring and surveillance inspection data will be used to inform future management and prioritise locations for ongoing lagarosiphon monitoring.

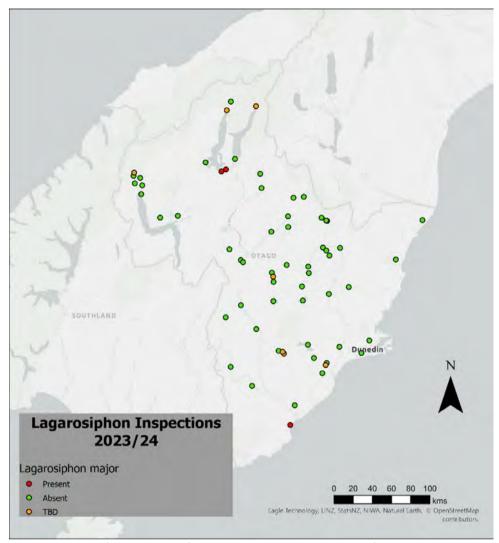


Figure 19. Status of lagarosiphon infestations during the 2023-24 round of monitoring and inspections as of March 2024.

### Check, Clean, Dry and Communications Campaign

- [98] The Check, Clean, Dry programme (CCD) is a Biosecurity New Zealand initiative aimed at preventing the spread of freshwater pests, such as didymo and lagarosiphon. ORC delivers the Check, Clean, Dry programme annually from December to February to engage recreational water users and facilitate behaviour change to prevent the spread of freshwater pests to and througout the Otago Region.
- [99] ORC received MPI funding to support the engagement of Check, Clean, Dry advocates over the summer season to attend events and engage with water users to promote the Check, Clean, Dry process and hand out collateral. The 2023-2024 season is summarised in a final report prepared by the Check, Clean, Dry Advocates (Appendix 10). The Community Coordinator Biosecurity represents ORC on the national Check, Clean, Dry working group.
- [100] The primary engagement groups that the advocates interacted with were event organizers, boaters, jet skiers, swimmers, fishers, kayakers/ paddleboarders and general

members of the public. The advocates collected information about the number of interactions, percentage of daily interaction totals for tourists and locals, and the different attitues to CCD (receptivity scale from 1 - 'not receptive' through to 5 - 'very receptive'). The advocates recorded a total of 642 interations. Of these, a 68 people answered with a score of 1-4 and were considered 'not receptive' of the CCD programme and 574 answered with a score of 5 indicating that they were 'very receptive' of the programme. Additionally, the majority of people spoken to were of local origin, with 70% being the lowest local percentage day. Outside of the main CCD season, ORC biosecurity staff attended events and engaged with an additional 125 people (Table 4). Feedback from the 2023 – 2024 season will be collated and used to inform the 2024-2025 season.

Table 4. Number of events attended and individual interactions 2023-2024

			CCD Advocates	ORC Staff
Number of events attended		s attended	12	4
Number	of	individual	642	125
interactions				

[101] During the Check, Clean, Dry season, a communications campaign was initiated to increase awareness of lagarosiphon as a freshwater pest and promote the Check, Clean, Dry programme (Figure 20). This included a full page information piece in the Allied press holiday guide and Otago Daily Times; four Social Media posts introducing the Check, Clean, Dry programme and advocates; On Stream and Te Mātāpuna/ The Source information articles about lagarosiphon and Check, Clean Dry and an update to the ORC Pest Hub.



Figure 20. Examples of Otago Regional Council communications campaign to increase awareness of lagarosiphon as a freshwater pest and the Check, Clean, Dry programme.

[102] In 2022-2023 it was identified that existing Check, Clean, Dry and freswater pest signage required updating and additional high-use locations would benefit from signage installation.

[103] To date, permissions have been obtained for installation of 70 new signs. Of these, 35 have already been installed and an additional 35 are pending installation over the winter season (Figure 21 and Figure 22).

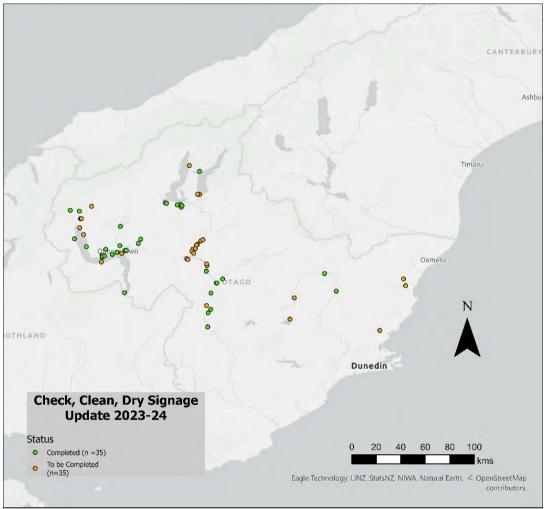


Figure 21. Locations of new installed Check, Clean, Dry signage and pending installations througout Otago.



Figure 22. Examples of new Check, Clean, Dry signage installed at high-risk locations througout the Otago region

#### Research

[104] Manaaki whenua, Landcare Research are currently researching the grazing impacts of a native aquatic caterpillar (*Hygraula nitens*) on lagarosiphon infestations in Otago and other regions. ORC Biosecurity staff assist Landcare researchers annually to collect samples of suspected caterpillar-grazed lagarosiphon plants at two sites (Figure 23). The results will be shared with ORC when the study is complete.



Figure 23. Lagarosiphon in Lake Dunstan showing the effects of grazing by Hygraula nitens.

[105] Manaaki whenua, Landcare Research are currently investigating the feasibility of trialling biocontrol agents for lagarosiphon to potentially reduce its biomass and competitive dominance. This information will be communicated once the investigation is complete.

# **CONSIDERATIONS**

# **Strategic Framework and Policy Considerations**

[106] Our strategic directions commit ORC to delivering integrated environmental management, engaging communities and collaborating to deliver, and this work is consistent with those commitments. Where water quality is degrading, ORC is required to implement an action plan to address the degradation. This work is an early example of such a plan.

#### **Financial Considerations**

- [107] The budgets for these projects have been accounted for in the Long-Term Plan 2021-2031 and subsequent annual plans.
- [108] To implement actions in these catchments financial/funding discussions have occurred through the Long-Term Plan 2024-2034 for future years funding.
- [109] ORC in kind time contributing to the Toitū Te Hakapupu project is reaching what was envisaged when the project was originally funded.
- [110] The LINZ report on lagarosiphon suggests that funding for surveillance at high risks sites could be funded by ORC. The amount suggested is \$125,400. This is not currently budgeted for.

# **Significance and Engagement**

[111] The recommendations of this report are consistent with the council's Significance and Engagement Policy.

# **Legislative and Risk Considerations**

[112] This paper does not trigger legislative or risk considerations.

# **Climate Change Considerations**

[113] Lake Tuakitoto plays a significant role as a catchment ponding area during flood events in the Lower Clutha Flood Control and Drainage Scheme.

#### **Communications Considerations**

[114] Communications around the projects is ongoing and the Environmental Implementation staff will work with the Communications team.

# **NEXT STEPS**

- [115] If endorsed, delivery of implementation plans for Tomahawk Lagoon and Lake Tuakitoto will continue.
- [116] Work to deliver on these projects and programmes will continue.

# **REFERENCES**

[117] Otago Regional Council (2004) Regional Plan: Water for Otago. Published by the Otago Regional Council, Dunedin.

# **ATTACHMENTS**

- 1. Tomohaka Tomahawk Lagoon Implementation Plan DRAFT [9.4.1 8 pages]
- 2. Tomahawk Lagoon Outline Management Plan [9.4.2 4 pages]
- 3. Lake Tuakitoto Implementation Plan DRAFT [9.4.3 8 pages]
- 4. Lake Tuakitoto Outline Management Plan [9.4.4 5 pages]
- Caw Rpt 3947 Ecological assessment of Lake Tuakitoto and Tomahawk Lagoon 20230828
   [9.4.5 129 pages]
- 6. 230614 Aukaha Waiwahakaata CV S\_ FINAL [9.4.6 45 pages]
- 7. 20230620 Statement of Expectation Waiwhakaata FINAL [9.4.7 31 pages]
- 8. LINZ otago aquatics update ORC council meeting 8 May 2024 [9.4.8 13 pages]
- 9. Otago Aquatics 20240408 [9.4.9 14 pages]
- 10. Check Clean Dry Final Report 2023 24 [9.4.10 4 pages]



# Tomohaka / Tomahawk Lagoon Implementation Plan

# 1. Purpose

The purpose of this Implementation Plan is to provide clarity on the actions required to implement recommended management actions identified in the ecological assessment of Tomohaka / Tomahawk Lagoon (hereon in referred to as Tomahawk Lagoon), which was completed in July 2023. The intention is that the Implementation Plan will remain a living document, used to achieve two primary purposes:

- 1. To guide delivery of recommended management actions
- 2. To use as a basis for discussion with mana whenua, key stakeholders, and community representatives

#### 2. Context

In response to concerns about water quality, the 2017/18 Annual Plan provided for Otago Regional Council (ORC) staff to work with the local community to scope lake restoration works for Tomahawk Lagoon. Engagement and consultation with the local community around Tomahawk Lagoon was initiated as water quality was found to be degrading. Local citizen science group ECOTAGO helped to identify that there are elevated levels of sediment, E. coli, nitrates and phosphates found within the lagoon and Lagoon Creek (contributing waterway). Cyanobacteria is found within the lagoon regularly in the summer months. The community also raised other concerns to do with water levels and sediment.

The engagement and consultation process included the following steps:

- In February 2018, a workshop was held with the community, where community goals and values for the Tomahawk Lagoon catchment were identified.
- In May 2018, a second workshop was held with the community where potential projects for the lagoon and catchment were identified.
- In early 2021, ORC staff prepared a draft outline management plan based on the above consultation feedback.
- In March 2021, a key stakeholder meeting for Tomahawk Lagoon catchment was held to
  discuss the draft outline management plan, and feedback was provided. At this meeting,
  key stakeholders had the opportunity to vote for the projects within the plan that they
  identified as being the highest priority for implementation.

- On the 29 April 2021, a drop-in session was held at Grant Braes AFC Clubrooms so that the community could vote on the projects that they identified as being the highest priority for implementation, 40 community members attended this session and provided feedback.
- In April 2021 online consultation was held with the community, to complement the drop-in session, so that they could provide their votes on the projects that they identified as being the highest priority for implementation. 59 people participated in this opportunity and provided their votes.
- The three projects that received the highest votes for implementation within the Tomahawk Lagoon catchment were:
- ► An Ecological Assessment of the lagoon and catchment.
- ► A permanent water quality monitoring suite established.
- ► Formation and support of a community catchment group.

The sum of \$100,000 has been approved in the 2021-31 Long Term Plan for 2021/22 for projects to improve biodiversity and water quality within the Tomahawk Lagoon catchment. The sum of \$80,000 has been provided in each of the 2022/2023 and 2023/2024 financial years.

On 14 April 2022, report ENV2201<sup>2</sup> was presented to the Implementation Committee where the proposed Management Plans including priority projects for implementation for Tomahawk Lagoon were considered. The resolution made was that the Committee:

- 1. **Notes** this report.
- 2. **Approves** the initial management plan and ongoing development of management plans for Tomahawk Lagoon and Lake Tuakitoto catchments with their communities.
- 3. **Approves** commencement of project implementation.
- 4. **Notes** that project implementation will proceed this financial year, slightly accelerated for Tomahawk Lagoon, and as planned for Lake Tuakitoto.
- 5. **Notes** implementation in future years is dependent on Annual Plan decisions of Council and will be guided by the ecological assessments and priorities that arise through these.

Following the approval of the implementation of the initial management plan by the Implementation Committee:

- In April 2022, Otago Regional Council submitted a Request for Proposal (RFP) on the Government Tender Services (GETs) website for: "Lake Tuakitoto and Tomahawk Lagoon – Ecological Assessment".
- In June 2022, ORC awarded the contract to Cawthron Institute, who would deliver an ecological assessment for Tomahawk Lagoon to identify and provide guidance on where action could be delivered for best investment and environmental outcomes.
- In March 2023, Cawthron Institute undertook a field study at Tomahawk Lagoon.
- In July 2023, Cawthron Institute delivered a report¹ on the ecological assessment and potential management actions for Tomahawk Lagoon, which incorporates historical and field study data.

- In July 2023, ORC shared this report with community representatives, mana whenua, and key stakeholders.

The ecological assessment identified several recommended management actions with the goal to enhance freshwater quality of Tomahawk Lagoon and the wider catchment. These are summarised in Table 1.

**Table 1** Summary of potential recommended management actions from the Ecological Assessment of Tomahawk Lagoon.

Goal	Management Action	Priority
Reducing contaminants in the lagoons	Explore the possibility of zoning the catchment as a nutrient- sensitive zone in the Otago Regional Council Land / Water Plan	Highest
	Undertake fencing and riparian planting; buffers in forestry areas	Highest
	Enhance existing wetlands in the catchment	High
	Construct a wetland at the outlet of Lagoon Creek	Medium

#### 3. Scope

The Implementation Plan sets out the outcomes, objectives, activities, deliverables, tasks, and ORC teams responsible for the implementation of the potential management actions listed in Table 1. It also identifies potential roles and responsibilities of mana whenua, key stakeholders, community groups, key risks, and mitigation strategies.

The Implementation Plan covers the period from receipt of the ecological assessment from Cawthron Institute (July 2023) to June 2025. Note that the date to which funding from the ORC Long-term and Annual plans is allocated for this project ends in June 2024, however a carry-over of funding into 2024/25 has been requested to allow appropriate timeframes for delivery.

### 4. Structure of Plan

The draft Implementation Plan:

- Presents a logic model to conceptualise management action implementation and timeframes.
- ii. Defines potential roles and responsibilities of those involved in implementation.
- iii. Identifies risks to delivery and risk mitigations.

# i. Implementation Programme

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A thriving Tomahawk Lagoon catchment, where water quality and biodiversity are enhanced through community action to contribute to a healthy ecosystem for all to enjoy.

Inputs (The resources used to deliver activities and outputs in the project)	Activities (Project actions that lead to outputs with timing of delivery)	Outputs (what is produced and delivered with associated measures of success)	Short-term Outcomes 0-6 months	Medium-term outcomes 6-18 months	Long-term Outcomes >18 months
Partners  - Aukaha - Ōtakou Rūnaka  Key Stakeholders  - DCC - DOC - Ecotago Trust - Fish and Game Council - Tomahawk Lagoon Catchment Group - Otago Peninsula Biodiversity Group - Otago Peninsula Community Board - Save the Otago Peninsula - Tomahawk-Smaills Beachcare Trust - Birds New Zealand - NZ Landcare Trust - Community members/schools  Funding - FY 21/22 \$100,000 - FY 22/23 \$80,000 - FY 23/24 \$80,000  ORC Staff Contractors  Ecological Assessment Report	Activity Group 1  ORC Drafts Implementation Plan for Recommended Management Actions from Ecological Assessment (April 2024). Work collaboratively with mana whenua, stakeholders, and community to develop plan (May 2024). ORC explores zoning of catchment (April 2024).  Activity Group 2  Deliver stormwater education event (April 2024). Develop signage to facilitate community education. Assess options and viability of education initiatives relevant to the programme's Vision (May 2024).  Activity Group 3  Work with landowners to identify and prioritise areas in the catchment for habitat enhancement activities (May 2024). Discuss cost-sharing mechanism and collaboration with the landowners and community (June 2024). Discuss activities with ORC natural hazards and engineering to identify any risks (May 2024). Engage/collaborate with landowners and community groups to fence, plant, and maintain priority sites (June 2024, June 2025). Plant appropriate plant species.  Activity Group 4  Discussions with DOC, Fish & Game, mana whenua, landowners, and community around wetland	Potential enhancement areas are identified with landowners and prioritised (maps produced)  - Potential enhancement areas are identified with landowners and prioritised (maps produced)  - Planting and fencing budget is allocated to sites according to priority and viability (habitat enhancement plans developed)  - Landowners working with project to undertake riparian and wetland enhancement (number of landowner areaments/similar in place, number of planting and fencing plans in place)  - Planting and fencing the planting and fencing plans in place  - Plants planted (# of plants; size (area) of enhancement plans developed)  - Fences constructed (metres of fencing)  Output Group 4  - Working Group for Wetland Construction formed.  - Wetland Construction Plan created Implementation Plan and budget created.	A collaborative effort has confirmed the Implementation Plan and timeframes (0-3 months)  Increased engagement with landowners and community around enhancing water quality values in the Tomahawk Lagoon catchment  Discussions had with DOC, Fish and Game, Mana Whenua, landowners and community around wetland construction  Areas for habitat enhancement are identified and plans are produced	Habitat is enhanced through planting and fencing  Opportunities to support community education are explored	Improved Stream and Lagoon water quality

Environmental Implementation Committee - 8 May 2024

# ii. Roles and Responsibilities

This project is a collaborative project between mana whenua, key stakeholders, community, and ORC. It is important to understand the roles that different parties could potentially have in delivery of the management actions for Tomahawk Lagoon. Some of the roles are more certain, such as ORC's role in overall oversight of the project. Others are yet to be explored and confirmed with mana whenua, stakeholders, and community.

#### ORC's roles will include:

- ► Project delivery and oversight
- ▶ Leading the stormwater education event
- ► Co-ordinate the Wetland Construction Working Group
- ► Identify natural hazards and risks of activities
- ► Manage contractors
- ► Provide best practice advice to landowners

Table 2 Potential roles for Mana whenua, stakeholders, community

Organisation/s	Potential roles
Mana whenua and Aukaha	Working Group for Wetland Construction.
	Advice on rongoā species to include in plantings.
Dunedin City Council (DCC)	Permission for signage installation. Participation in stormwater education events.
	Provide stormwater education advice.
Department of Conservation (DOC)	Working Group for Wetland Construction.
Ecotago Trust	Deliver water quality programme 2024. Participation in stormwater education event.
	Provide options for future education initiatives.
Fish and Game - Otago	Working Group for Wetland Construction.
Fomahawk Lagoon Community Catchment Group	Support with landowner engagement.
Otago Peninsula Biodiversity Group (OPBG)	Advertise planting days.
Otago Peninsula Community Board	Engage in project and identify opportunities.
ave The Otago Peninsula (STOP)	Advertise planting days.
omahawk-Smaills Beachcare Trust	Facilitation of planting.
	Support with landowner engagement.
irds New Zealand	Engage in project and identify opportunities.
Z Landcare Trust	Engage in project and identify opportunities.
Community members/ Schools	Attend planting days and other events.
•	Provide options for future education initiatives.

# iii. Risks and Mitigations

There are some potential risks in delivery of management actions at Tomahawk Lagoon. Identifying these risks and potential mitigations is a useful first step in minimising these risks.

Table 3 Risks and mitigations

Activity	Risk	Likelihood	Impact	Mitigations
Explore the possibility of zoning the catchment as a nutrient-sensitive zone in the Otago Regional Council Land / Water Plan	Appropriate planning tools may not be available	High	Low	Ongoing engagement with landowners. Catchment Advisors to provide best practice advice (the piggery in the upper catchment may be ceasing operation which will decrease impacts of farming activities).
Undertake fencing and planting; enhance existing wetlands in the catchment	Lack of buy-in from landowners	Low	High	Consult with landowners early. Provide education. Provide co-funding incentives. Work with community groups to plan and deliver work.
Department of Conservation (DOC)	Risk of disturbing archaeology (part of the Lower Lagoon is within the 2GP Archaeological Alert Layer)	Low	High	Consult with Heritage New Zealand before undertaking any works in this area.
Develop a plan to construct a wetland at the outlet of Lagoon Creek	Lack of buy-in from stakeholders	Low	High	Consult early. Include relevant parties.
Stormwater education	Messaging about improving stormwater is ineffective.  Event is poorly attended.	Medium	Medium	Provide a wide variety of resources including interactive displays.  Advertise widely.

# 5. Budget

Note that while the total spend remains the same, the annual budget allocations differ to allow appropriate timeframes for delivery.

			2022	2/23	2023/	24	2024/2	.5	Total - Budget
Activity Group	Tasks	Activities	Budget	Actual	Budget	Actual	Budget	Actual	
1	<b>Ecological Assessment and consultation</b>	Cawthron Institute Contract	56,125.50	56,125.50					56,125.50
		May 2023 Open Day Event and Workshop	600.00	528.90					528.90
2	Zoning and stormwater education	SLR Consulting - Stormwater education resources			7,328.00				7,328.00
		Stormwater education day			5,000.00				5,000.00
		Support community water quality monitoring			12,600.00				12,600.00
		Support education initiatives					12,000.00		12,000.00
		Signage - production and installation			1,600.00				1,600.00
3	Enhancing riparian and wetland habitat	Planting			27,500.00		66,317.60		93,817.60
		Fencing			18,000.00		23,000.00		41,000.00
4	Wetland construction planning	Construction plan - contractor					30,000.00		30,000.00
Total			\$ 56,725.50	\$ 56,654.40	\$ 72,028.00	\$ -	\$ 131,317.60	\$ -	\$ 260,000.00

# 6. References

- Kelly DJ, Schallenberg M, Waters S. 2023. Ecological assessment of Lake Tuakitoto and Tomahawk Lagoon and options for lake rehabilitation. Nelson: Cawthron Institute. Cawthron Report 3947. Prepared for Otago Regional Council.
- 2. Otago Regional Council. 2022. Implementation Committee Agenda 14 April 2022 Report No. ENV2201. <a href="https://www.orc.govt.nz/news-and-events/events/2022/april/implementation-committee-14-april">https://www.orc.govt.nz/news-and-events/events/2022/april/implementation-committee-14-april</a>



# Tomahawk Lagoon Catchment Outline Management Plan April 2022

#### Vision

A thriving Tomahawk Lagoon catchment, where water quality and biodiversity are enhanced through community action to contribute to a healthy ecosystem for all to enjoy.

# **Values**

- The natural environment of Tomahawk Lagoon and the ecosystem is to be protected and enhanced
  - o Land use within the catchment has been altered over time with the removal of native vegetation with associated increased sedimentation and contamination within the catchment. There are both historic and current causes to these issues and finding a balanced solution in some cases will be complex. The health of the catchment as a whole is important and links to how it is functioning and enjoyed. Tomahawk Lagoon is a significant ecological area.
- Appropriate recreational uses to align with the wildlife refuge status of Tomahawk Lagoon are to be protected and enhanced
  - Tomahawk Lagoon has many recreational assets such as fishing, walking, kayaking. By improving public access the recreational capacity and ability of people to enjoy the lagoon is enhanced. It is important that recreational use of Tomahawk Lagoon respects the environment, mana whenua values and property rights. A connection between the environment, the local community and visitors to the area is important. Opportunity for community to contribute to the enhancement of the Lagoon.

# Issues

- Algal Blooms
- Minimal Environmental Data
- Water Quality
- Pest management (animals and weeds)
- Weir
- Flooding
- Sedimentation
- Access
- Biodiversity (Food Webs and Habitat)

# **Objectives**

- To improve the water quality and meet the National Freshwater and Otago Regional Council Land and Water Plan standards in Tomahawk Lagoon and the catchment which feeds this for environmental, mana whenua, and recreational uses
- Working with mana whenua to identify projects of significance to collaborate on and bring to fruition.

- Support a healthy ecosystem which sustains and enables mahika kai and improves biodiversity
- Improve water quality to allow for recreational fishing
- To preserve and protect the wetlands and streams, their margins and the saline environment within the catchment so that there is no further degradation of water within the catchment
- To encourage and support soil conservation to minimise sedimentation
- To maintain and improve for accessible public access around Tomahawk Lagoon
- To ensure there is no toxic algae present in the water and that the water is suitable for recreational contact year-round.
- Collation of existing data and define future research direction

# **Potential Projects**

#### - Ecological Assessment

Investigate the balance between the needs of human interaction with the lagoon and wildlife (hydrological function, ecology, wildlife, walking tracks, flood hazard, core sample). Include assessment of what the limits are for the system in this catchment (tipping point). What are the key stressors and how resilient is the catchment. What actions do we need to undertake to make the catchment more resilient.

#### Water Quality Data

Have a permanent water quality monitoring site installed to establish baseline data and ensure mahika kai safety.

#### Outlet

Sediment management around the outlet to ensure that there is flushing and better flow of water in and out of the lagoon.

## Citizen science

Support ongoing water quality monitoring programme as a way to generate data for the catchment and as an important community engagement tool.

# - Education and awareness

Engaging, educating and inspiring the local community to support this action plan. This area is to be a source of learning for local schools. Development of resources to assist with this engagement and education

# Pest and weed programme

Support and provide resources to assist neighbours to form groups to tackle weed and pest species in a combined and aligned effort. The aim is to control predators of birds and to minimise impacts on the native forest in the area and to control weeds where fast growing exotic species out compete natives.

# - Fencing project to exclude stock from waterways

Support for landowners to exclude stock from waterways

## - Native plant restoration

Support, advice and resources provided to aid landowners with riparian planting projects to restore the ecosystem (planting plans provided? Plants provided/co funded)

 Research which riparian plants will be most effective – leverage off relationships with university/schools

# - Community Planting Events

Community planting days and events where people can come together to help restore the lagoon and its catchment.

# - Catchment group formed and supported

Joining of agencies and the community. Establish a 'Friends of Tomahawk Lagoon' with members of the community and stakeholder representatives

## - Recreation (boardwalk, walkway, boat ramps)

Identify opportunities with DoC and private landowners for sections surrounding the lagoon to be restored and developed for public access.

- Nursery- Support Yellow Eyed Penguin Trust or Tomahawk Smaills Beach Care Trust
   To provide locally grown plants for planting within the catchment
- Study of flora and fauna present in this area as an engagement and education tool. A reason
  why we should protect the area. (Leverage University, Otago Botanical Society may have
  done a study)

#### - Algae Removal

Use technology to reduce the frequency of algal blooms in the lagoon and enhance mahika kai and recreational opportunities.

Investigate floating wetlands <u>Algae Removal and Wildlife Habitat Using Floating Treatment</u> Wetland Technology | Case Study | Aquabio Environmental Technologies, Inc.

# - Sediment Removal around Weir (top lagoon)

Remove sediment from around weir to improve water quality by increasing the turnover of water between upper and lower lagoons. Upgrade weir.

#### Stormwater from urban area

Knowledge lacking in the public – education – stormwater drains to sea. Developers, and general public. Improve general water literacy levels.

#### Storytelling exercises

What did the catchment look like historically and how was it used. Use visuals and tie this into the ecological assessment. Stories from mana whenua.

# Pest fish in the lagoon

Investigate the impacts environmentally vs recreationally.

# **Indicators of success**

- Number and size (area) of riparian enhancement projects completed each year.
- Metres of riparian margin fenced each year
- Metres of riparian margin planted each year
- Water quality indicators (macro-invertebrates, Nitrate and Phosphate levels etc)
- Number of and quality of public access points
- Number of community members engaged in work/workshops in the area
- Number of hours doing pest control, types of pests removed.
- Number of community members undertaking citizen science and how often this is done

# **Opportunities**

The restoration of Tomahawk Lagoon will require the collaboration of partners and stakeholders working together.

- Collaboration with neighbouring catchment groups
- Biosecurity programmes incorporated
- Community planting programmes
- Million Metres crowd funding campaign
- Walkway

Motivated property owners

# **Priority Actions:**

Following engagement with the Tomahawk Lagoon community and key stakeholders in April 2021 the three projects which are to be prioritised are:

# 1) Catchment group formed and supported

Joining of agencies and the community. Establish a 'Friends of Tomahawk Lagoon' with members of the community and stakeholder representatives

#### 2) Ecological Assessment

Investigate the balance between the needs of human interaction with the lagoon and wildlife (hydrological function, ecology, wildlife, walking tracks, flood hazard, core sample). Include assessment of what the limits are for the system in this catchment (tipping point). What are the key stressors and how resilient is the catchment. What actions do we need to undertake to make the catchment more resilient.

## 3) Water Quality Data

Have a permanent water quality monitoring site installed to establish baseline data and ensure mahika kai safety.

# **Delivery of Priority Actions**

- **By 30 June 2022** Otago Regional Council will work with the local community, agencies and key stakeholders and support the set up of a catchment group for Tomahawk Lagoon.
- **By 30 June 2022** Otago Regional Council will obtain information from consultants around the cost of an Ecological Assessment and commence a request for proposal process.
- By 30 June 2022 Otago Regional Council will investigate options for a water quality monitoring site to be located within Tomahawk Lagoon with installation of this to be carried out by September 2022.

# Actions for 2022/23

- For this financial year, Otago Regional Council will support the set-up of a catchment group for Tomahawk Lagoon. This is led by Otago Catchment Communities with ORC as a support entity.
- **By 31 Jan 2023**, ORC will select a project from the outline management plan to commence delivery on for this financial year.
- By 30 June 2023, the final ecological assessment for this catchment is to be provided.



# Lake Tuakitoto Implementation Plan

# 1. Purpose

The purpose of this Implementation Plan is to provide clarity on the actions required to implement recommended management actions from the ecological assessment of Roto-Nui-a-Whatu / Lake Tuakitoto (hereon in referred to as Lake Tuakitoto).

The intention is that the implementation plan will remain a living document, used to achieve two primary purposes:

- 1. To guide the development of workstream project plans
- 2. To use as a basis for discussion with mana whenua, key stakeholders, and community representatives

# 2. Context

In response to concerns about water quality, the 2017/18 Annual Plan provided for Otago Regional Council (ORC) staff to work with the local community to scope lake restoration works for Lake Tuakitoto. Engagement and consultation with the local community around Lake Tuakitoto was initiated as water quality was found to be degrading. Through ORC's State of Environment (SoE) monitoring it was identified that elevated levels of chlorophyll a, nitrates and phosphates are found within the Lake and the catchment has elevated levels of nitrate-nitrate nitrogen and E. coli.

The engagement and consultation process included the following steps:

- In April 2018, a workshop was held with the community which identified goals and values for the Lake Tuakitoto catchment. In June 2018, a second workshop was held where potential projects were identified at a high level following on from the first workshop.
- In early 2021, ORC staff prepared a draft outline management plan based on the above consultation feedback.
- In January 2022 a key stakeholder meeting for the Lake Tuakitoto catchment was held to
  discuss the draft outline management plan and feedback was provided. At this meeting
  stakeholders also had the opportunity to vote for the projects within the plan which they
  identified as being the highest priority for implementation.
- In January and February 2022 online consultation was held with the community so that they could vote on projects that they identified as being the highest priority for implementation. 59 people participated in this consultation exercise.
- The three projects that received the highest votes for implementation within the Lake Tuakitoto catchment were:

- An Ecological Assessment of the lake and catchment;
- ▶ Water Quality Data;
- ► Hydrological Assessment.

The sum of \$100,000 has been provided for in the 2021-2031 Long Term Plan for the 2021/22 Financial Year for projects to improve biodiversity and water quality within the Lake Tuakitoto catchment. The sum of \$80,000 has been provided in 2022/2023 and \$80,000 in 2023/2024.

On 14 April 2022, report ENV2201<sup>2</sup> was presented to the Implementation Committee where the proposed Management Plans including priority projects for implementation for Lake Tuakitoto were considered. The resolution made was that the Committee:

- 1. Notes this report.
- 2. **Approves** the initial management plan and ongoing development of management plans for Tomahawk Lagoon and Lake Tuakitoto catchments with their communities.
- 3. **Approves** commencement of project implementation.
- 4. **Notes** that project implementation will proceed this financial year, slightly accelerated for Tomahawk Lagoon, and as planned for Lake Tuakitoto.
- 5. **Notes** implementation in future years is dependent on Annual Plan decisions of Council and will be guided by the ecological assessments and priorities that arise through these.

Following the approval of the implementation of the initial management plan by the Implementation Committee:

- In April 2022, Otago Regional Council submitted a Request for Proposal (RFP) on the Government Tender Services (GETs) website for: "Lake Tuakitoto and Tomahawk Lagoon – Ecological Assessment".
- In June 2022, ORC awarded the contract to Cawthron Institute, who would deliver an ecological assessment for Lake Tuakitoto to identify and provide guidance on where action could be delivered for best investment and environmental outcomes.
- In March 2023, Cawthron Institute undertook a field study at Lake Tuakitoto.
- In July 2023, Cawthron Institute delivered a report¹ on the ecological assessment and
  potential management actions for Lake Tuakitoto, which incorporates historical and field
  study data.
- In July 2023, ORC shared this report with community representatives, mana whenua, and key stakeholders.

The ecological assessment identified several recommended management actions with the goal to enhance freshwater quality of Lake Tuakitoto and the wider catchment. These are summarised in Table 1.

Table 1 Summary of potential recommended management actions from the Ecological Assessment of Lake Tuakitoto.

Goal	Management Action	Priority
Reducing stream nutrient loads in inflows	Divert more flows from Lovells / Frasers Creek to drain to wetland to increase nutrient removal before entering Lake Tuakitoto	Highest
	Riparian enhancement and farm plans in Upper Lovells and Stony Creeks to reduce catchment nutrient losses from agricultural land and forestry	High
	Evaluate adding Stony Creek inflow to wetland diversion or realignment of diversion race bypassing the lake to the outlet channel	Medium
Improving kākahi recruitment	Monitoring of fish passage at outlet channel sill and Kaitangata Locks to assess passage and operational requirements	High
	Pest fish control to reduce perch populations and spawning, and enhance native fish that could serve as hosts for kākahi larvae	Medium
Controlling internal phosphorous	Applying phosphorous binding / capping agents (e.g., alum, Phoslock) to the lakebed to reduce phosphorous recycling	Trials needed
loading	Mechanical harvesting of macroalgal mats to reduce dissolved oxygen and pH variation that drive internal loads	Trials needed

In addition, modelling used in the 2015 ORC report 'Groundwater Contamination Risk, Septic Tank Density and Distribution within Otago' determined that the Inch Clutha had a medium level of contamination risk due to the possibility of failing septic tanks. The Lake Tuakitoto catchment provides an opportunity to pilot an Onsite Wastewater Management System education programme that could then be extended to the wider region.

# 3. Scope

The Implementation Plan sets out the outcomes, objectives, activities, deliverables, tasks, and ORC teams responsible for the implementation of the potential management actions listed in Table 1. It also identifies potential roles and responsibilities of mana whenua, key stakeholders, community groups, key risks, and mitigation strategies.

The Implementation Plan covers the period from receipt of the ecological assessment from Cawthron Institute (July 2023) to June 2024; the date to which funding from the ORC Long-term and Annual plans is allocated to this project.

# 4. Structure of Plan

The Implementation Plan:

- Presents a logic model to conceptualise management action implementation and timeframes.
- ii. Defines potential roles and responsibilities of those involved in implementation.
- iii. Identifies risks to delivery and risk mitigations.

# i. Implementation Programme

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A thriving Lake Tuakitoto catchment, where water quality and biodiversity are maintained and enhanced through community action to contribute to a healthy ecosystem for all to enjoy.

Vision	VISION healthy ecosystem for all to enjoy.									
Inputs (The resources used to deliver activities and outputs in the project)	Activities (Project actions that lead to outputs with timing of delivery)	Outputs (what is produced and delivered with associated measures of success)	Short-term Outcomes <sup>0-6 months</sup>	Medium-term outcomes 6-18 months	Long-term Outcomes >18 months					
Partners  - Aukaha - Ötakou Rūnaka  Key Stakeholders  - CDC - DOC - Otago South River Care - Lower Clutha Catchment Group - Fish and Game - Otago - Forest and Bird  Funding  - FY 21/22 \$100,000 - FY 22/23 \$80,000 - FY 22/23 \$80,000  ORC Staff  Contractors  Ecological Assessment Report  Groundwater Contamination Risk, Septic Tank Density and Distribution within Otago Report	Activity Group 1  ORC Drafts Implementation Plan for Recommended Management Actions from Ecological Assessment (April 2024). Vork collaboratively with mana whenua, stakeholders, and community to develop plan (May 2024)  Activity Group 2  ORC to design and pilot Onsite Wasteward Management System education programme in catchment (June 2024). Develop signage to facilitate community education focussing on environmental and cultural values (June 2025). Scope work to improve access and visitation (June 2024).  Activity Group 3  Discussions with ORC natural hazards and engineering to identify any risks of below activities (May 2024). Engage/Collaborate with catchment groups, landowners and community groups to fence, plant and maintain priority areas (June 2024, June 2025). Plant appropriate plant species.  Activity Group 4  Contract consultant/engage community to deliver fish passage study at outlet channel sill and Kaitangata Locks, including associated recommended management actions (if any)  Activity Group 5  Investigate diversion of water through wetland.	Output Group 1  - Final Lake Tuakitoto Implementation Plan created (May 2024).  Output Group 2  - Onsite Wastewater Management System Education Programme delivered Signage installed Access improved.  Output Group 3  - Landowners working with project to undertake riparian enhancement (number of landowner agreements/similar in place; number of hobitat enhancement plans developed) - Plants planted (# of plants; # and size (area) of riparian enhancement projects completed) - Fences constructed (metres of riparian margin fenced)  Output Group 4  - Report on Fish Passage study of Lake Tuakitoto outlets (June 2024).  Output Group 5  - Hydrological assessment (June 2024).	A collaborative effort has confirmed the implementation plan and timeframes (0-3 months)  Increased engagement with landowners and community around enhancing water quality values in the Lake Tuakitoto catchment	Riparian zones enhanced through planting and fencing  Improved understanding of and decision making around fish passage at Lake Tuakitoto  Access and visitation improved	Improved Stream and Lake water quality  Community has a greater sense of connection to the natural environment					

Environmental Implementation Committee - 8 May 2024

# ii. Roles and Responsibilities

This project is a collaborative project between mana whenua, key stakeholders, community, and ORC. It is important to understand the roles that different parties could potentially have in delivery of the management actions for Tomahawk Lagoon. Some of the roles are more certain, such as ORC's role in overall oversight of the project. Others are yet to be explored and confirmed with mana whenua, stakeholders, and community.

#### ORC's roles will include:

- ► Project delivery and oversight
- ▶ Deliver the Onsite Wastewater Management System Education pilot
- ► Identify natural hazards and risks of activities
- ► Manage contractors
- ► Sign production and install
- ► Provide best practice advice to landowners

Table 2 Potential roles for Mana whenua, stakeholders, community

Organisation/s	Potential roles
Mana whenua and Aukaha	Contract to provide content for signage.
	Advice on rongoā species to include in plantings.
Clutha District Council (CDC)	Permission for signage installation.
	Feedback on works to improve access and visitation.
Department of Conservation (DOC)	Input on ways to enhance native fish species and control exotic perch populations.
	Feedback on works to improve access and visitation.
Otago South River Care Group/ Lake	Delivery of fencing and planting activities.
Tuakitoto Catchment Group	Support with landowner engagement.
	Feedback on works to improve access and visitation.
Fish and Game - Otago	Discuss options to control perch as part of wider fish management plan.
Forest and Bird - Otago	Engage in project and identify opportunities.
	Advertise planting days.
	Feedback on works to improve access and visitation.
Community members	Attend planting days and other events. Feedback on works to improve access and visitation.

# iii. Risks and Mitigations

There are some potential risks in delivery of management actions at Lake Tuakitoto. Identifying these risks and potential mitigations is a useful first step in minimising these risks.

Table 3 Risks and mitigations

Activity	Risk	Likelihood	Impact	Mitigations
Undertake fencing and planting in priority areas	Lack of buy-in from landowners	Low	High	Direct fund existing, well- established catchment groups to plan and deliver work. Provide co-funding incentives.
Onsite Wastewater Management System education pilot	Low levels of participation Messaging is ineffective.	Medium	Low	Provide incentives for initial participation. Use plain language with engaging messaging.
Delivery of Fish passage study and Hydrological assessment	Contractors unavailable	Medium	High	Prioritise engagement of contractors.



# 5. Budget

Note that while the total spend remains the same, the annual budget allocations differ to allow appropriate timeframes for delivery.

			20	22/23	2023	/24	2024/	25	Total - Budget
<b>Activity Group</b>		Activities	Budget	Actual	Budget	Actual	Budget	Actual	Total - buuget
1	<b>Ecological Assessment and consultation</b>	Cawthron Institute Contract	56,125	56,125.50					56,125.50
		May 2023 Open Day Event and Workshop	250	00 205.53					205.53
		April 2023 Robson Lagoon Event	450	00 423.53					423.53
		ORC Environmental Monitoring			5,000.00		5,000.00		10,000.00
2	Education and engagement	Onsite Wastewater Management System education pilot			750.00				750.00
		Signage - production and installation					2,450.00		2,450.00
		Contractor - Scope works to improve access and visitatio	n		5,000.00				5,000.00
3	Enhancing riparian habitat	Fencing and planting			20,000.00		90,045.44		110,045.44
4	Investigate fish passages	Contractor - Fish passage study			30,000.00				30,000.00
5	Investigate stream diversion	Contractor - Hydrological assessment			45,000.00				45,000.00
Total			\$ 56,825.	50 \$ 56,754.56	\$105,750.00	\$ -	\$ 97,495.44	\$ -	\$ 260,000.00

# 6. References

- Kelly DJ, Schallenberg M, Waters S. 2023. Ecological assessment of Lake Tuakitoto and Tomahawk Lagoon and options for lake rehabilitation. Nelson: Cawthron Institute. Cawthron Report 3947. Prepared for Otago Regional Council.
- Otago Regional Council. 2022. Implementation Committee Agenda 14 April 2022 Report No. ENV2201. <a href="https://www.orc.govt.nz/news-and-events/2022/april/implementation-committee-14-april">https://www.orc.govt.nz/news-and-events/2022/april/implementation-committee-14-april</a>
- 3. Otago Regional Counil. 2015. Groundwater Contamination Risk, Septic Tank Density and Distribution within Otago. <a href="https://www.orc.govt.nz/media/1654/groundwater-contamination-risk.pdf">https://www.orc.govt.nz/media/1654/groundwater-contamination-risk.pdf</a>



# Lake Tuakitoto Catchment Outline Management Plan April 2022

#### Vision

A thriving Lake Tuakitoto catchment, where water quality and biodiversity are maintained and enhanced through community action to contribute to a healthy ecosystem for all to enjoy.

# **Values**

- The natural environment and ecosystem of Lake Tuakitoto and it's catchment are to be protected and enhanced
  - Land use within the catchment has been altered over time with the removal of
    native vegetation with associated increased sedimentation and contamination
    within the catchment. There are both historic and current causes to these issues and
    finding a balanced solution in some cases will be complex. The health of the
    catchment as a whole is important and links to how it is functioning and enjoyed.
  - Lake Tuakitoto is considered a nationally important freshwater fishery habitat which supports longfin eel, shortfin eel, whitebait/inanga, common bully and giant kokopu.
  - o Lake Tuakitoto is a regionally significant wetland as it provides roosting, feeding and breeding habitat for Banded Dotterel, Marsh Crake, Spotless Crake and the South Island Fernbird as well as habitat for giant kokopu, swamp nettle and *Isolepis basilaris*. There is also important habitat for waterfowl, waders and swamp birds including supporting a significant proportion of the population and breeding of Mallard, New Zealand Shoveller/Kuruwhengi, Black Swan and Grey Teal.
  - There is a high diversity of indigenous flora and fauna. Exceptionally high diversity of bird life present with over 50 species of bird recorded.
  - To preserve and protect the wetlands, rivers and streams and their margins that there is no further loss or degradation within the catchment
- Recreational uses of Lake Tuakitoto are enabled.
  - o Lake Tuakitoto has many recreational assets such as fishing, walking, bird watching and hunting. By improving public access the recreational capacity and ability of people to enjoy the lagoon is enhanced. It is important that the impacts that recreation has on the environment, the values of mana whenua and property rights are managed carefully. A connection between the environment, the local community and visitors to the area is important. There may be times, such as in duck shooting season where the area is not suitable for recreational activities such as walking to be undertaken and this is important to note.
- Mana whenua values are protected and enhanced.
  - Highly valued by Kāi Tahu for cultural and spiritual beliefs, values and uses including mahika kai and waahi taoka. Important for its historical associations and as a traditional food gathering area.
- Hydrological values in regards to maintaining water quality and low flows as well as reducing flood flows.

Lake Tuakitoto and surround wetlands perform a valuable hydrological function.
 Serves as a flood ponding area and is an integral art of the Lower Clutha Flood
 Control and Drainage Scheme.

#### Issues

- Flooding -the ideal lake level
- Water quality (Nutrient levels are high)
- Impacts on the freshwater mussel population
- Boundary location ORC vs Private landowners
- Sedimentation
- Degraded habitat for Giant kökapu, īnanga
- Fish Passage restrictions due to infrastructure

#### **Objectives**

- To improve the water quality and meet the National Freshwater and Otago Regional Council Land and Water Plan standards in Lake Tuakitoto and the catchment which feeds this for environmental, mana whenua, and recreational uses
- To improve biodiversity within the catchment
- Support a healthy ecosystem which sustains and enables mahika kai
- Improve water quality to support recreational fishing.
- To preserve and protect the wetlands, rivers and streams, their margins and the saline environment so that there is no further loss or degradation within the catchment
- To encourage and support soil conservation to minimise sedimentation
- To maintain and enhance public access around Lake Tuakitoto
- To ensure that the existing mussel beds present in the lake are enhanced and managed effectively
- To promote Lake Tuakitoto and encourage people to visit and use the lake.
- The management of the Lake is influenced by good quality science.
- To manage flood risk and land drainage for adjacent land

# Robsons Lagoon Climate Resilience Project - Delivered by ORC

This project will upgrade infrastructure to assist with the flood management within and adjacent to the Robson Lagoon, whilst protecting its natural and ecological values. Robson Lagoon is part of the regionally significant Lake Tuakitoto Wetland complex and the project is to replace flow management structures to allow sustainable water levels for habitat and during flood events as well as providing for native fish passage.

# **Potential Projects**

# **Catchment Wide projects:**

# **Ecological Assessment**

 Investigate the balance between the needs of human interaction with the wildlife (hydrological function, ecology, wildlife, walking tracks, flood hazard etc). Include assessment of what the limits are for the system in this catchment (tipping point). What are the key stressors and how resilient is the catchment. What actions do we need to undertake to make the catchment more resilient.

#### **Water Quality Improvements**

- Water Quality Data is relevant and influences management of the lake. Introduce a water testing programme including locations around the lake and within the catchment to assist with identifying sources of poor water quality.
- Funding scheme provided for landowners to restore buffer/riparian zones and recreate wetlands in the upper catchment (including fencing).
  - Citizen science
    Support ongoing water quality monitoring programme as a way to generate data for the catchment and as an important community engagement tool.

#### Hydrology

 Investigate the impacts of flooding within the catchment and further research to ensure that the current lake levels are sufficient to support environmental enhancement, flood protection and recreation.

#### **Improve Biodiversity**

- Facilitate a riparian planting plan for the catchment (include community planting days)
- Ecosystems restored
   Support, advice and resources provided to aid landowners with riparian planting projects to restore the ecosystem. Riparian planting and wetland restoration. Sediment traps/filter strips/wetlands in place to stop sediment entering the lake.
- Pest and weed programme
   Support and provide resources to assist neighbours to form groups to tackle weed and pest species in a combined and aligned effort. The aim is to control predators of birds and to minimise impacts on the native forest in the area and to control weeds where fast growing exotic species out compete natives. Weed species include crack willow, glyceria and rank grass
- Retain and maintain native fish populations such as Giant kokapu, inanga and kakahi (freshwater mussels). Need further research into mussel breeding and investigate the possibility of mussel spat ropes in place in culverts.

# Fish Passage assessment and remediation/creation of habitat where required.

- Create deeper areas in the lake for fish refuge and where they can stay cool.
- Develop a fish passage management strategy
   Examine fish passage issues within the catchment and develop a plan to prioritise these and how to implement changes to rectify these.

# **Community Outcomes**

- Catchment group formed and supported
- Nursery Support existing or support creation of a new nursery.
   To provide locally grown plants for planting within the catchment
- Collaborative research projects with Telford, University of Otago, local schools. Field trips to this area.
- Communications plan to promote the Lake.

# Lake specific projects:

#### **Access and Walking track improvement**

- Survey the location of the regionally significant wetland
- To maintain and develop public access around Lake Tuakitoto
   Better signage directing people to the lake, maintain walking track and upgrade so suitable for cyclists and walkers. Identify opportunities with DoC and private landowners for sections surrounding the lagoon to be restored and developed for public access.
- Carpark needs maintained/upgraded.
   Entry to be upgraded and set off the road for safety.
- Some short tracks off the main track as the main track is quite long. Include viewing points for bird watching, picnic tables/benches, jetty or boat access, interactive elements for kids eg. Climbing structures

# **Otago Regional Council owned land**

 Undertake a feasibility study in consultation with the community about the use of ORC owned land and what the best use for this land is.

#### Indicators of success

- Number and size (area) of riparian enhancement projects completed each year.
- Metres of riparian margin fenced each year
- Metres of riparian margin planted each year
- Water quality indicators
- Number of and quality of public access points
- Community surveys
- Count of number of people who use the area
- Number of fish barriers rectified
- Egg counts for Inanga following habitat restoration to measure impact of restoration.
- Fish surveys to show thriving populations

# **Opportunities**

The restoration of Lake Tuakitoto will require the collaboration of partners and stakeholders working together.

- Collaboration with neighbouring catchment groups
- Biosecurity programmes incorporated
- Community planting programmes
- Million Metres crowd funding campaign
- Walkway
- Motivated property owners

# **Priority Actions**

Following engagement with the Lake Tuakitoto community and key stakeholders in February 2022 the three projects which are to be prioritised are:

# 1) Ecological Assessment

Investigate the balance between the needs of human interaction with the wildlife (hydrological function, ecology, wildlife, walking tracks, flood hazard etc). Include assessment of what the limits are for the system in this catchment (tipping point). What are the key stressors and how resilient is the catchment. What actions do we need to undertake to make the catchment more resilient.

# 2) Water Quality Data

Water Quality Data is relevant and influences management of the lake. Introduce a water testing programme including locations around the lake and within the catchment to assist with identifying sources of poor water quality.

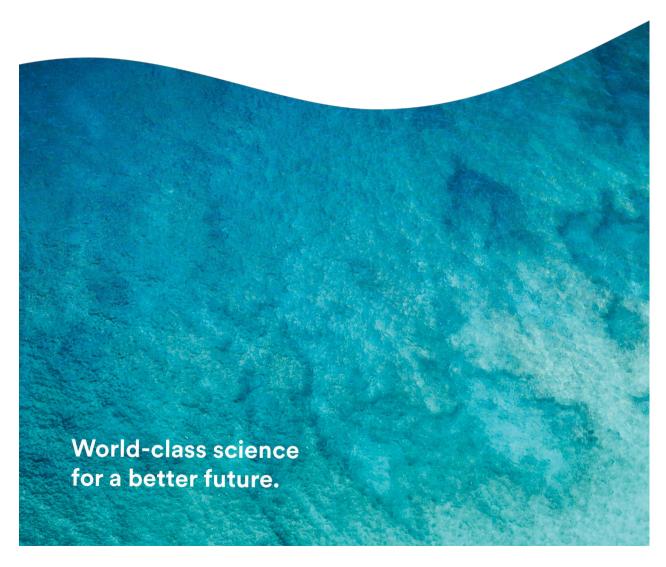
# 3) Hydrological Assessment

Investigate the impacts of flooding within the catchment and further research to ensure that the current lake levels are sufficient to support environmental enhancement, flood protection and recreation.



REPORT NO. 3947

# ECOLOGICAL ASSESSMENT OF LAKE TUAKITOTO AND TOMAHAWK LAGOON AND OPTIONS FOR LAKE REHABILITATION



Environmental Implementation Committee - 8 May 2024

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Environmental Implementation Committee - 8 May 20	)Z4	

Environmental Implementation Committee 8 May 2024 - MATTERS FOR CONSIDERATION

AUGUST 2023

# ECOLOGICAL ASSESSMENT OF LAKE TUAKITOTO AND TOMAHAWK LAGOON AND OPTIONS FOR LAKE REHABILITATION

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Prepared for Otago Regional Council



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Environmental Implementation Committee - 8 May 2024		
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Environmental Implementation Committee 8 May 2024 - MATTERS FOR CONSIDERATION

#### **EXECUTIVE SUMMARY**

Lake Tuakitoto and the Tomahawk Lagoons are significant shallow coastal lakes in the Otago Region. They are highly valued, having outstanding wildlife, biodiversity, and recreational resources and amenities. In response to concerns about degrading water quality, the Otago Regional Council (ORC) has engaged Cawthron Institute and the University of Otago to conduct a study into ecological health and processes that control water quality in Lake Tuakitoto and the Tomahawk Lagoons. The overall aim of the study and this report is to provide an understanding of restoration options that could be employed to improve water quality and safeguard the ecological health of the lakes. This report presents the recommendations developed through:

- identifying the values and restoration aspirations held by stakeholders
- summarising relevant water quality and ecosystem health data for the lakes and their catchments
- · determining key processes and limits that drive the ecological health of the lakes
- presenting recommendations on options for improving lake ecological health and enhancing values for stakeholders (note that this does not include quantitative assessments of costs or benefits).

Review of existing environmental data for the lakes indicated that ecological values are currently being compromised by continued degradation in water quality, which impacts the ecological health and condition of the lakes.

# Lake Tuakitoto - current state

For Lake Tuakitoto, increasing total nitrogen and total phosphorus concentrations in the lake are contributing to extensive macroalgae and phytoplankton blooms, which now exceed the regional and national guidelines for the protection of ecosystem health. Undesirable feedback processes that drive internal nutrient loads from lake sediments appear to have become established in the lake, leading to high water column pH and possibly low, transient dissolved oxygen concentrations. Such poor water quality conditions have flow-on effects to sensitive biota such as native fish and, in particular, kākahi, which have declined by 85% in biomass since observations were first made in the 1990s. Unfortunately, this means that the important ecosystem services kākahi provide to the lake by filtering lake water and removing algae have greatly declined. Thick macroalgae mats were seen to cover around 70% of the lakebed; these mats contribute to highly variable water quality conditions, smother kākahi habitat and drive the transfer of phosphorus contained in lakebed sediments back into the water column.

# Lake Tuakitoto - rehabilitation options

The greatest priority for managing ecosystem health in Lake Tuakitoto should be focused on reducing nutrient loads to the lake, which would have flow-on effects for several of the other management priorities (e.g. enhancing kākahi populations, controlling macroalgae). In particular, reconnection of the major inflows to the wetland at the top of the lake is likely to

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AUGUST 2023

improve the attenuation of sediment and nutrients in the tributaries before they discharge into the lake. This includes Stony Creek, which is presently diverted directly to the lake via a diversion race, thereby circumventing the wetland into which it naturally flowed. Alternatively, realignment of the diversion race to bypass the lake and discharge directly to the lake outlet canal could be another option for removing some of the nutrient and sediment load to the lake. Catchment stream care initiatives focused on improving riparian areas and developing farm plans are also needed to reduce contaminant loads from inflow streams to the lake.

Managing internal nutrient loading in Lake Tuakitoto, which is driven mainly by macroalgae mats, is likely to be complex due to limited knowledge on controlling macroalgae. We recommend trialling sediment capping and macroalgal harvesting options at smaller spatial scales to determine their possible effectiveness before a wider lake-scale intervention can be considered. Other rehabilitation priorities recommended for the lake are to manage European perch, improve native fish populations (i.e. hosts for the parasitic kākahi larval stage), and address fish passage issues caused by the outlet weir and tidal gates near the outlet's confluence with the lower Clutha River (Kaitangata locks).

# Tomahawk Lagoon - current state

Monitoring data for the Tomahawk Lagoons collected since 2016 indicate that both lagoons and their inflow creeks breach regional and national water quality guidelines. The lagoons are subject to occasional algal blooms, often caused by cyanobacterial species that can produce toxins harmful to people and animals, especially dogs. Historical data from the 1960s and 1970s shows that Upper Tomahawk Lagoon underwent repeated shifts between a macrophyte-dominated state and a phytoplankton-dominated state. High concentrations of nitrate, dissolved reactive phosphorus and suspended sediment in inflows are the most important contributors to this variability. Grazing by black swans can also contribute to these shifts by reducing macrophytes. The use of empirical catchment and lake models suggests that nitrogen loads will need to be substantially reduced in order for the lagoons to meet total nitrogen guidelines. The lakebed of the lower lagoon also contains substantial amounts of phosphorus, which can be mobilised to the water column by sediment resuspension, anoxic conditions, high pH conditions and microbial organic matter mineralisation. The presence of a self-sustaining population of European perch in the lagoons may also mediate water clarity due to the zooplanktivorous diet of juvenile perch.

### Tomahawk Lagoon - rehabilitation options

Restoration options for the Tomahawk Lagoons are somewhat constrained due to the encroachment of urban areas and the fact that the lagoons are managed as a wildlife reserve. The greatest priority will be to manage high nutrient and sediment concentrations in the inflow creeks, which highlights the need for reductions in contaminant flows from land to waterways. This could be achieved by fencing and planting riparian buffer zones along waterways, ensuring forestry blocks provide an adequate buffer zone along waterbodies, and encouraging wetland protection and enhancement in the catchment. In addition, we suggest that the shallow lake area near the inflow from Lagoon Creek could be engineered to be a wetland. The internal loads of nutrients from the lakebeds to the water column are more

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difficult to control, as dredging and phosphorus capping are likely to have undesired side effects.

Although artificial openings of the sand barrier between the lower lagoon and Tomahawk Beach alter the hydrology of the lagoons, the need for flood management to protect houses and roading infrastructure negates consideration of alteration of the water level regime of the lagoons.

Management of exotic species – including black swans, European perch and exotic zooplankton species – could assist in mediating shifts between turbid and clear water states in the lagoons. However, when swan culling has been undertaken elsewhere by Fish & Game, recolonisation by swans from the larger South Island population has been rapid. Furthermore, the Tomahawk Lagoons are a wildlife refuge, making it unlikely that approval for a long-term programme of swan culling could be obtained.

# Monitoring

A range of monitoring recommendations was also made for the lakes. Improving monitoring could assist decision-making regarding rehabilitation options. Monitoring recommendations included monitoring: (1) the inflowing tributaries, (2) wetland function, (3) physico-chemical fluctuations within the lake, (4) kākahi recruitment dynamics, and (5) native fish (both in the lakes and at potential barriers to fish passage).

Environmental Implementation Committee - 8 Mar	y 2024	

Environmental Implementation Committee 8 May 2024 - MATTERS FOR CONSIDERATION

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# **GLOSSARY**

Term	Definition
Adsorb	To gather a dissolved substance on a surface in a condensed layer.
Anoxia	A complete absence of dissolved oxygen in its free $\ensuremath{O}_2$ chemical form.
Bioavailable (nutrient)	The degree to which nutrients are available for absorption and utilisation by living organisms. Nutrients may exist in 'bioavailable' forms, which may be adsorbed by organisms, or in forms that are not bioavailable and hence may not be adsorbed by organisms.
CLUES	Catchment Land Use and Environmental Sustainability (CLUES) model is a catchment model that predicts nutrient run-off to waterbodies based on soil, rainfall and catchment land use. It has been used as a tool to estimate annual nutrient inflows to lakes.
Conductivity	A measure of the concentration of ions in water. Measured as the degree to which a specified material conducts electricity, calculated as the ratio of the current density in the material to the electric field that causes the flow of current.
Eutrophic lake	A lake with high phytoplankton productivity due to excessive inorganic nutrients, especially nitrogen and phosphorus. Eutrophic lakes often experience low dissolved oxygen in their bottom waters due to greater amounts of heterotrophic (e.g. decomposition) processes occurring in their hypolimnion. They are prone to algal and cyanobacterial blooms, which can promote greater respiration by bacteria living in sediments.
Hypolimnion (hypolimnetic)	The dense, bottom layer of water in a thermally stratified lake or reservoir. It is the layer that lies below the thermocline and has little exchange of dissolved gases and solutes with the overlying epilimnion.
Internal loading	Process by which dissolved inorganic phosphorus (phosphate) and nitrogen (ammonium) flux occurs from lakebed sediments into the bottom waters (hypolimnion) of lakes during conditions of low dissolved oxygen. Typically, this results from changes in oxidation–reduction (redox) conditions at the sediment–water interface that favour reduction of particulate-bound nutrients to dissolved (phosphate, ammonium) forms, and results in their solubilisation into the water column.
Kākahi	Freshwater mussel, Echyridella menziesii.
LakeSPI	Lake Submerged Plant Index. A monitoring protocol for aquatic macrophytes that evaluates the health of the macrophyte community based on native and invasive macrophyte condition.
Macroalgae	Algae or cyanobacteria that grow attached to the bed and are visible, typically forming mats or long filaments. Can grow to thick levels (> 5 cm) that can cause nuisance issues such as smothering of biota and dissolved oxygen fluctuations.
Macrophyte	A species of aquatic plant that is rooted in the lakebed and generally remains below the waterline. Invasive macrophytes, or weeds, are invasive species that occur in Aotearoa New Zealand (e.g. curly pondweed, <i>Potamogeton crispus</i> ).
Mahinga kai*	The production and gathering of all foods and other natural resources, and areas where they are sourced.

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Mesotrophic lake A lake with an intermediate level of productivity. Mesotrophic lakes

are commonly clear water lakes and reservoirs with medium levels

of nutrients and phytoplankton production.

**Phytoplankton** Autotrophic (i.e. able to photosynthesise) components of the

plankton community. They include algae, cyanobacteria and some

mixotrophic groups such as dinoflagellates.

Rohe District, region or territory.

**Solubilise** Make a substance soluble or more soluble.

Sorbtion A physical and chemical process by which one substance becomes

attached to another.

**Supertrophic** A water source that has very high algal / cyanobacterial productivity

due to excessive inorganic nutrients. These waters are highly prone to regular algal and cyanobacterial blooms and are likely to experience oxygen depletion due to greater levels of heterotrophic (e.g. decomposition) processes occurring in their hypolimnion.

**Thermocline** In a thermally stratified waterbody, the location in the temperature

gradient where the temperature change per unit distance is maximal. This can persist for months in seasonally stratifying lakes, or for shorter periods of time (e.g. hours) in shallow, polymictic lakes.

Tuna Eels, including the longfin eel (Anguilla dieffenbachii) and shortfin eel

(Anguilla australis).

#### **Notes**

Most te reo Māori definitions in this glossary are from the Te Aka Māori–English, English–Māori Dictionary and Index, which is indexed to the Te Whanake Māori language series.

<sup>\*</sup> This is the Waitangi Tribunal definition for mahinga kai used during the Kāi Tahu claim settlement process.

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### 1. INTRODUCTION

### 1.1. Coastal lake management in Otago

The Otago Region contains significant coastal lake and wetland environments (Otago Regional Council 2022). In response to concerns about degrading water quality, the Otago Regional Council (ORC) has engaged Cawthron Institute (Cawthron) and the University of Otago to conduct a study into ecological health and processes that control water quality in Lake Tuakitoto and Tomahawk Lagoon. The aim of the study is to provide an understanding of restoration measures that could be employed to improve water quality and safeguard the ecological health of the lakes.

The implementation of the National Policy Statement for Freshwater Management (NPS-FM; MfE 2022) has mandated regional authorities to establish and implement limits on resource use to protect water quality and ecological values of waterbodies. In Otago, as in many parts of Aotearoa New Zealand, agriculture is a widespread land use. Therefore, management of nutrients is expected to be a critical component of maintaining ecological and other (e.g. recreational, aesthetic) values of lakes. While in-lake nutrient processing is well researched, there is considerable complexity (e.g. Moss 1983; Søndergaard et al. 2005; Abell et al. 2011), including important interactions with key biological components (e.g. macrophytes, zooplankton, fish; Jeppessen et al. 2007; Moss 2013). These ecological interactions are often lake specific, and gaining an understanding of the local conditions is helpful when designing lake rehabilitation plans (Howard-Williams and Kelly 2003).

Previous community workshops held in 2018 with the communities of South Dunedin (Tomahawk Lagoons) and Kaitangata (Lake Tuakitoto) identified a need for further understanding of the ecology of coastal lake ecosystems. Specifically the objectives identified for this study were to:

Investigate the balance between the needs of human interaction with the wildlife (hydrological function, ecology, wildlife, flood hazard etc). Include assessment of what the limits are for the system in this catchment (tipping point). What are the key stressors and how resilient is the catchment. What actions do we need to undertake to make the catchment more resilient.

# 1.2. Background on shallow lake ecology

# 1.2.1. Eutrophication of shallow lakes

Primary productivity in lake systems is strongly limited by nutrient availability (Søndergaard et al. 2005), and while numerous nutrients are critical, the dominant role of the macronutrients nitrogen (N) and phosphorus (P) in controlling phytoplankton biomass in lakes is well established (Wetzel 2001; Abell et al. 2011).

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Phosphorus is mainly bioavailable in the form of the soluble orthophosphate ion ( $PO_4^{-3}$ ), and the concentration of this ion in natural waters is commonly reduced by its affinity for binding to particulate sediment. Bioavailable N generally occurs in lake waters in much higher concentrations than bioavailable P, and hence phytoplankton biomass may be limited by the lower availability of dissolved P. In addition, N limitation may be circumvented due to the fixation of atmospheric N by various bloomforming cyanobacteria (Wetzel 2001; Søndergaard et al. 2005). Many studies have demonstrated N limitation in lake systems (e.g. White et al. 1986), and such systems may also be co-limited, experience a change in the limiting nutrient over time, or be limited by light (Burger et al. 2007; Moss et al. 2013).

When catchments are undisturbed and covered by longstanding native vegetation, nutrient inputs to a typical lake tend to be low. In comparison, when a catchment is disturbed, the nutrient and sediment losses to the lake are usually high. In the undisturbed condition, shallow lakes are more likely to have well-developed macrophyte (aquatic plant) communities, which outcompete planktonic algae, stabilise the lake's bed and suppress algal blooms. As nutrient and sediment loads increase, excess nutrients will be taken up by macroalgae that then compete with macrophytes for light. If nutrient and sediment loads continue to increase, macrophytes may collapse, resulting in a destabilised lakebed, more wind-induced sediment resuspension and high levels of available nutrients, which in turn lead to algal blooms. This is a highly simplified, but often useful, conceptual model of shallow lake eutrophication (Figure 1).

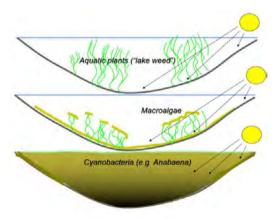


Figure 1. Conceptual model of the shallow lake eutrophication process. When nutrient and sediment loads are low, shallow lakes tend to have abundant macrophyte communities. As nutrient and sediment loads increase, macroalgae use excess nutrients and begin to compete with macrophytes for light. At high rates of nutrient and sediment loading, macrophyte communities collapse, resulting in algal blooms. See text for detailed explanation.

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However, rather than a gradual progression, the manifestation of eutrophication in shallow lakes tends to result in sudden changes and shifts in productivity as a result of ecological feedbacks. Negative feedbacks resist change, while positive feedbacks accelerate change. This leads to tipping points, where small changes in a stressor (e.g. nutrient load) result in large changes in degradation (Figure 2). An example of such a feedback mechanism is the effects of macrophytes on the damping of turbulence, lakebed stabilisation, light availability and nutrient availability – all of which favour macrophyte growth over algal growth. Once the collapse of macrophytes occurs (perhaps mediated by macroalgal proliferation), a tipping point is reached and these negative feedbacks disappear, resulting in a shift in conditions favouring algal proliferation (e.g. high nutrient availability, low light penetration, wind-induced sediment resuspension).

Algae grow much faster than macrophytes and are able to benefit more from excess nutrient availability. Some algae (e.g. some cyanobacteria, dinoflagellates) can move vertically in the water column, enabling them to rise up to compete with macrophytes for light. High algal biomass can also reduce light penetration to the lakebed, suppressing macrophyte growth. The loss of macrophytes from a shallow lake allows greater wind-induced turbulence, greater sediment resuspension and higher levels of turbidity, further impeding light penetration into lakes.

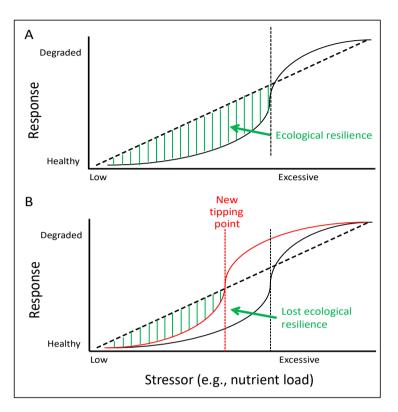


Figure 2. Conceptual model of eutrophication of shallow lakes showing ecological resilience, tipping points and hysteresis. The black dashed line shows a linear stressor-response relationship. The stressor level (nutrient loading rate) relates to a response in the condition of the lake (in terms of algal blooms). The curved black line is the degradation trajectory (as nutrient loads are increased) with feedbacks conferring ecological resilience and resulting in a tipping point (dashed vertical line). The red line is the recovery trajectory (as nutrient loads are reduced). The difference between the tipping points illustrates hysteresis in the system.

This dynamic of alternating stable states is a phenomenon that has been reported for many shallow lakes (Scheffer 2004). In fact, this was observed for Upper Tomahawk Lagoon from data collected in the late 1960s and early 1970s (Mitchell 1989); the data indicated alternating states of dominance by macrophyte biomass and phytoplankton biomass, whereby the states were not just seasonal but lasted over multiple years before shifting to the alternative state. To our knowledge, this dynamic has not been reported for Lower Tomahawk Lagoon, although this may indicate a lack of data rather than the absence of the dynamic.

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#### 1.2.2. Internal loading processes in lakes

The transport of P from a lake's catchment (external load) – predominantly associated with fertiliser application, eroded sediment or organic material – is the primary source of P in most lake systems. However, once P is in the lake, a significant proportion may settle to the bottom of the lake and be bound in the lakebed sediments, constituting a major reservoir of P (Wetzel 2001). Hence, a key aspect to consider in the management of lake systems is the potential for the recycling of these accumulated 'legacy' nutrients from the sediment back into the water column (Figure 3). This process, referred to as 'internal loading', can greatly increase annual loads of P to the water column, over and above the load from external nutrient sources (Søndergaard et al. 2005; Gibbs 2011). Lake sediments can therefore be both a source and sink for P, and internal loading may delay lake recovery following reductions in catchment loads (Cooke et al. 2005). Knowledge of the forms in which P is bound within sediment and an understanding of the complex chemical and biological interactions that govern nutrient fluxes between the sediment and the water column are critical for identifying eutrophication in a given lake system.

Shallow lakes (i.e. lakes with maximum depths < 10 m) tend to respond to nutrients in a different manner to deep lakes, and thus have their own ecology and management challenges (Scheffer and van Nes 2007). Deep lakes often undergo significant periods of thermal stratification. Shallow lakes are generally well mixed, and when stratification events do occur, they tend to be short-lived and spatially discrete, and often require an additional factor to stabilise the water column, such as the presence of macrophyte beds, salinity incursions or prolonged periods of calm weather (Waters 2016). Even short stratification events may result in rapid deoxygenation of the lake bottom water, and anoxia may result in nutrient release from the sediment.

Excessive algal growth or dense macrophytes may also produce high water column pH. When pH is > 9, there is the possibility of desorption (release) of P from lake sediments and, hence, pH-driven recycling to the water column (Jacoby et al. 1982). In addition, shallow lakes experience frequent resuspension of the bed sediments into the water column, which may release P contained in sediment pore water and / or from the sediment itself (Cyr et al. 2009). The relative importance of these internal loading processes is lake specific. Understanding the occurrence and frequency of bottom-water deoxygenation, high pH and P sorption / desorption dynamics, as well as the manner in which P is bound to the sediments, reveals the key drivers of potential internal nutrient loading.

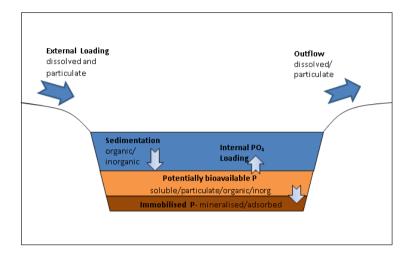


Figure 3. Simplified diagram of lake phosphorus (P) dynamics (adapted from Søndergaard 2007). The blue colour represents water and the brown shades represent lakebed sediments.

Many shallow lakes, with large legacy phosphorus reservoirs, have resisted restoration efforts (in the form of decreased external loads) due to compensatory internal P loading from the lake sediments (Cooke et al. 2005; Schindler 2012). Such internal loading may typically last 10–15 years after reductions of external loads (Jeppesen et al. 2007), and in some instances, may last more than 20 years (Kangur et al. 2013). Results of long-term, whole ecosystem studies indicate that the management of P is the key to controlling eutrophication and remediating lake systems (Schindler 2006, 2012). The identification of lake-specific sources and processes that result in internal P loading will also inform successful restoration programmes and allow targeted and cost-effective interventions.

# 1.2.3. Coastal lake management issues

Otago's coastal lakes have high wildlife (waterbird), biodiversity, mahinga kai and sports fishing values. They also provide scenic values within their rural and urban settings, and thus local communities have strong connections to the lakes / lagoons and closely monitor their condition. Key issues with respect to managing water quality, ecology and biodiversity for the coastal lakes included the following points that were identified in workshops:

### Lake Tuakitoto

Water level management:

- flooding of land / infrastructure, higher water level regime
- kākahi habitat reduced.

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#### Siltation:

• silt infilling the lake.

# Water quality:

· causes of poor water quality.

#### Biodiversity and aquatic habitats:

- fish passage an issue
- mussel breeding
- mahinga kai and native fish habitat (īnanga, eels, kākahi)
- pest species Canada geese, willow, other noxious weeds.

#### **Tomahawk Lagoons**

Water level management:

- water level regulation of the lagoons
- · artificial openings of the lagoons.

### Siltation:

· soil erosion and sediment infilling of the lagoons.

### Biodiversity and aquatic habitats:

- drivers of occasional algal / cyanobacterial blooms
- · stormwater drainage into the lagoon.

A range of environmental monitoring data has been collected by ORC and other organisations such as Ecotago to understand the state of the Otago coastal lakes. Subsequent sections of the report will document and analyse these data, evaluate state and trends relative to regional and national guidelines, and make recommendations for rehabilitation options for Otago lakes.

### 1.2.4. Otago Regional Council Water Plan standards and national guidelines

To assess ecological state, some comparator attributes and attribute levels are needed. The most appropriate of these are the shallow lake attributes listed in the NPS-FM (MfE 2022) and in Schedule 15 of the ORC Water Plan (Otago Regional Council 2022) (Table 1).

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Table 1. Lake condition attributes applying to Lake Tuakitoto and the Tomahawk Lagoons. NPS-FM – National Policy Statement for Freshwater Management (MfE 2022). ORC Water Plan – Regional Plan: Water for Otago (Otago Regional Council 2022).

Attribute	Compulsory value	How measured	How calculated	Type or attribute
NPS-FM				
Chlorophyll-a	Ecosystem health (Aquatic life)	Water column     Monthly samples	Annual median     Annual maximum     For intermittently open / closed lakes, calculate only for closed periods	Requiring limit setting
Total nitrogen	Ecosystem health (Water quality)	Water column     Monthly samples	<ul> <li>Annual median</li> <li>For intermittently open / closed lakes, calculate only for closed periods</li> </ul>	Requiring limit setting
Total phosphorus	Ecosystem health (Water quality)	Water column     Monthly samples	<ul> <li>Annual median</li> <li>For intermittently open / closed lakes, calculate only for closed periods</li> </ul>	Requiring limit setting
Ammonia toxicity	Ecosystem health (Water quality)	<ul><li>Water column</li><li>Monthly samples</li></ul>	<ul> <li>Annual median</li> </ul>	Requiring limit setting
Nitrate toxicity	Ecosystem health (Water quality)	<ul><li>Water column</li><li>Monthly samples</li></ul>	<ul><li>Annual median</li><li>Annual 95th percentile</li></ul>	Requiring limit setting
E. coli	Human contact	Water column     Monthly samples	Four statistical parameters calculated on monthly data measured over 5 years	Requiring limit setting
Cyanobacteria	Human contact	<ul><li>Water column</li><li>Monthly samples</li></ul>	80th percentile	Requiring limit setting
Dissolved oxygen	Ecosystem health (Water quality)	<ul> <li>Continuous monitoring near lakebed or monthly profiling</li> </ul>	Annual minimum	Requiring action plan
Macrophytes (invasive impact)	Ecosystem health (Aquatic life)	<ul> <li>LakeSPI survey every 3 years</li> </ul>	<ul> <li>% of maximum potential score</li> </ul>	Requiring action plan
Macrophytes (native condition)	Ecosystem health (Aquatic life)	<ul> <li>LakeSPI survey every 3 years</li> </ul>	<ul> <li>% of maximum potential score</li> </ul>	Requiring action plan

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Attribute	Compulsory value	How measured	How calculated	Type or attribute				
Otago Regional Council Water Plan								
Total nitrogen	Water quality	<ul><li>Water column</li><li>Monthly samples</li></ul>	<ul> <li>80% of samples over 5 years meet the threshold</li> </ul>	n/a				
Total phosphorus	Water quality	<ul><li>Water column</li><li>Monthly samples</li></ul>	<ul> <li>80% of samples over 5 years meet the threshold</li> </ul>	n/a				
Ammoniacal nitrogen	Water quality	<ul><li>Water column</li><li>Monthly samples</li></ul>	<ul> <li>80% of samples over 5 years meet the threshold</li> </ul>	n/a				
E. coli	Water quality	<ul><li>Water column</li><li>Monthly samples</li></ul>	<ul> <li>80% of samples over 5 years meet the threshold</li> </ul>	n/a				
Turbidity	Water quality	<ul><li>Water column</li><li>Monthly samples</li></ul>	<ul> <li>80% of samples over 5 years meet the threshold</li> </ul>	n/a				

The NPS-FM classifies the condition of waterbodies into four classes: A, B, C and D. These can be interpreted as indicating excellent, good, fair and unacceptable conditions, respectively. The threshold between the C and D classes is the 'national bottom line'. If a waterbody falls below this, Regional Councils must either identify the lake as one that could not meet the national bottom line for intrinsic reasons, or councils must set in place policies or plans aimed at achieving at least the national bottom line.

### 1.3. Purpose of this report

To further understand the ecological functions of Lake Tuakitoto and the Tomahawk Lagoons and provide options for the rehabilitation of the lakes, we assess current ecological condition and make recommendations on future management actions to restore the water quality, ecological health of the lakes. Specifically, this report:

- · identifies the values and restoration aspirations held by stakeholders
- summarises relevant water quality and ecosystem health data for the lakes and their catchments
- determines key processes and limits that drive the ecological health of the two coastal lakes
- presents recommendations on options for improving lake ecological health and enhancing values for stakeholders (note that this does not include quantitative assessments of costs or benefits).

This report is intended to support the subsequent development of an action plan to improve management and rehabilitation of the lakes.

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### 2. LAKE TUAKITOTO

## 2.1. Background on Lake Tuakitoto

Lake Tuakitoto is a freshwater wetland situated in the lower Clutha River catchment in South Otago. It has an open-water area of 131.8 ha and a mean depth of around 0.7 m. The lake is modified and is a remnant of a much larger wetland system, which included Lake Kaitangata. Lake Tuakitoto has three main inflowing tributaries: Lovells Creek, Stony Creek and Frasers Stream. Large areas surrounding the lake have been drained and reclaimed for farming purposes, and modifications to the drainage network mean that significant portions of flow from Lovells Creek and Stony Creek now bypass the wetland via a drainage channel that enters the lake directly at its northern end (Figure 4). Control of flows entering the lake via the diversion is achieved by a control gate at the head of the lake, which has been recently upgraded to be electronically controlled. A sill, which is in place downstream of the lake in the outlet canal, controls lake level, particularly at the lower levels. A gate (Kaitangata locks) at the junction of the lake outlet canal with the Clutha River manages flows exiting the lake; this gate is closed during flood periods in the lower Clutha River to minimise flooding of upstream areas. Lake Tuakitoto and the surrounding wetlands perform a valuable hydrological function as a flood ponding area integral to flood management of the lower Clutha River.

The lake and its associated wetlands have high values including:

- 1. listed as a Significant Wetland in the Clutha District Plan. Described as a rush and sedge swamp, lowland lake, with an artificial water level.
- 2. habitat for nationally or internationally rare or threatened species, including feeding and breeding habitat for the threatened Australasian bittern / matuku-hūrepo (Botaurus poiciloptilus) and banded dotterel / tūturiwhatu (Charadrius bicinctus bicinctus). Also breeding area for the marsh crake / kotoreke, (Porzana pusilla affinis), spotless crake / pūweto (Porzana tabuensis plumbea) and South Island fernbird / mātātā (Poodytes punctatus). Habitat for threatened giant kōkopu (Galaxias argenteus). The threatened nettle (Urtica linearifolia) and Isolepis basilaris are present on the swamp margin.
- regionally and nationally important habitat for waterfowl, waders and swamp birds, including a significant proportion of the national population of mallard (Anas platyrhynchos), New Zealand shoveler / kuruwhengi (Anas rhynchotis variegata), grey teal / tētē moroiti (Anas gracilis) and black swan (Cygnus atratus). All these species breed here.
- 4. kākahi (*Echyridella menziesii*) populations within the lake, which have been found to filter the lake, enhancing water clarity.
- supporting a commercial eel fishery, as well as recreational fisheries for European perch (*Perca fluviatilis*) and brown trout (*Salmo trutta*). Giant kōkopu (*Galaxias argenteus*) are found in two of its tributary streams.

6. highly valued by Kāi Tahu for cultural and spiritual beliefs, values and uses, including wāhi taoka. Wetland highly valued by Kāi Tahu for its historical associations and as a gathering area.

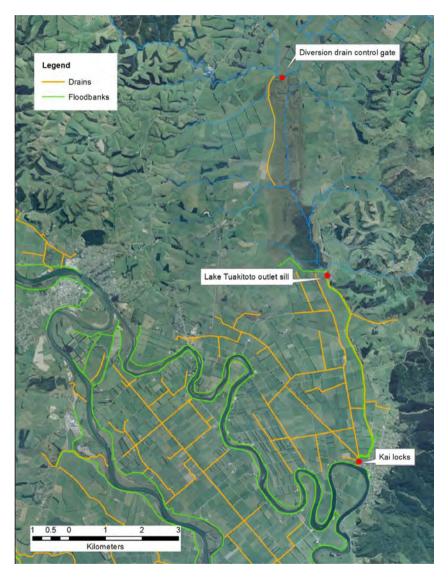


Figure 4. Lake Tuakitoto showing drains (yellow lines), floodbanks (green lines) and locations of drainage scheme structures that may influence lake level (red circles). Source: Ozanne (2014).

# 2.2. Lake Tuakitoto catchment

The Lake Tuakitoto catchment is 143 km² in total area, with the main inflows to the lake coming from the sub-catchments of Lovells Creek, Frasers Stream and Stony Creek. Catchment vegetation is primarily modified pastoral farmland used for intensive grazing (75%) and plantation forestry (15%) (Figure 5; Table 2). Small areas of indigenous forest occur in the upper portions of Frasers Stream, but the most significant remaining area of native vegetation comprises wetland vegetation (3.7 km²) lying immediately north and east of the lake. The wetland has had significant encroachment by willows (*Salix* sp.).

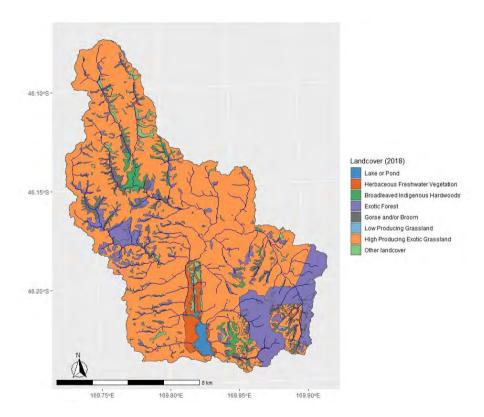


Figure 5. Map of the Lake Tuakitoto catchment and landcover classes based on LCDB5. Source: Landcare Research (2018).

Table 2. Landcover (LCDB5; Landcare Research 2018) for the Lake Tuakitoto catchment.

Landcover category	Area (km²)	Percent of catchment (%)
Broadleaved Indigenous Hardwoods	3.8	2.6
Deciduous Hardwoods	0.8	0.6
Manuka and / or Kanuka	0.9	0.6
Matagouri or Grey Scrub	0.2	0.1
Gorse and / or Broom	5.0	3.5
Herbaceous Freshwater Vegetation	3.7	2.6
High Producing Exotic Grassland	107.2	74.9
Low Producing Grassland	0.1	0.1
Exotic Forest	21.2	14.8
Built-up Area (settlement)	0.2	0.1
Total	143.0	

### 2.3. Stream inflows

Intensification of land use in the catchment has affected water quality, particularly in the lower part of Lovells Creek and Stony Creek (Table 3). Several monitoring sites in these streams exceeded ORC Water Plan limits (Schedule 15) for nitrate and *E. coli* as evidenced in detailed monitoring conducted in 2012–13 (Ozanne 2014). The 2012–13 monitoring data also indicated very high concentrations of total nitrogen (TN) and total phosphorus (TP) at sites in the lower portions of Lovells and Stony Creeks. Concentrations of TN (80th percentile) were in some cases 2–4 times higher than lake ecosystem health NPS-FM national bottom-line limits (800 mg.m<sup>-3</sup> for polymictic lakes) and up to five times greater than NPS-FM national bottom-line values for TP (50 mg.m<sup>-3</sup>). Therefore, it is with high certainty that concentrations of total nutrients to Lake Tuakitoto in inflows are well in excess of meeting NPS-FM national bottom-line values in the lake.

ORC have recently added sites within the Tuakitoto catchment to its stream state of the environment monitoring programme. It is expected that data from this monitoring will provide updated information on water quality in lake inflows to inform the management options that are recommended in this report (Rachael Ozanne, ORC, pers. comm., 26 May 2023).

Table 3. Water quality parameters (80th percentiles) for Lake Tuakitoto river inflow sites (2012–13 data) with receiving water quality limits in plan change 6A. Values that exceeded the limit are in bold type. Values were calculated using samples collected when flows were at or below median flow (0.143 m³ s⁻¹), as this is when Schedule 15 limits apply. Data source: Ozanne (2014).

Site name	TN	NNN	NH₄-N	DRP	TP	E. coli
	(mg.m <sup>-3</sup> )	(100 ml <sup>-1</sup> )				
ORC Schedule 15 limit	none	444	100	26	none	260
Lovells Creek						
West Branch (Hillend Rd)	3380	1956	30	5	262	670
East Branch (Fallaburn Rd)	1078	700	5	20	56	84
NW Branch (Fallaburn Rd)	1020	468	5	16	105	3260
Bloxham Rd	746	384	5	11	40	568
Station Rd	792	366	6	15	45	1300
West Branch (Hillend Rd)	3380	1956	30	5	262	670
Frasers Stream						
Elliotvale Rd	334	41	5	13	31	200
Station Rd	592	201	9	11	47	372
Stony Creek						
Hillend Rd	2018	1074	39	23	156	754
Stony Creek (Hillend Rd)	1384	1032	5	20	55	406
Stony Creek at SH1	924	480	5	20	83	1420

# 2.4. Lake Tuakitoto palaeohistory

As part of the New Zealand Ministry of Business, Innovation and Employment research programme – Our lakes' health: past, present, future (Lakes380; C05X1707), sediment cores were collected from Lake Tuakitoto to examine the palaeohistory of the lake. This work involves using sediment indicators of historical water quality and other characteristics that provide information on conditions in the lake dating back to pre-European settlement and, for some lakes, prior to arrival of Māori.

#### 2.4.1. Sediment cores

Pine pollen was detected in the sediment core to a depth of 10 cm, with all records beyond this sediment sub-sample depth (13 cm) containing no pollen from exotic taxa. This suggest that approximately 10–13 cm of sediment has been deposited in the lake in the last 180 years following the arrival of Europeans in the area (Figure 6). The pollen results from the deepest sample in the sediment core indicate that podocarp forest was prevalent in the region prior to European settlement. It is likely that the landscape was also modified prior to European settlement given the presence

of bracken fern (*Pteridium esculentum*) pollen (common following vegetation disturbance) and charcoal (a proxy for fire) in sediments below 13 cm.

There was also a notable rise in algal pigments post-European arrival, with a steady increase from about 6 cm. The algal signal is difficult to interpret and may have been influenced both by macroalgae and phytoplankton growth in the water column.

#### POLLEN, CHARCOAL AND ALGAE LEVELS FOR THE PAST ~1500 YEARS

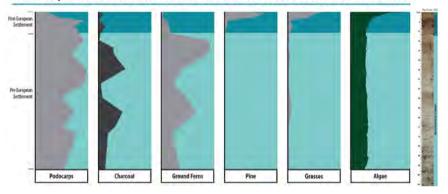


Figure 6. History of catchment vegetation in sediment core records for Lake Tuakitoto showing arrival of exotic pine pollen at approximately 12 cm sediment depth. Also shown is the prevalence of charcoal prior to European arrival, indicating fires in the landscape. Algal pigments are also shown indicating a recent increase in algae associated with benthic macroalgae and / or phytoplankton biomass increases.

#### 2.5. Lake water levels

Water levels in Lake Tuakitoto are managed by the outlet sill as well as the diversion race at the head of the lake, which diverts inflow water directly to the lake during high flow periods. Two main policy measures related to managing water levels in the lake are now in place:

- The Local Water Conservation (Lake Tuakitoto) Notice 1991 set the boundary of
  the lake area at 101.42 m above datum. This level was set to ensure land outside
  of the Lake Tuakitoto area was not significantly adversely affected by manipulation
  of lake water levels. The intent of this was to protect grazing land, which requires
  good land drainage and flood mitigation.
- A minimum lake level of 100.77 m above datum (0.77 m above sea level) was set for the lake for the period beginning 30 September in any year and ending 16 May in the following year. The intent of this was to protect the regionally significant recreational and wildlife features of the lake. This level was adopted by the ORC Water Plan (Otago Regional Council 2022).

Water level monitoring for Lake Tuakitoto indicates the lake experiences high variation in water levels, with annual variation typically between 100.7 m and 102.5 m (relative to datum), indicating approximately 1.8 m of water level fluctuation (Figure 7). This suggests a relatively large range of variation given that normal water levels provide a mean lake depth of 0.7 m. Increases in minimum water levels were apparent in the dataset after 2013 when the minimum water level was formally adopted into the Otago Regional Water Plan (Otago Regional Council 2022). Prior to this time, minimum water levels, which usually coincide with mid-summer periods, were around 100.6 m between 2002 and 2012, almost 20 cm lower than recent years (2013–23). The recent raising of lake level under the new levels adopted in 2013 will have reduced the areas around the lake margin that regularly underwent drying and will have improved habitats for lake edge-dwelling biota.

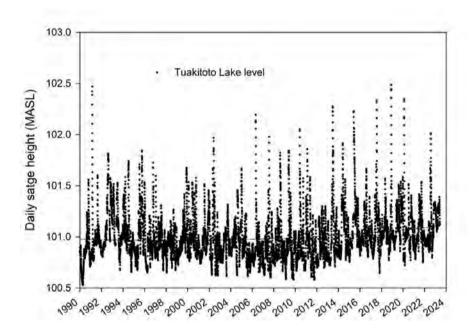


Figure 7. Water levels in Lake Tuakitoto between 1990 and 2023. Data expressed in metres above datum (0.77 MASL).Note that the height of 100.77 is set as a minimum water level for the lake in the Otago Regional Council Water Plan. Data source: Otago Regional Council.

### 2.6. Lake Tuakitoto water quality

Water quality conditions in Lake Tuakitoto have been monitored by ORC at the lake outlet since 1994, with more regular monthly monitoring occurring since 2013. This includes monitoring of physico-chemical conditions, nutrients, phytoplankton biomass and water clarity. The following sections outline the state and trends of water quality in the lake.

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### 2.6.1. Physico-chemistry

Physico-chemical conditions for Lake Tuakitoto at the lake outlet have been collected as spot-monitoring events since 1994, with readings taken at the time of water sampling at the site. Results from water temperature monitoring indicate that lake temperatures mostly ranged between 4 and 22 °C annually (Figure 8). Based on seasonal Mann–Kendall analyses (which normalises for the month the data was collected), temperature increased over the last 10 years of monitoring (2014–23; Table 4). Therefore, a slight warming of the lake outflows has occurred in recent time, possibly associated with climate variation. However, it is worth noting that spot measurements of surface water temperature are poorly suited to detecting long-term temperature trends because data trends can be influenced by normal daily variation caused by collecting measurements at different times of day. Long-term data of lake water temperature using thermistor loggers would be desirable and provide a better understanding of whether lake temperatures are trending and how this might affect temperature-sensitive biota or metabolic processes in the lake.

Surface water conductivity at the lake outlet has varied considerably over time. Typically, the lake outlet water varied between 150–220 µs.cm<sup>-1</sup>, but on some monitoring occasions it dropped below 100 µs.cm<sup>-1</sup>. These low conductivity events are probably associated with floods, when water from the lower Clutha River propagated upstream via the outlet canal that joins the river at the Kaitangata gates. Backflows of water into the lake are complex and depend on flow and tidal conditions in the lower Clutha River, as well as the opening of the control gates that are operated by ORC. Importantly, there were no instances of brackish water being transferred to the lower Clutha River through the canal into Lake Tuakitoto, which remained below 300 µs.cm<sup>-1</sup> on all occasions. There was a trend for increasing conductivity over the past 10 years of monitoring (2014–23; Table 4), with a median concentration of 183 µs.cm<sup>-1</sup>. This increasing trend could be associated with increasing nutrient concentrations, or by higher lake temperatures that would promote greater rates of evapotranspiration.

Surface water pH at the lake outlet indicates that pH has been increasing in the lake (Figure 9), and more importantly, at times the pH exceeds 9, the level at which particulate P appears to solubilise (Waters et al. 2020). Although such high water column pH events are relatively infrequent, it is probable that higher pH occurs near the sediment—water interface, which is related to benthic algal primary productivity. The lakebed is known to have extensive coverage of filamentous green algal communities (Ozanne 2014), which can mediate pH shifts near the bed and recycle sediment P to the water column (Goa et al. 2012; Vadeboncoeur et al. 2021). Concurrent increases in water column dissolved reactive phosphorus (DRP) concentrations indicate that this could potentially be driven by high pH from photosynthesis by benthic (and planktonic) algae. Further monitoring of daily pH

fluctuations both in surface waters and near the bed of the lake (associated with benthic algae) would provide important information to inform how benthic algal communities may be driving nutrient recycling in the lake.

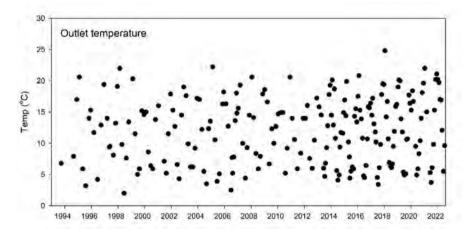


Figure 8. Lake outlet water temperature from spot monitoring between 1994 and 2023. Data source: Otago Regional Council.

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Table 4. Trends in water quality parameters in Lake Tuakitoto between 2014 and 2023. Data source: Otago Regional Council.

	Median (2014–23)	Seasonal Mann–Kendall test stat	P-value	Trend
Temperature (°C)	12.80	2.449	0.0143	Increasing
Dissolved oxygen (mg.l <sup>-1</sup> )	8.93 (82.8%)	2.434	0.0149	Increasing
Conductivity (µs.cm <sup>-1</sup> )	183.0	2.841	0.0107	increasing
pH	7.60	3.639	0.0003	Strongly increasing
Ammonium-N (mg.m <sup>-3</sup> )	39.00	-1.731	0.0835	Moderately decreasing
Nitrate / nitrite-N (mg.m <sup>-3</sup> )	57.00	-0.764	0.4446	No trend
Dissolved reactive-P (mg.m <sup>-3</sup> )	37.50	3.706	0.0002	Strongly increasing
Chlorophyll-a (mg.m <sup>-3</sup> )	5.00	1.840	0.0658	Moderately increasing
Total phosphorus (mg.m <sup>-3</sup> )	103.00	1.934	0.0531	Moderately increasing
Total nitrogen (mg.m <sup>-3</sup> )	1045.00	1.642	0.1000	Moderately increasing
Turbidity (NTU)	6.00	-1.336	0.1814	No trend
Total suspended solids (g.m <sup>-3</sup> )	5.25	-2.661	0.0078	Strongly decreasing

Monitoring data for dissolved oxygen (DO) collected in spot measurements since 1994 (Figure 9) suggest that water column concentrations at the outlet were consistently high (median 8.93 mg.l<sup>-1</sup>) and did not occur at levels associated with oxygen stress to sensitive biota (NPS-FM limit of 4 mg.l<sup>-1</sup>). However, it should be noted that daytime surface water measurements of DO will reflect lake conditions when production of DO is highest and when the water column is expected to show high DO levels. Night-time measurements may differ considerably, particularly for a lake such as Tuakitoto where there is considerable biomass of primary producers. Furthermore, there may be short periods when DO may decline around the benthic mats or at the lakebed, and this would not be measured in outflow. Hence, the spotmonitoring data are poorly suited for understanding oxygen dynamics in the lake and do not necessarily identify if DO conditions are stressful to aquatic life. We would recommend continuous monitoring of DO at multiple levels (i.e. surface, near-bed) over weeks to months during the summer period to gain a better understanding of DO variation in Lake Tuakitoto. Given the extent of benthic algal mats in the lake, it is quite possible DO conditions could vary considerably over depth and time, and this could result in oxygen stress to fish and other species.

Another related factor is that low DO conditions at the lakebed (associated with algal mats) can promote particulate P solubilisation, which occurs under anoxic conditions (Wood et al. 2015). Both DRP and ammonia release could increase water column

dissolved nutrients and stimulate algal metabolism and biomass accrual. This is discussed further in Section 2.3.4.

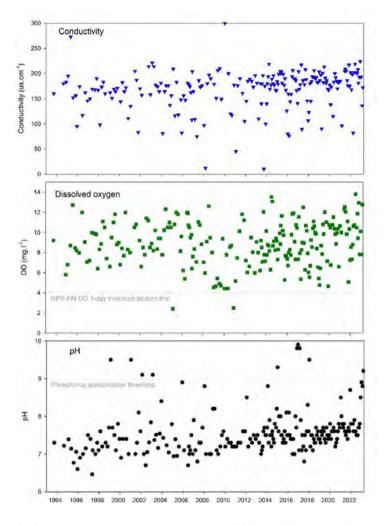


Figure 9. Surface water conductivity, dissolved oxygen (DO) and pH between 1994 and 2023 in Lake Tuakitoto (at outlet). Data source: Otago Regional Council.

### 2.6.2. Trophic level index

Water quality outcomes for the lake are strongly associated with the nutrient status and phytoplankton biomass in the lake. Burns et al. (2000) developed a monitoring protocol for assessing the trophic status of lakes in Aotearoa New Zealand called the

trophic level index (TLI), which is based on measurements of TN, TP, chlorophyll-a (chl-a), and Secchi disc depth (Table 5).

Table 5. Ranges of total nitrogen (TN), total phosphorus (TP) and chlorophyll-a (chl-a) concentrations and Secchi disc depth for trophic level states of Aotearoa New Zealand lakes according to Burns et al. (2000).

Trophic state	TLI	Chl- <i>a</i> (mg.m <sup>-3</sup> )	TN (mg.m <sup>-3</sup> )	TP (mg.m <sup>-3</sup> )	Secchi (m)	Algal and cyanobacteria bloom risk
Microtrophic	1–2	0.33-0.8	34–73	1.8–4.1	15–25	Very low
Oligotrophic	2–3	0.8–2	73–157	4.1–9	7–15	Low
Mesotrophic	3–4	2–5	157–337	9–20	2.8–7	Intermediate
Eutrophic	4–5	5–12	337–725	20–43	1.1-2.8	High
Supertophic	5–6	12–31	725–1,558	43–96	0.4-1.1	Very high
Hypertrophic	6+	> 31	> 1,558	> 96	< 0.4	Very high

For Lake Tuakitoto, monitoring at the outlet site included three of the four TLI parameters, thus TLI was calculated using only the TN, TP and chl-*a* components, termed TLI3. This has been routinely carried out for other lakes in Aotearoa New Zealand, particularly those monitored by water sampling from helicopters, which does not permit dropping a Secchi disc to look at lake visual clarity. In Lake Tuakitoto, TLI3 mostly fluctuated within the supertrophic range, meaning a very high level of nutrient status for the lake (Figure 10). While we did not test for trends in the annual TLI index, there have been moderately increasing trends for total nutrient and chl-*a* levels in the lake over the past 10 years (Table 4).

In the past year, ORC has moved the monitoring of all TLI parameters in Lake Tuakitoto to a mid-lake site to better align with the national TLI monitoring protocols (Burns et al. 2000); however, insufficient data were available to calculate annual TLI for the lake site.

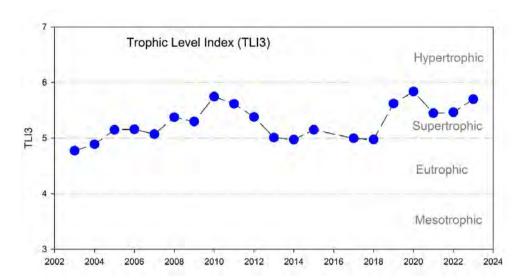


Figure 10. Lake trophic level index (TLI3) for Lake Tuakitoto based on surface water sampling of the lake outlet between 2002 and 2023. Data source: Otago Regional Council.

### 2.6.3. Total nutrient concentrations

Concentrations of TN and TP have consistently been high at the lake outlet site in Lake Tuakitoto. Over the past 10 years of monitoring, the median concentration of TN was 1045 mg.m<sup>-3</sup> and the median TP was 103 mg.m<sup>-3</sup>, which are within the supertrophic range (Burns et al. 2000). Both parameters were in excess of the NPS-FM national bottom lines (NPS-FM limits: TP = 50 mg.m<sup>-3</sup>; TN = 800 mg.m<sup>-3</sup>) for the protection of aquatic health over the entire monitoring record between 1996 and 2023 (Figure 11). Based on seasonal Mann–Kendal tests between 2014 and 2023, both TN and TP showed moderately increasing trends (Table 4).

These results show there is a high risk of promoting algal blooms and benthic algal growth, and potentially promoting cyanobacterial-dominated conditions. The very high DRP concentrations (also discussed in Section 2.3.5) would further contribute to risks of cyanobacteria. Because some cyanobacteria can produce toxins and provide limited benefit for animal grazers (zooplankton, kākahi, macrobenthos), there is further risk to the food web of the lake.

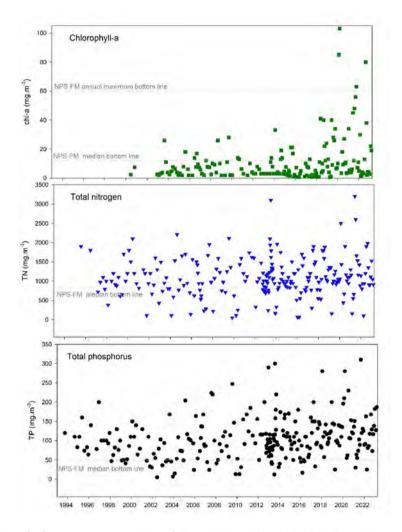


Figure 11. Surface water concentrations of phytoplankton chlorophyll-a (chl-a), total nitrogen (TN) and total phosphorus (TP) between 1993 and 2023 in Lake Tuakitoto (at outlet). Also shown are national bottom lines for the NPS-FM for the three ecosystem health lake attributes. Data source: Otago Regional Council.

### 2.6.4. Phytoplankton biomass

ORC have monitored phytoplankton biomass (measured as chl-*a*) at the lake outlet since 1995, and more recently (since 2013) at monthly intervals (Figure 11). Historically, the high nutrient concentrations in the lake have not resulted in associated algal blooms, with a corresponding 10-year median chl-*a* concentration (5 mg.m<sup>-3</sup>) indicative of meso-eutrophic conditions. Previous research on Lake

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Tuakitoto has demonstrated that water filtration by kākahi populations results in high rates of filtration of phytoplankton, thereby maintaining relatively lower algal biomass in the lake and limiting chances for phytoplankton blooms (Ogilvie and Mitchell 1995, Ozanne 2014).

More recent phytoplankton biomass data (since 2018) indicates that the mid-summer chl-a can exceeded the annual maximum NPS-FM guidelines of 60 mg.m<sup>-3</sup>, doing so in each of the last four monitoring years. This recent increase in phytoplankton biomass is indicative of changes in lake-wide processes that are likely to negatively affect water quality and are considered in relation to other water quality and ecology variables below.

#### 2.6.5. Dissolved nutrients

Concentrations of dissolved nutrients have been monitored by ORC at the lake outlet since 1995, more recently (since 2013) at monthly intervals. Associated with the timing of increasing phytoplankton biomass in 2018, there have been concurrent increases in DRP in Lake Tuakitoto (Figure 12). Trends in DRP indicate strongly increasing concentrations over the monitoring record, with a 10-year median of 37.5 mg.m<sup>-3</sup>. Normally DRP comprises only a small fraction of the TP pool in shallow lakes (often at undetectable levels) because it is so readily taken up by primary producers. High concentrations of in-lake DRP are often associated with internal nutrient cycling processes, which can occur when particulate-bound P is solubilised under either low oxygen or high pH conditions (Waters et al. 2020). The timing of very high DRP events (in excess of 90 mg.m<sup>-3</sup>) can be seen in obvious peaks, which have occurred during the summers (December to March) of 2015, 2018 and 2020, with smaller peaks in 2019 and 2021. Summer maxima suggest that primary production by algae, which is greatest in warm summer months, is likely to be driving these peaks by increasing daytime water column pH and potentially reducing DO during night-time periods. The dissolution of DRP during such conditions is likely to be accelerating the growth of phytoplankton and benthic algae in the lake in a positive-feedback process.

Concentrations of dissolved inorganic nitrogen (DIN) have been in intermediate ranges, with median concentrations of ammonia and nitrate / nitrite of 39 mg.m<sup>-3</sup> and 57 mg.m<sup>-3</sup>, respectively. However, at times concentrations of nitrate+nitrite can regularly approach 1000 mg.m<sup>-3</sup> in winter and spring when water levels are high and uptake by aquatic plants in the lake is lower. Both parameters have had either no trend (ammonia) or a slight reducing trend (nitrate+nitrite) in the past 10 years of monitoring (Table 4). Limits for nitrate and ammonia toxicity to sensitive aquatic life are set in the NPS-FM; however, these national bottom-line guideline concentrations are very high with respect to levels that would promote ecological effects. There were no instances in which the ammonia-N toxicity bottom line was exceeded and only one instance in 2008 when the nitrate toxicity bottom line was exceeded.

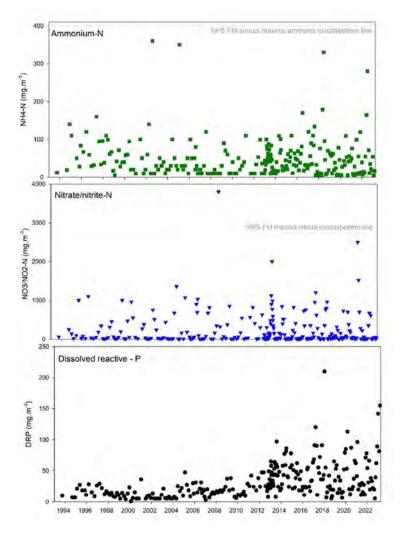


Figure 12. Surface water concentrations of nitrate / nitrite and dissolved reactive phosphorus (DRP) between 1993 and 2023 in Lake Tuakitoto (at outlet). Also shown is the NPS-FM nitrate toxicity median national bottom line indicating severe acute stress to sensitive aquatic species above this threshold. Data source: Otago Regional Council.

Nutrient ratios can be useful for investigating potential nutrient limitation of algal growth in lakes and providing information for restoration measures focusing on the limiting nutrient. DIN:TP ratios near 1, and TN:TP ratios near 7 (Redfield ratio by mass) indicate that supply of N and P are roughly balanced in relation to the demands of plant and algae growth. Increasing departures from these thresholds could suggest that primary productivity in a system is increasingly limited by either N (<< than the

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thresholds) or P (>> than the thresholds), with single nutrient limitation more likely to occur when ratios exceed double or half the balanced ratios (i.e. for DIN:TP, P-limited when ratio > 2, N-limited when ratio < 0.5. For TN:TP, P-limited when ratio > 14, N-limited when ratio < 3.5. For Lake Tuakitoto using median data (whole season), ratios of DIN:TP were approximately 0.91 and TN:TP were approximately 9.9, both of which suggest that nutrient ratios are within the co-limitation ranges by N and P. This finding indicates that both nutrients are important for maintaining healthy waterbodies and are occurring in balance with those required for algal growth. Hence, mitigation strategies for managing both N and P should be considered to reduce algal productivity and blooms in the lake.

### 2.6.6. Lake clarity

Water clarity at the outlet of Lake Tuakitoto has been assessed since 1994 using three different water quality indicators (Figure 13). Black disc clarity, which is a measurement of horizontal sighting distance, was available between 1998 and 2005. Data for black disc clarity suggest that water clarity of lake outlet water was typically quite low, usually less than 1 m, but on few occasions was up to 3.6 m.

Measurements of other water clarity parameters included turbidity and total suspended solids (TSS), and these have been recorded over the entire monitoring record since 1994. The 10-year (2014–23) median values for TSS and turbidity were 5.25 g.m<sup>-3</sup> and 6.0 NTU, respectively. Both values suggest moderate concentrations of suspensoids (particulate matter) in the outlet water, which limits clarity of lake water. Interestingly, TSS has been significantly decreasing over the past 10 years (no significant trend for turbidity) of the monitoring record, indicating that the clarity of outflows has increased (Table 4). Although causes of this decline in TSS are not certain, we surmise that the increasing prevalence of benthic mats covering the lakebed may be preventing resuspension of sediment during windy periods, which is contributing to lower TSS and increasing the water clarity.

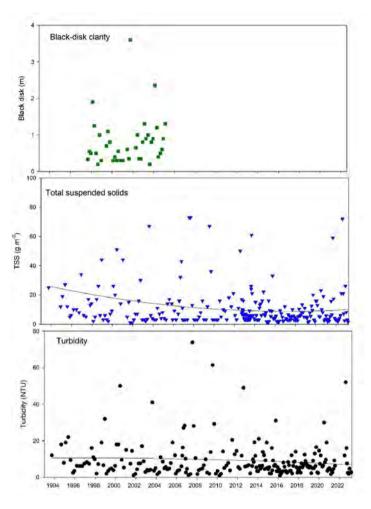


Figure 13. Monitoring results for lake clarity parameters in Lake Tuakitoto between 1994 and 2023.

Also shown are polynomial regression lines for total suspended solids (TSS) and turbidity data indicating moderate declines in these variables over the monitoring record. Data source: Otago Regional Council.

# 2.6.7. Sediment chemistry

Sediment geochemistry data was analysed in six surface sediment samples collected from Lake Tuakitoto (Methods in Appendix 2). A short sediment core (0–24 cm) was also collected from a mid-lake site (K12) using a Uwitec gravity corer. The sediment was sectioned into 2 cm (0–16) and 4 cm (16–24) sections, collected in 50 mL centrifuge tubes and sent to Analytica Laboratories (Hamilton) for total recoverable P analysis. In addition, a surface sediment sample (0–2 cm) was collected in June 2020

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as part of the Lakes380 programme. This sample was analysed for P fractionation by sequential chemical extraction (Figure 14) and quantification of P anoxic release rate (Figure 15). The sequential extraction followed the methods outlined in Waters et al. (2023). The release rates were determined by slurry experiments conducted in the Cawthron Laboratory under anoxic conditions and as such represent maximum potential release rate rather than environmentally realistic rates.

This data provides a snapshot of the general sediment geochemistry and is particularly focused on the question of legacy nutrients, especially P. To place the Lake Tuakitoto sediment geochemistry in a national context, we have compared the data to a multi-lake dataset compiled under the Lakes380 programme, including data from 83 shallow (< 10 m) lakes from around Aotearoa New Zealand. When interpreting the Lakes380 Tuakitoto data, it should be noted that geochemistry parameters can display high spatial variability, and hence single samples may not be representative of the whole lakebed.

The Lake Tuakitoto sediments had high bulk densities and low organic matter content relative to the national dataset (Table 6). The exception to this was the southernmost site (K2), which had high organic matter (51%). TN was also low relative to nationwide sediments. These parameters may reflect repeated sediment resuspension, which is common in shallow lakes such as Tuakitoto and can result in decomposition of organic material in the water column, rather than sequestration in the sediments.

Copper (Cu) and zinc (Zn) concentrations in sediments were elevated relative to the national sediment dataset but were below the low trigger values for sediment quality guidelines (ANZECC and ARMCANZ 2000), as were lead (Pb) and cadmium (Cd). Iron (Fe), manganese (Mn), aluminium (Al) and calcium (Ca) are all associated with mineral phases known to bind P in sediments. The Lake Tuakitoto sediments were low in Ca, high in Mn and slightly elevated in Fe and Al relative to the national dataset.

The P content of the Lake Tuakitoto sediments was similar to the national median (Table 6; Figure 14), while the average was lowered due to the low TP content in the southernmost sample ( $K2 = 460 \text{ mg.kg}^{-1} \text{ dw}$ ). When this sample was excluded, the Lake Tuakitoto mean TP (1,408 mg.kg<sup>-1</sup> dw) was also similar to national shallow lake average. There appeared to be a southward decrease in TP content of the sediment, although this is based on a limited spatial survey. There was a strong correlation between Fe and P content in the sediment ( $R^2 = 0.89$ ) likely indicating an important role of Fe mineral phases, such as Fe oxyhydroxides, in binding P (Dzombek and Morel 1990; Wang et al. 2013).

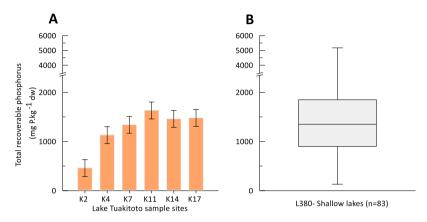


Figure 14. Total phosphorus in the six sediment samples taken in Lake Tuakitoto in this study (plot A). The error bars denote the standard error of the six samples. The box and whisker plots (plot B) show summary statistics (range, 25th and 75th quartiles and median) for total phosphorus contents in the top 0–2 cm of sediment in 83 shallow lakes (< 10 m depth) sampled during the Lakes380 national-scale study. The sample sites in plot A are arranged from south (left) to north (right).

The P fractionation analysis conducted on the sediment sample collected during the Lakes380 programme resulted in a somewhat higher TP than that obtained from total recoverable analyses (Figure 15). This finding is common and is the result of a more robust chemical extraction procedure combined with a degree of 'carry over' whereby a small proportion of P may be reabsorbed and hence reanalysed (Waters et al. 2020). The analysis indicated a very high proportion of redox-sensitive P (56% of TP compared with the shallow lake average and median of 24% and 21%, respectively). This confirms the likely importance of redox-sensitive P-binding minerals such as Fe oxyhydroxides and indicates a strong susceptibility to P release under anoxic conditions. While the pH-soluble fraction appears relatively minor, it is about average for shallow lakes nationwide (Tuakitoto = 16 % of TP relative to a national shallow lake mean and median of 18% and 16%, respectively). It should also be noted that much of the bound P in the redox-sensitive P fraction may also be susceptible to release by elevated pH (> 9.2). The anoxic release rate obtained by laboratory glovebox, slurry experiments indicated Lake Tuakitoto had a high potential release rate, near the 75th percentile of the national dataset (Figure 16).

Table 6. Key statistics for the bulk sediment geochemistry parameters for six surface sediment (0–2 cm) samples collected from Lake Tuakitoto, and the data samples collected during the Lakes380 programme. For comparison, the summary statistics for 83 shallow lakes sampled during the Lakes380 programme are also presented.

		Lake Tuakitoto this study (n = 6)			Lakes380	shallow lak	<b>es</b> (n = 83)
	Unit	Min.	Max.	Mean	Median	Mean	Median
Bulk density	g.cm <sup>-3</sup>	0.18	0.43	0.275	0.241	0.1536	0.12
Organic matter	%	4.90	51.0	15.8	8.6	32.2	28.0
Total P*	mg.kg <sup>-1</sup> dw	460	1,630	1,250	1,400	1,494	1,340
Total N*	mg.kg <sup>-1</sup> dw	0.36	0.70	0.55	0.56	1.45	1.39
Fe*	mg.kg <sup>-1</sup> dw	15,800	40,700	30,883	31,500	31,847	25,300
Mn*	mg.kg <sup>-1</sup> dw	377	1,610	1,021	994	705.7	433
Al*	mg.kg <sup>-1</sup> dw	11,300	26,800	20,167	20,300	19,445	17,800
Ca*	mg.kg <sup>-1</sup> dw	2,430	4,580	3,688	3,815	13,007	5,855
Pb*	mg.kg <sup>-1</sup> dw	14.3	34.3	26.2	26.7	19.1	16.65
Cu*	mg.kg <sup>-1</sup> dw	26.9	40.9	34.7	35.8	23.0	17.9
Cd*	mg.kg <sup>-1</sup> dw	0.11	0.24	0.17	0.17	0.195	0.13
Zn*	mg.kg <sup>-1</sup> dw	72.5	167	123	123	75.6	60.9
S*	mg.kg <sup>-1</sup> dw	880	1,900	1,208	1,080	6,654	3,980

<sup>\*</sup> Total P = total recoverable phosphorus, Total N = total recoverable nitrogen, Fe = iron, Mn = manganese, Al = aluminium, Ca = calcium, Pb = lead, Cu = copper, Cd = cadmium, Zn = zinc, S = sulphur, dw = dry weight.

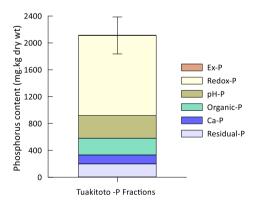


Figure 15. Sediment phosphorus fractions in the surface sediment sample (0–2cm) taken in Lake Tuakitoto during the Lakes380 national-scale study. The error bar denotes a 13% error associated with analysis and sampling.

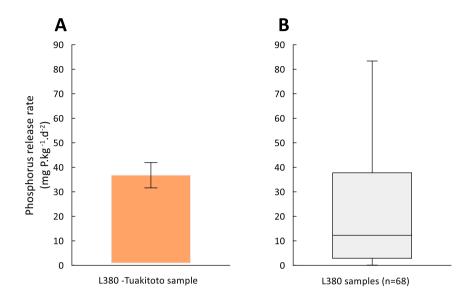


Figure 16. Phosphorus release rates determined by slurry experiment in A) a single surface sediment (0–2cm) sample from Lake Tuakitoto, and B) summary statistics (range, 25th and 75th quartiles and median) on release rates determined for Lakes380 (L380) shallow lake sediment samples (*n* = 68). The error bar on plot A is the standard error derived from the 68 lake dataset.

The TP profile in the short core from the mid-lake site of Tuakitoto showed a strong downcore decrease in P content, with a particularly steep gradient in the upper 6–7 cm (Figure 17). This pattern may be a result of rapid increases in recent sedimentation of P, but may also be indicative of a flux of P from deeper sediment towards the sediment—water interface, which is associated with anoxia and mobilisation in the deeper sediments (Waters et al. 2020).

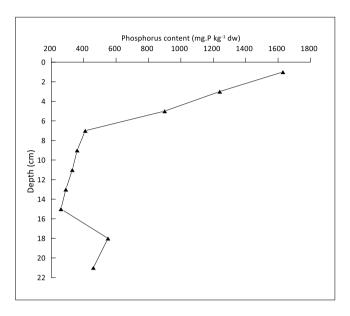


Figure 17. Phosphorus content profile in a short sediment core from the mid-lake sample site K12.

The relatively high P content of the Lake Tuakitoto sediments combined with the very high proportion of the redox-sensitive P fraction, the high potential release rates and the downcore pattern in TP content all indicate that significant internal P loading is likely to be occurring in the lake. This may be driven by high pH (> 9.2), which is observed in the water quality record (see Figure 4) and *I* or anoxic conditions at the sediment—water interface. Although such anoxia is not evident in the water quality data, it is likely that anoxia as well as high pH conditions exist near the bottom of the benthic algal mats proliferating in the lake (discussed in the next section).

# 2.6.8. Macrophytes and macroalgae

Hamilton (1990) and McKinnon and Mitchell (1994) reported very low macrophyte biomass in Lake Tuakitoto compared to other shallow lowland lakes that they sampled. In 2006, aquatic plants were surveyed at three shoreline locations as part of a national coastal lakes study (Drake et al. 2010). These surveys of macrophytes and macroalgae were made along transects extending 50 m out from the lakeshore. The study used underwater viewers (shallow areas) and sediment grabs (deep areas), and recorded observations of lakebed cover by different species over the transect. They observed low-moderate coverage of the bed by the macrophytes *Lilaeopsis ruthiana* and *Glossostigma* sp., predominantly in shallow areas along the shoreline. There were also records of filamentous green macroalgae covering portions of the transects, in some cases covering up to 80% of the lakebed (Drake et al. 2009).

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During fieldwork conducted in March 2023, aquatic plant surveys were conducted in the same manner as in 2006, along 50 m transects at the same three shoreline sites. There were no submerged macrophytes observed on any of the three transects, with only some *Carex* sp. (sedge) and *Juncus* sp. (rush) emergent plant species observed along the lake edge (Figure 18). Cover by filamentous macroalgae was extensive, with thick mats covering most of the bed area and in some cases extending upwards of 0.5 m from the lakebed. Overall, macroalgae covered 69% of the lakebed, averaged across all the transects. There were obvious growths of macroalgae to the surface of some parts of the lake, and in some cases, mats formed large floating rafts of decaying material that could be expected to provide significant inputs of dissolved nutrients to the lake water column (Figure 19). The floating rafts of macroalgae likely formed as accumulations of material that had originated in areas where mats become buoyant with oxygen bubbles and float off the lakebed. We also observed areas where mats had partly lifted off the lakebed.

The finding of very low macrophyte biomass and cover in Lake Tuakitoto in our March 2023 survey was confirmed by de Winton et al. (2023), who attempted to carry out a systematic macrophyte survey of the lake in June 2023. They reported that the lake had < 10% cover of macrophytes and 30–80% cover of filamentous green algae, which also exhibited as surface-floating mats. Isolate sprigs of the macrophytes *Elodea canadensis*, *Ruppia polycarpa* and *Potamogeton ochreatus* were found. The authors reported that the dense macroalgal cover likely impacted other benthic organisms. They also suggested that a deepening of the lake could benefit the macrophyte communities of the lake. The LakeSPI (Lake Submerged Plant Index) score reported for the lake was 0 (functionally devegetated).

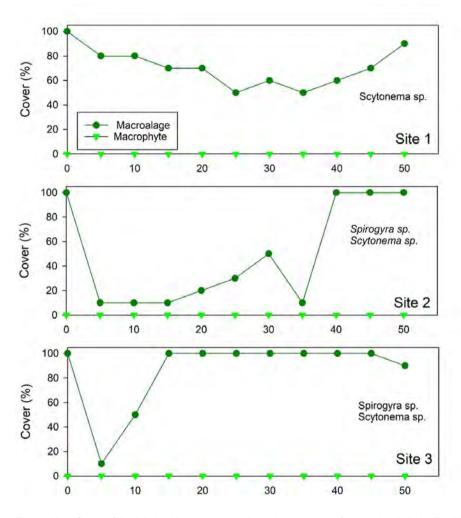


Figure 18. Cover of the lakebed by macroalgae based on surveys of three sites in Lake Tuakitoto in March 2023.

Although it was not the intention of the field survey to focus in detail on benthic macroalgae, a preliminary investigation of their coverage and species composition was conducted due to their prevalence in the lake. Mats were comprised mainly of two types: long, bright green filaments of the genus *Spirogyra* (Chlorophyta); and thick olive-brown filamentous mats, which predominantly comprised the cyanobacteria taxa *Scytonema* sp. (Figure 19). The filamentous green alga *Spirogyra* is known to form nuisance growths in lakes, is highly resistant to grazers and can modify food web pathways to higher trophic levels such as fish (Stewart et al. 2021; Vadeboncoeur et al. 2021). *Scytonema* mats appear to comprise a much greater proportion of

macroalgae cover in Lake Tuakitoto, with some species (e.g. *S. cripsum*) known to produce saxitoxin, a cyanotoxin (Smith et al. 2012). Benthic mats dominated by cyanobacteria are found in many aquatic habitats (Scott and Marcarelli 2012); they have been documented in lakes (e.g. Smith et al. 2012; Wood et al. 2012) and alpine tarns (Novis and Visnovsky 2011), including several Canterbury high country lakes (Smith et al. 2012). The taxonomic composition of *Scytonema* mats in Lake Tuakitoto and other associated cyanobacteria-inhabiting mats were not explored in detail during this study, and there is poor knowledge of the seasonal variability in cover and biomass in the lake. In order to better understand these dynamics, we highly recommend a more detailed monitoring of macroalgae, including quantifying its seasonal cover, biomass and species composition.

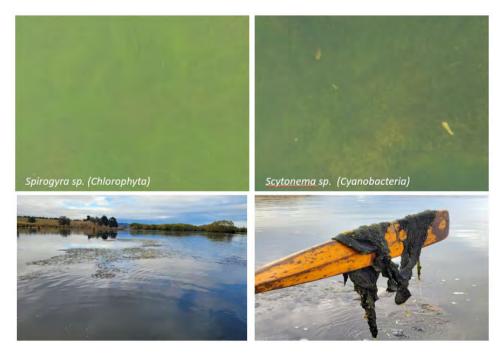


Figure 19. Images of benthic macroalgae prevalent in Lake Tuakitoto during the March 2023 Cawthron field surveys. *Spirogyra* sp. is a long filamentous green algae that can dominate benthic habitat in some lakes (e.g. Lake Baikal) (Vadeboncoeur et al. 2021). *Scytonema* sp. is a filamentous cyanobacteria species that has been recorded in other South Island lakes, with some species capable of producing saxitoxins (e.g. Smith et al. 2011, 2012). Also noteworthy was the prevalence of large floating rafts of macroalgae, which likely accumulated from areas of the bed where macroalgal mats become buoyant and float to the surface.

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### 2.7. Lake food web

#### 2.7.1. Kākahi

Historical surveys have been conducted on kākahi (freshwater mussel) populations in Lake Tuakitoto (Ogilvie 1993), including the quantification of kākahi filtration rates due to the large populations that were observed in the 1990s (Ogilvie and Mitchell 1995). It was concluded that the lake water filtration by kākahi was a major driver of water clarity in Lake Tuakitoto, with the entire volume of the lake filtered in only a 32-hour period (Table 7). This rapid filtration rate had a stabilising effect on phytoplankton biomass in the lake, reducing phytoplankton biomass relative to the lake's nutrient status.

As part of a wider monitoring investigation into the Lake Tuakitoto catchment, ORC reconducted the kākahi survey at the same 26 sites in 2013 (Ozanne 2014). The 2013 survey showed that mussel biomass was reduced by 52% compared to the 1991 survey, and lake filtration rates declined from 32 hours to 102 hours. These changes were thought to result from both a decline in overall density of kākahi and an increase in the portions of the lake devoid of mussels. The absence of mussels at previously occupied habitats was associated with extended periods of low water levels in the lake. Since the 2013 monitoring, water level management of the lake has been modified to a provide higher summer minimum water levels, which should benefit kākahi.

In March 2023, kākahi surveys were reconducted at the same 26 sites (see Appendix 1 for sites); however, concerns regarding high *E. coli* levels and extensive cyanobacteria meant that dive surveys were not undertaken by snorkellers, and instead abundances were estimated from video surveillance of multiple quadrats on the lakebed. Surveillance of kākahi by video quadrats has been used in other monitoring investigations, and some research has been undertaken into understanding the differences in effectiveness between the two methods. It was reported that monitoring data using the two different methods followed similar trends, but the video surveillance reported slightly lower counts of mussels because some were buried in the sediment. The density estimates of mussels were roughly 20% lower using video quadrats compared with finger sifting by snorkelling (Nuri et al. 2022).

Observations of kākahi at 22 sites in Lake Tuakitoto during March 2023 (four sites could not be assessed due to high turbidity) indicated that significant declines in the abundances of kākahi have occurred since the last survey in 2013 (Figure 20). Mean abundance of kākahi in 2023 was 0.75 per m², approximately 65% lower than in 2013 and 86% lower than in 1991 (Table 7). After adjusting the values upwards by 20% to account for fewer mussels being detected using video surveillance (Nuri et al. 2022), these declines are marginally lower, approximately 59% lower than in 2013 and 84%

lower than in 1991. Because kākahi were considerably larger in size in 2023, this meant that declines in the overall biomass of kākahi were slightly lower, which was estimated to be on average 57% lower in 2023 than in 2013. The most obvious declines in abundances were for populations located in central portions of the lake, which historically had abundances of kākahi of up to 27 individuals per  $m^2$ , whereas recent monitoring of the central areas found highest densities were between 1–2 kākahi per  $m^2$ . Significantly lower abundances of kākahi at shallow sites, noted during 2013, did not occur in 2023. Few sites in the 2023 survey had shallow depths, with only two sites having water levels less than 0.5 m (in 2013 monitoring, 18 sites had water depth < 0.5 m). Hence, it did not appear that shallow water depth was a significant factor contributing to lower kākahi abundances.

The prevalence of thick macroalgal mats appeared to have a negative effect on kākahi abundance. While the macroalgae made it much harder to detect kākahi in video quadrats, considerable time was spent by the field team scooping bed materials using kick-nets in macroalgal covered areas, but this did not yield any kākahi detections. Kākahi seemed to avoid areas of the lakebed covered with thick macroalgae. Effort was made to take video images in areas with low macroalgae abundance to improve chances of detecting kākahi, which likely introduced some sampling bias into our survey. However, even with this bias towards detecting more kākahi in clearer parts of the lakebed, there were still strong declines in abundances compared with previous surveys.

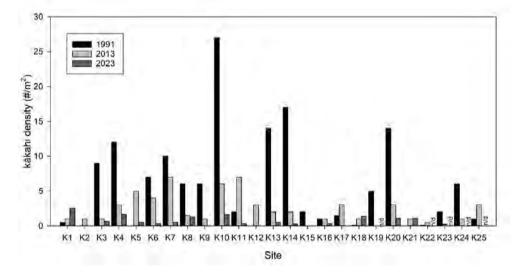


Figure 20. Abundances of kākahi observed at 26 sites in Lake Tuakitoto in 1991 and during a resurvey in 2013 and 2023. Data source: Ozanne (2014).

Table 7. Comparison of mussel filtration calculations between 1991, 2013 and 2023 kākahi surveys. Assumptions on filtration rates were based on Ogilvie and Mitchell (1995). Data source: Ozanne (2014).

Statistic	1991	2013	2023
Area (km)	1.18	1.18	1.18
Depth (m)	0.7	0.7	0.7
Volume (m³)	826,000	826,000	826,000
Stations with no mussels	2	4	4
Stations less than 0.5 m depth	4	18	2
Mean mussel abundance per site (m²)	5.5	2.2	0.75
Mean biomass per site (g.m-2)	12.3	5.86	2.51
Mean filtration rate (l.hr-1.g-1)	1.91	1.26	0.54
Active filtering (%)	0.93	0.93	0.93
Volume water filtered (m³.hr-¹)	21.85	6.87	2.94
Time to filter entire lake volume (d)	1.3	4.3	9.9

Declines in biomass of kākahi in 2023 had flow-on effects on predictions of lake water filtration by the kākahi population. Filtration rates from the original 1991 surveys (Ogilvie and Mitchell 1995) were used to calculate filtration rates that took into account mussel size distribution across the 22 sites surveyed. Using the 2023 population data, we estimated that lake filtration rates have further reduced to 2.94 m³/hr, meaning that the whole lake water column is now filtered in approximately 10 days. This filtration rate is approximately 2.3 times longer than in 2013 (4.3 days) and 7.6 times longer than in 1991 (Ozanne 2014). While the 2023 filtration rate indicates relatively rapid clearance of phytoplankton, filtration capacity is now considerably lower than historical estimates, which means that phytoplankton have a greater period for biomass accumulation and there is potential for blooms when phytoplankton growth rates become very rapid (Ogilvie 1993). Because phytoplankton can double in a single day during high-growth periods (i.e. blooms), kākahi filtration would now not be capable of controlling phytoplankton growth in Lake Tuakitoto. This is consistent with recent increases in the lake's phytoplankton biomass observed in ORC monitoring data.

Because kākahi are so effective at stabilising phytoplankton, further declines in populations would be expected to result in direct increases in phytoplankton biomass and productivity. Because algal productivity can have a self-reinforcing (positive-feedback) effect on nutrient concentrations through influencing pH and DO, it is important to maintain kākahi populations. There are currently high concentrations of water column total and dissolved nutrients in Lake Tuakitoto, and large sedimentary

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pools of P could be solubilised if algal productivity is high enough to cause pH and DO shifts. There is still a relatively poor understanding of whether recent trends of increasing pH and high DRP are driven predominantly by benthic algae (acting at the sediment—water interface), phytoplankton (acting over the whole water column); or a combination of both. Our observations of the extensive coverage of macroalgae mats would suggest this is the most important factor controlling these dynamics.

### Kākahi age structure and recruitment

Kākahi shell lengths were measured at multiple sites by collecting lakebed material using a 500  $\mu$ m kick-nets from the boat. In some instances, kākahi could be observed on the bed and were directly scooped up in kick-nets, but more passive towing of nets over the lakebed was also effective in collecting mussels. In total, 48 individuals were collected for measurement of shell length to better understand the population size structure.

Shell lengths of kākahi varied between 46 mm and 108 mm, with the greatest number of individuals measured between 70–90 mm shell length (Figure 21). This indicated that the population consisted mostly of large mature adult individuals, with no individuals within the juvenile size range of less than 38 mm (James 1985). Based on size distribution data from the 2013 kākahi survey (Ozanne 2014), individuals of greater than 60 mm length were only found in Lake Tuakitoto, suggesting a highly skewed age structure towards older kākahi. A considerably higher proportion of individuals in smaller size ranges would be expected if kākahi populations were successfully breeding and good growing conditions were available for young kākahi. However, this was not the case for the Lake Tuakitoto population, which had no immature individuals and was comprised mostly of old mature mussels. This raises concern that conditions in the lake are not resulting in successful breeding, or that habitat conditions are not supporting the growth of juvenile kākahi and their development to early adult stages.

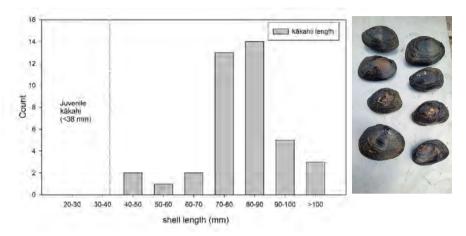


Figure 21. Measurements of shell length of kākahi in the March 2023 survey at 22 sites and picture showing the large kākahi size range, up to 108 mm shell length. Photo: David Kelly,

General declines in once abundant populations of kākahi have been observed across many Aotearoa New Zealand lakes (Grainger et al. 2014). The decrease in kākahi populations has been attributed largely to declining water quality and potentially to changes in the productivity and composition of phytoplankton, the main food source for these filter feeders (James 1985). Less is known about the importance of early lifehistory stages to kākahi population dynamics and how this can affect recruitment of kākahi populations. Kākahi have complex life histories, which include larval stages and different habitat requirements for juvenile and adult mussels. Glochidium larvae are released from kākahi parasitise fish. The larvae attached to the gill lamellae or skin of a fish before releasing as juveniles, moving to soft sediments of the littoral zone to filter feed until maturity. It is known that adult koaro (Galaxias brevipinnis) and common bullies (Gobiomorphus cotidanus) are hosts for kākahi glochidia (juveniles). However, since the introduction of exotic piscivorous fishes, such as European perch and brown trout, to many Aotearoa New Zealand lakes, native host species can be greatly reduced in abundance. The observation that kākahi populations in Lake Tuakitoto are decreasing and lack significant recruitment raises serious concerns for the population and suggests that intervention may be prudent (discussed in Section 2.6)

#### 2.7.2. Native fish communities

Fish communities have been monitored in Lake Tuakitoto since the 1980s, and data are available in the New Zealand Freshwater Fisheries Database (Table 8). Catch data from these historical fish surveys indicate that the most abundant species reported were shortfin eel, European perch (*Perca fluviatilis*) and brown trout, with occasional records of common bullies (toitoi, *Gobiomorphus cotidianus*), giant kōkopu

(*Galaxias argenteus*), shortfin eel (*Anguilla australis*) and longfin eel (*Anguilla dieffenbachii*). Somewhat unusual for the reported catch data in Lake Tuakitoto were the relatively low occurrences of catches (and low abundances) of smaller native fish species such as common bullies, īnanga (*Galaxias maculatus*) and kōaro (*Galaxias brevipinnis*), which were rarely or never recorded in the catch records. These species often comprise the greatest proportions of fish catch records for other lowland coastal lakes (Drake et al. 2010).

Table 8. Summary of fish catch data from the New Zealand Freshwater Fisheries Database for Lake Tuakitoto between 1984 and 2020. Source: NIWA – NZFFDB.

Year / month	Organisation	Method	Species caught	Mean relative abundance (fish/net/d)
1984–85	Fish & Game	Fyke nets	Shortfin eel	31.7
May-July	NZ	Gee-minnow traps	Longfin eel	2
			Brown trout	2.7
			Perch	17.2
			Bully (unidentified)	1
1995	Private	Fyke nets	Giant kōkopu	7
December	individuals		Shortfin eel	2
			Longfin eel	4
			Perch	1
			Brown trout	1
2002	Department of	Fyke nets	Shortfin eel	2
June	Conservation		Perch	11
			Common bully	_
			Brown trout	13
2013	Department of	Fyke nets	Giant kōkopu	1.8
June	Conservation		Shortfin eel	1
			Perch	1
2020 March	Department of	Fyke nets	Eels	5.1
	Conservation	Multi-panel gill nets	Galaxiids	3.3
			Perch	22.4
			Common bully	1
			Brown trout	5.3

A previous study of shallow coastal lakes collected fish catch data from 46 lakes across Aotearoa New Zealand using a standardised fishing effort (Drake et al. 2010). This included catch records for Lake Tuakitoto in March 2006, which employed a combination of fyke nets and gee-minnow traps at three sites spread across the lake (Drake et al. 2010). In March 2023, this survey methodology was repeated in Lake

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Tuakitoto at the same sites to gain a better understanding of the present status of fish communities in the lake. The catches in 2023 were also compared to the earlier survey and to a range of South Island lakes included in the original lowland lake study.

Fish caught during the 2023 survey included shortfin eels, longfin eels, īnanga, common bully and perch (Figure 22). Results of the 2023 fish catches suggested shortfin and longfin eels were abundant, but other species such as common bully, īnanga and European perch were in very low abundance. Comparison of the catch data with previous assessments conducted in Lake Tuakitoto in 2006 and in 22 South Island lakes suggest that both eel species are currently very abundant in the lake, but other taxa that are generally more abundant, such as common bullies, are very low (only two individual fish caught in 2023). This pattern of very low abundances of both common bully and īnanga was also present in the previous 2006 survey. There were relatively high abundances of perch caught in Lake Tuakitoto, particularly in 2006 when European perch were caught at the highest rate of all 22 South Island lakes.

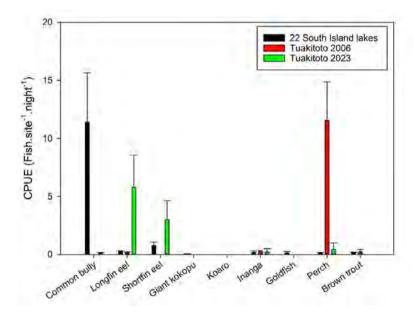


Figure 22. Mean (± standard error) catch per unit effort of fish species in Lake Tuakitoto during fish surveys from 2006 and March 2023. Also shown are mean catch data from 22 South Island shallow coastal lakes fished with the same fishing effort. Data source: Drake et al. (2010).

Native fish surveys data from 22 lowland coastal lakes in Aotearoa New Zealand between 2006 and 2009 indicated a strong inverse relationship between catch rates for perch and for common bullies (Drake et al. 2010). For Lake Tuakitoto, no common bullies were caught, and the lake had the highest perch catch rates (2.96 fish.trap<sup>-1</sup>.hr<sup>-1</sup>) of all lakes in the dataset (Figure 23). Catch rates of European perch in 2023 were significantly lower than in 2006; although the reasons for this decrease are not clear, anglers have anecdotally reported that fish catches have been poor in the lake over the past 3 years (Ian Hadland, Otago Fish & Game, pers. comm., 28 May 2023). The combination of very low abundances of fish observed in catch records and by angers indicates a wider recent decline in fish habitat in the lake. The extent of benthic algal mats that can grow to the lake surface during low water periods may be driving major changes in habitat quality and affecting daily variability in DO and pH. The required high-frequency monitoring data to quantify physico-chemical dynamics within the lake was not available; therefore we suggest this is a high priority for further investigation.

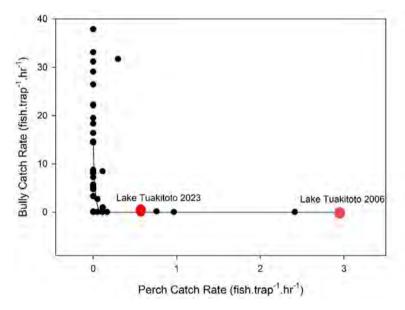


Figure 23. Catch rates of common bullies and European perch in 38 shallow coastal lakes in Aotearoa New Zealand. Data source: Drake et al. (2010).

Previous investigations have identified fish passage barriers to Lake Tuakitoto (Mitchell 1977). The outlet canal from Lake Tuakitoto has two barriers that can periodically block fish passage: a sill downstream from the lake outlet that controls lake levels, and the Kaitangata floodgates, which protect the surrounding reclaimed swampland when the Clutha River floods. The sill affects the passage of fish at low lake levels when outflow water levels recede below the level of the sill. The floodgates

can block fish passage when the gates are completely closed to prevent Clutha River floodwaters from entering the lake; however, it is expected this would be intermittent because one of the gates is normally left open to facilitate passage (ORC workshop, pers. comm., 26 May 2023). It is currently unclear if other aspects associated with these barriers, such as outflow velocities or the duration of low water levels, are impeding fish passage over the sill for significant time periods, and it was beyond the scope of this report to determine such aspects. Our review of fish catch records indicate that migratory species with limited or poor climbing ability, such as īnanga and common bullies, are in very low abundances in Lake Tuakitoto, which does indicate a fish passage issue. A further assessment and monitoring of fish passage around these two barriers is recommended to better understand how, and if, these barriers are continuing to significantly impede fish migration.



Figure 24. Aerial picture of Lake Tuakitoto (25 January 2023) during waterbird population monitoring showing the areal extent of surface growing benthic algal mats covering the lake. Source: lan Hadland, Otago Fish & Game.

### 2.7.3. Waterbirds

Populations of waterbirds are cited as an important value for Lake Tuakitoto, which has highly abundant waterfowl populations that provide recreational hunting opportunities on the lake. The lake also provides habitat for other rare waterbirds such as bittern, marsh crake / kotoreke and spotless crake / pūweto. Waterbirds can also have important effects on ecological dynamics in shallow lakes because some species are grazers and can recycle plant material and input nutrients back into the lake. In particular, black swans can have an effect on the standing stocks of aquatic plants by grazing (Mitchell et al. 1988). For very shallow lakes like Lake Tuakitoto,

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swans are able to graze over most of the lake surface and thus can have a strong effect on aquatic plant production when swan densities are high.

Otago Fish & Game have monitored black swan populations (as well as other game birds) in Lake Tuakitoto since the 1970s, with a regular January flight survey of bird numbers undertaken annually. Median abundances of black swans over the past 10 years of monitoring (2014–2023) were 130 birds (min. 15 birds, max. 450 birds; Figure 25). Interestingly, bird count data suggest black swan populations have been declining in the lake, with an annual decline of approximately 0.5% over the 50-year record. This could be related to decreases in the availability of palatable aquatic plants such as macrophytes in the Lake Tuakitoto, which were more abundant in the lake historically (Drake et al. 2010). Swan densities are on average 0.98 birds/ha, with maximum densities (in the past 10 years) of around three birds/ha. These densities are not considered high for South Island coastal lakes, but even at these moderate densities, swans can have a significant effect on aquatic plant production. Because aquatic macrophytes in Lake Tuakitoto are presently so sparse, swans could present some barrier to macrophytes re-establishing over larger areas; however, they are unlikely to be the cause of the decline. We suggest that it is more likely the dominance of macroalgal communities across the lake has resulted from increasing nutrient supply to the lake, rather than from swan grazing removing macrophytes.

It is unclear if macroalgae growing in Lake Tuakitoto provides a significant food source for black swans. However, given its widespread coverage of the lakebed, it seems to be the most readily available food source. The cyanobacteria species *Scytonema*, which is a highly abundant macroalgae in the lake, can produce compounds that may be toxic to swans. Although we do not regard controlling swans as a necessary step to improve the lake health of Lake Tuakitoto, reducing swan numbers could improve the success of macrophyte recolonisation. Establishing such a programme would require discussion amongst wildlife management authorities (Department of Conservation and Fish & Game New Zealand) and ORC.

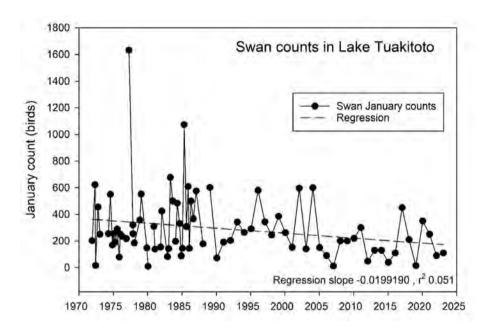


Figure 25. Annual counts of black swans in Lake Tuakitoto between 1973 and 2023. Also shown is a linear regression of counts over time suggesting approximately a 2% decline in numbers across the 50-year record.

## 2.8. Summary of key water quality and ecology findings

The following points summarise the key findings of historical water quality analyses for Lake Tuakitoto:

- Based on lake core data, sediment accumulation in Lake Tuakitoto has been low, with only 10–13 cm of deposited sediment over the past 180 years of European settlement.
- Water level fluctuations are high (> 1.8 m annually) relative to the lake's shallow mean depth of 0.7 m, but this is consistent with other shallow lakes with large catchments, and biota have likely adapted to such fluctuations. There was a trend indicating higher summer water levels in the past decade (2014–23) compared with previous records.
- Lake nutrient concentrations have been high for several decades and have
  increased moderately in the last decade. TN and TP concentrations are currently
  well in excess of the national bottom-line values set in the NPS-FM for the
  protection of ecosystem health. This is a result of high nutrient loads from
  inflowing tributaries (Lovells and Stony Creeks) that drain intensive farmland.
- More recently (since 2018) phytoplankton biomass has trended upward in the lake and now breaches the NPS-FM annual maximum guideline for chl-a. It is likely

that current growth rates of phytoplankton exceed the capacity of kākahi populations to filter algae from the water column. The relatively higher increase in chl-*a* has resulted both from increasing nutrient supply (bottom-up process) and further declines in kākahi populations (top-down process) in the lake.

- The relatively high P content of Lake Tuakitoto sediments, combined with the very
  high proportion of the redox-sensitive P fraction, the high potential release rates,
  and the downcore pattern in TP content, all indicate that significant internal P
  loading is likely occurring in the lake. This may be driven by high pH (> 9.2), which
  is observed in the water quality record and possibly the anoxic conditions near the
  lakebed.
- Increasing concentrations of DRP in Lake Tuakitoto, particularly during summer, is
  a worrying trend because it is a self-reinforcing (positive-feedback) process and
  can cause cyanobacterial blooms that could be harmful to lake ecological values
  and kākahi populations.
- Aquatic plant surveys in 2023 indicated limited or no submerged macrophytes species in the lake, and the benthic community is now dominated by thick growths of macroalgae, which is poor habitat for benthic biota. Based on a limited survey, macroalgae covered 69% of the lakebed and was dominated by the filamentous species *Spirogyra* sp. (Chlorophyta) and *Scytonema* sp. (Cyanobacteria), which are both known from other shallow Aotearoa New Zealand lakes and can proliferate to nuisance biomass (Vadeboncoeur et al. 2021). Extensive coverage by macroalgae is having a negative impact on benthic biota such as kākahi and is likely to be driving variations in pH and DO, which impact sensitive species such as fish and promote internal nutrient loading. Proliferation of macroalgae is likely to be primarily related to increasing nutrient loads to the lake, but grazing swans can also have a negative influence on aquatic macrophytes and can hinder macrophyte re-establishment.
- Surveys of kākahi indicate that abundances are continuing to decline in comparison to historical levels, with kākahi biomass in 2023 being 57% lower than in 2013, which had already declined from levels observed in the 1990s. The progressive trend for increasing kākahi shell size from 1991 to 2023 points to an ageing kākahi population that is not experiencing significant recruitment (breeding success) and will ultimately disappear unless conditions causing poor recruitment are not ameliorated. Poor recruitment is likely to be related to both poor lake water quality, a lack native host fish and macroalgae overgrowing suitable mussel habitat. Because of their very important role in filtering phytoplankton, kākahi are a critical to maintaining the water quality in Lake Tuakitoto, with the filtration rates declining to 43% of that in 2013 and now taking approximately 10 days to filter the lake water column.
- Fish surveys in 2023 found low abundances and diversity of native fish in Lake
   Tuakitoto and suggested that severe water quality conditions are preventing some
   species (common bullies, īnanga) from inhabiting the lake. Shortfin and longfin
   eels were the only species to occur at reasonable densities in Lake Tuakitoto,

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indicating poor fish community health by comparison to 22 other lowland coastal lakes. The low non-eel fish abundance results in a scarcity of hosts for the parasitic glochidia larvae of kākahi. Low abundances of native fish are also likely to be impacted by high European perch abundances in Lake Tuakitoto, with historical fish surveys indicating perch abundances were high compared to other lowland coastal lakes in Aotearoa New Zealand.

## 2.9. Proposed management options for Lake Tuakitoto

Previous community consultation around the values and aspirations for Lake Tuakitoto was facilitated by ORC in 2018. From information gathered during these consultation meetings, several lake restoration priorities were identified and written as objectives within the Tuakitoto management plan.

Objectives related to water quality and ecological health of the lake included:

- improving the water quality and meeting the national freshwater and ORC land and water plan standards in Lake Tuakitoto and the upstream catchment
- · improving biodiversity within the catchment
- · supporting a healthy ecosystem that sustains and enables mahinga kai
- improving water quality to support recreational fishing
- preserving and protecting the wetlands, rivers and streams, their margins and the saline environment to prevent further loss or degradation
- · encouraging and supporting soil conservation to minimise sedimentation
- maintaining and enhancing public access around Lake Tuakitoto
- ensuring that the existing kākahi beds present in the lake are enhanced and managed effectively
- promoting Lake Tuakitoto and encourage people to visit and use the lake
- · ensuring the management of the lake is influenced by good-quality science
- managing flood risk and land drainage for adjacent land.

Workshops with the community and stakeholders identified a range of rehabilitation priorities:

- riparian enhancement of catchment for water quality improvement
- excluding stock from lake margins
- creating wetlands and sediment traps (capturing silt)
- investigating fish passage options (Kaitangata locks fish ladder), spat ropes for culverts
- lake dredging sediment removal and creating deeper refuge areas

- maintaining minimum summer water level kākahi protection
- improving native fish habitat throughout the catchment giant k\u00f6kopu
- · researching freshwater mussel breeding
- · enhancing birdlife and waterfowl
- creating a pest management strategy for Canada geese, willow, glyceria, predators.

Based on our review of historical data, and investigations and understandings of ecological processes in Lake Tuakitoto, we propose four goals for managing stressors that would improve water quality and the ecological health of Lake Tuakitoto (Table 9). Some of these goals require multiple actions. While we have done our best to make recommendations using the best data available, in some cases further investigations need to be undertaken to support specific management actions. However, based on the reasonably good historical data availability and an understanding of appropriate restoration actions for shallow lakes (Abell et al. 2020), there was confidence in the recommended actions and their potential to achieve the goals.

#### 2.9.1. Management Goal 1: reducing stream nutrient loads in inflows

Nutrient loads to Lake Tuakitoto are high, and it is unlikely that the ecosystem health national bottom-line guidelines under the NPS-FM for TN (median 800 mg.m<sup>-3</sup>) and TP (median 50 mg.m<sup>-3</sup>) will be met unless significant stream remediation is taken in the inflow catchments to reduce nutrient loads. These understandings are based on 2012–13 monitoring data, and it is probable that loads are higher in 2023. At a workshop held at ORC (26 May 2023), it was signalled that further water quality monitoring in the inflow catchments by ORC is planned. Concentrations of TN and TP in lower portions of Lovells and Stony Creeks were high and are likely to be a major source of nutrient loads to Lake Tuakitoto. We see two options for reducing loads to the lake from the inflows:

- Divert greater proportions of combined flows from Lovells and Frasers Creek (yellow channel) into the wetland area to provide increased attenuation of nutrients prior to inflowing to Lake Tuakitoto. It is also recommended that the flows of Stony Creek be diverted through to the wetland area instead of their current flow directly to the lake.
- Increase riparian vegetation and enhance vegetation along upper portions of Lovells and Stony Creeks to reduce nutrient losses to the streams, potentially in conjunction with landowners developing farm plans.

Load-reduction targets for stream inflows were harder to ascertain because there was limited inflow data available to guide the prediction of the required load reductions. We estimated loads using two catchment models that predicted mean annual nutrient concentrations and flows for all stream reaches in Aotearoa New Zealand (Table 10).

The national CLUES model (V10.6; Woods et al. 2006) predicted relatively high loads of TN and TP to Lake Tuakitoto and suggested that current loads would need to be reduced by between 51% (for TP) and 69% (for TN) to meet NPS-FM bottom-line guidelines. These predictions are likely high given they overpredict current in-lake nutrient concentrations. The NZ River Maps model operated by NIWA predicted inflow concentrations that were more in-line with 2013 ORC monitoring 80th percentiles. The model also indicated around a 53% reduction in TN load is required to meet NPS-FM bottom-line lake standards, but that TP loads already meet these standards. The relatively low TP load predicted by NZ River Maps may be accurate, indicating that most of the TP in Lake Tuakitoto in excess of the 50 mg.m<sup>-3</sup> guideline results from internal loading processes. Load predictions using 2013 stream monitoring data collected by ORC for the lower Lovells, Frasers and Stony Creeks indicated potentially even lower load reductions may be required; however, this would not account for the high TN levels in Lake Tuakitoto, which are less likely to result from inlake nutrient loading processes. The differences between the load models suggests a moderate level of uncertainty for predicting inflow loads, and therefore nutrient and flow monitoring of inflow streams in their lower reaches (i.e. close to the lake) is recommended to better understand load-reduction targets.

Table 9. Predicted inflow nutrient concentrations by the CLUES (10.6) and NIWA NZ River Maps models, as well as the predicted in-lake values based on a mass balance model previously derived in a study of shallow coastal lakes for the South Island (Kelly et al. 2013). Also included in the table are reductions in loads necessary to meet NPS-FM lake bottom-line standards for TN (median 800 mg.m<sup>-3</sup>) and TP (median 50 mg.m<sup>-3</sup>).

	Inflow concentrations		Predicted in-lake concentrations		Estimated load reductions required to meet NPS-FM C band	
	TN (mg.m <sup>-3)</sup>	TP (mg.m <sup>-3</sup> )	TN (mg.m <sup>-3</sup> )	TP (mg.m <sup>-3</sup> )	TN reduction to meet NPS-FM 800 mg.m <sup>-3</sup>	TP reduction to meet NPS-FM 50 mg.m <sup>-3</sup>
CLUES model inflow mean	2,265	156.8	2,556	102.4	69%	51%
NIWA NZ River Maps inflow mean	1,508	57.3	1,702	49.1	53%	-2%
ORC Inflow monitoring 80th perc. 2012–13 (downstream sites)	868.1	50.8	868	50.8	8%	2%
ORC lake outflow median 2018–23			1,171	122.4	32%	59%

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#### Flow diversions

We see the current bypass of stream flows from Lovells and Frasers Creek via the drain as an opportunity to utilise ecosystem services the catchment already has available by diverting flows into the wetland (Figure 8). This may require altering drainage of the wetland so as not to encroach on adjacent pastoral land or potential purchases of pastoral land adjacent to wetland areas that could be affected. High water levels that exceed the upper limit of 101.4 m (above datum) more often occur in winter or spring. We anticipate that spring and summer will be the most important periods for diverting flows into the wetland, as these seasons are important for macroalgal growth. Limiting the extent of macroalgal development by reducing nutrients of inflows may be the only way to control macroalgae. Upgrading of the existing diversion gate at the head of the wetland was an important step for this process, as it allowed more automated control of water diverted into the wetland.

Flows from Stony Creek presently bypass the wetland area and are diverted directly to the lake via the diversion race. We would recommend this drainage is changed so that flows can be diverted, along with Lovells Creek and Frasers Stream flows, through the wetland area. Lower Stony Creek had high nutrient loads, suggesting diversion to the wetland could potentially reduce loads to the lake. An alternative to this option would be to re-align the existing diversion race to bypass the lake and input drainage of the race to the lake outlet canal. This would have the added value of being able to bypass high flows to the lake that would not normally be diverted to the wetland during higher flow periods because they would inundate neighbouring farmland.

When this option was initially considered, there was no nutrient data collected from within the wetland to quantify potential nutrient attenuation rates by the 365 ha wetland. We recommend monitoring water quality (specifically dissolved and total N and P and DO) at sites within the wetland (e.g. entrance and exit of flow) to better understand how effectively the wetland attenuates nutrients in inflows. The use of continuous monitoring sensors such as nitrate sensors could be highly effective for conducting such monitoring, given the difficult access to the site.

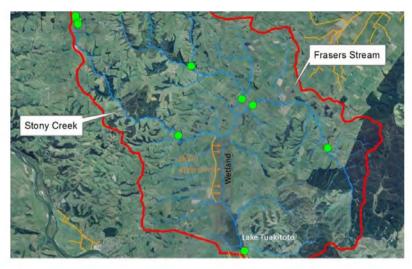


Figure 26. Lake Tuakitoto catchment showing the existing diversion of Lovells Creek into a drainage channel (yellow line) and potential points of flow diversions (orange arrows) into the wetland area located north of Lake Tuakitoto.

### Riparian management

Replanting of riparian zones along the lake tributaries could limit the extent of overland flow of P and sediment inputs to the lake. Stream water quality monitoring data indicated that the upper portion of Lovells Creek (particularly West Basin) and Stony Creek (upstream of Station Road) had some of the highest nutrient yields in the catchment. Actions could include:

- fencing of riparian margins of streams and the lake edge to discourage stock from directly accessing waterways
- enhancing stream and lakeside vegetation (e.g. toetoe or harakeke) along steeper banks to trap sediment prior to it entering the waterways
- replanting low-growing riparian vegetation along lake margins to encourage nutrient uptake of overland flow and shallow groundwater
- replanting native trees (in place of willows and pines) where shading or cover is
  desired, using species that are not seasonal in their growth and regeneration
  patterns (e.g. mānuka or kānuka) and do not generate large amounts of autumn
  leaf litter.

It is not expected that riparian enhancement alone would achieve the reductions in nutrient loads necessary to meet water quality guidelines for Lake Tuakitoto. From experience, riparian planting is likely to make only small improvements in inflow nutrient concentrations, most significantly for sediment and associated sediment-bound P. However, this is an important intervention to reduce erosion and the impact of heavy stock accessing the margins of tributaries and the lake.

#### Land-use management by farm plans

It is recommended that farm plans are developed or modified in order to identify ways to minimise nutrient losses to the lake. The plans should also consider inflow tributaries for farms bordering the lake and its tributaries. Freshwater farm plans will provide farmers with the flexibility to find the right solution for their farm and catchment, as well as encourage actions to reduce a farm's impact on fresh water, including calculations of nutrient losses to waterways through tools such as Overseer (Overseer Limited, https://www.overseer.org.nz). Freshwater farm plans will bring together many existing requirements and allow for better recognition of on-farm efforts to improve fresh water. Such plans can demonstrate how farms are meeting other regulatory requirements, including those below:

- National Environmental Standards for Freshwater 2020
- nitrogen-cap regulations
- · stock exclusion regulations
- · intensive winter grazing regulations
- · regional plans and consent requirements.

The extent of nutrient reductions to the lake required to meet plan standards is likely to be moderate (See Table 9). This may preclude consideration of converting some land parcels to other uses with lower nutrient losses, such as forestry, which already occurs in a small proportion of the catchment area.

## 2.9.2. Management Goal 2: controlling internal phosphorus recycling

Although reducing external nutrient loads to the lake (Management Goal 1) may reduce in-lake nutrients, legacy nutrients currently stored in lake sediments could potentially provide a source of P to the lake for decades, as observed in other catchment restoration projects (Søndergaard et al. 2013). Since about 2018, water quality conditions in Lake Tuakitoto have shown sharp rises in dissolved P consistent with internal recycling of P into the water column as DRP during summer. The timing of these events is associated with periods of high phytoplankton and benthic algal biomass in the lake, and generally occurs over peak productivity between December and March. However, mats die-off, and decomposition later in the summer / autumn period could also yield considerable inputs of dissolved nutrients to the lake. Limiting the extent to which DRP is recycled into the water column would further reduce summer algal blooms and lessen the risk of cyanobacterial blooms that could impact kākahi.

### Sediment capping

Sediment-capping agents have been used to reduce internal nutrient loads by strongly binding sedimentary P pools and reducing nutrient solubilisation during high pH or low DO events (Gibbs and Hickey 2018). Sediment capping involves creating a boundary layer of capping agent between the bed sediment and the water column. The use of

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active capping agents requires the formation of only a thin (e.g. 5 mm) layer of capping agent at the sediment surface, which inactivates P via metal binding (e.g. with iron, aluminium, lanthanum). The use of such agents has achieved good results internationally, especially in shallow lake systems. Active capping agents consist of more or less granular pellets, which are applied evenly over the lakebed to provide a 1–2 mm thick layer (Gibbs and Hickey 2018).

Passive capping involves the formation of a thick (1–8 cm), inert boundary layer on the surface of the bed sediment that reduces the flux of contaminants from sediment to water column to the rate of molecular diffusion (Hamilton et al. 2018). Numerous capping agents have been used including sand, gravel and clay and more recently, local soils modified with various additives such as chitosan (Pan et al. 2012). The disadvantage of these types of capping agents is the potential effect on benthic fauna from depositing so much material on the lakebed (Hamilton et al. 2018). In addition, multiple applications of passive and active capping agents may be required, as continued sedimentation buries capping layers and, in the case of active agents, binding capacity becomes saturated.

However, the use of geochemical capping agents in Lake Tuakitoto raises several concerns regarding how effective they might be for controlling internal nutrient loading. This includes:

- 1. Shallow lake depth throughout could mean that the cap is regularly disturbed by wind-wave resuspension and thus have inconsistent effects.
- 2. Thick benthic algae could reduce the effectiveness of capping agents in forming a cohesive capping surface over the sediment.
- 3. Capping agents could potentially harm kākahi both from direct contact and ingestion.

It should be noted that all the P-inactivation techniques described relate to controlling P release to the water column with a view to managing planktonic algae. No research literature was found on the use of P-inactivation agents for the control of benthic algal mats. In addition, the effectiveness of various P-inactivation agents can be influenced by other water chemistry parameters such as alkalinity (Gibbs and Hickey 2018). Further field investigation possibly using mesocosm trials could aid understanding the effectiveness of capping agents in Lake Tuakitoto. Further information would also be needed on sediment properties (grain size, P content, sediment oxygen-demand) as well as on DO and pH dynamics in the lake during periods of high risk of internal loading (January to March). This data would provide a better understanding of processes that drive such internal recycling and control interventions. The effects of capping agents on kākahi populations in the lake are uncertain and further investigation on this may also be required (Tempero 2015).

#### Controlling macroalgae

Our analyses of water quality data suggests that macroalgae are likely to be the main factor controlling internal recycling of nutrients from sediments into the water column. This is driven by creating physico-chemical conditions that drive solubilisation of P (Wood et al. 2015), but it also occurs when mats are dislodged (or float) from the bed and accumulate at the water surface where they decompose. We suggest that reducing the extent of macroalgae cover and biomass would reduce the magnitude of internal loads.

There is limited research on the control of benthic mats in temperate lake systems in Aotearoa New Zealand (Wood et al. 2012). Work on urban-lake or farm dams has shown benthic algae can be controlled using herbicides (Sink 2014). However, at a larger scale, the use of herbicides is probably impractical. Nutrient load reduction is likely the most practical method for controlling macroalgal proliferations. However, mechanical methods to reduce macroalgal biomass could be employed on a short-term basis. This could consist of suction dredging areas of the bed (Figure 27), or mechanically raking the material off the bed. Collection (or suction dredging) of floating macroalgal material would be beneficial because as this material decomposes it directly contributes nutrients to the water. Mechanical harvesting or suction dredging over larger areas of the lake would be a large undertaking and potentially require a harvester specially designed for the lake. A separate dewatering and composting facility would also need to be constructed.

A better understanding of macroalgae seasonality, biomass / cover, and accrual rates are needed to better evaluate this option and determine how rapidly mats would regrow in the lake should harvesting occur. Our expectation is that macroalgae mats represent several years growth, but this is based only on observations from other deep lakes (Kelly et al. 2017).





Figure 27. Floating suction dredge barge operating on Lake Wanaka (left) – used for removing invasive plants (*Lagarosiphon major*); divers operating the dredge at the lakebed (right). Photos: David Kelly, Cawthron.

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#### 2.9.3. Management Goal 3: improving kākahi recruitment

Kākahi populations in Lake Tuakitoto enhance water quality by grazing on phytoplankton biomass. Based on monitoring data collected between 1991 and 2023, kākahi abundances have declined by over 85% in Lake Tuakitoto. Water quality data indicate that phytoplankton biomass has markedly increased over this period, suggesting a reduction of kākahi grazing. Declines in kākahi appears to be mostly related to poor recruitment (i.e. reproductive success), with its current population comprised of large-shelled, mature individuals. A previous hypothesis that kākahi declines were related to unusually low summer water levels between 2002–2012 is unlikely to explain the reduction in kākahi (Ozanne 2014). We suggest that the combination of degraded water quality with high variation in DO and pH, the smothering of benthic habitat by macroalgae and the low abundances of hosts for glochidia are the most likely causes of continued declines in kākahi. It is not certain which of these factors is most affecting kākahi and a more detailed population study is required to answer such questions.

While Management Goals 1 and 2 address the water quality and macroalgae issues that are likely to negatively affect kākahi, we recommend that actions are taken to improve bully and galaxiid glochidia host abundances. High abundances of European perch are likely to be substantially reducing native fish populations through predation and competition (McDowall 1987). Perch appears to have a strong effect on native fish populations (common bullies, īnanga, kōaro) in Lake Tuakitoto, with no bullies or galaxiids found in a survey conducted in 2006, and very low abundances of these found in 2023. We suggest that controlling perch populations in the lake could improve kākahi recruitment by improving native fish populations. This could consist of a mix of measures including gill netting of adult perch and juveniles. Perch spawn on hard substrates on lake margins, and the use of removable hard structures to attract perch spawning has been experimentally tested as a way of reducing perch spawning success. We suggest that a range of measures are undertaken as part of an enhancement plan for Lake Tuakitoto.

Monitoring of both native fish communities and kākahi in Lake Tuakitoto would clarify and confirm the need for perch control. However, given that perch are a sport fish species managed by Fish & Game New Zealand, it could be timely to discuss such options as part of a wider fish management plan. The Department of Conservation may also provide input on ways to enhance native fish species and control exotic perch populations.

### 2.9.4. Management Goal 4. Fish passage

Previous investigations have identified fish passage barriers to Lake Tuakitoto (Mitchell 1977). The scarcity of native fish hosts (mainly common bully and īnanga) for kākahi glochidia could be an important factor contributing to the decline of kākahi in Lake Tuakitoto. However, the extent to which operations of the existing control

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structures affect fish passage in and out of Lake Tuakitoto is uncertain. For instance, the outlet sill that regulates lake levels can hinder fish passage in and out of the lake when lake levels are low and may restrict the passage of poor climbing species such as īnanga and common bullies (Kelly and McDowall 2004). The Kaitangata locks, which protects the surrounding reclaimed swampland when the Clutha floods, can block fish passage intermittently when the gates are completely closed, but a gate is normally left partially open to facilitate passage. However, it is unclear if other aspects associated with the lock, such as outflow velocities around the gates, are impeding fish passage for poorer swimming species over longer periods.

We recommend a detailed review of the fish passage structures to explore potential mitigations if the barriers are impeding fish migration. This would likely include installation of a passage structure around the sill for low water level passage. The use of hydroacoustic cameras that can effectively monitor fish moving around, or over, structures could be beneficial (e.g. Kelly et al. 2019). This review should also investigate key migration periods when special management of fish passage infrastructure would be beneficial.

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#### 3. TOMAHAWK LAGOON

## 3.1. Background on Tomahawk Lagoon

The Tomahawk Lagoons comprise a coastal aquatic system encompassing a small catchment on the southern side of the base of the Otago Peninsula (Figure 28). Two standing waterbodies are referred to as the Tomahawk Lagoons: (1) the eastern or Upper Tomahawk Lagoon, which is a freshwater lake, and (2) the western or Lower Tomahawk Lagoon, which is a brackish, impounded, intermittently closed estuary that also resembles a shallow lake / lagoon (Table 11). Upper Tomahawk Lagoon is also sometimes referred to as Tomahawk Lagoon #2. The two lake / lagoon systems are connected by a short channel, which discharges to the lower lagoon via a weir and restricts drainage of the upper lagoon. Background morphological information on the lagoons is presented in Table 11.

Lagoon Creek drains the eastern part of the catchment into the upper lagoon, while an unnamed creek drains the western catchment into the northern end of the lower lagoon. Other creeks and drainage features in the catchment are ephemeral. The outlet of the lower lagoon discharges to the sea across Tomahawk Beach. Due to variations in outflow discharge and sand accretion on the beach, the outflow is often blocked by sand, causing the level of the lower lagoon to rise. The outlet is sometimes artificially opened to prevent the flooding of land and infrastructure. This allows for migration of fish and invertebrates into and out of the lagoon system. When the lagoon is open to the sea, saline intrusions can occur whereby high tides and storm surges flow into the lagoon, which cause a rise in the lagoon's salinity and often result in the deposition of kelp and other seaweeds.

The lagoons are managed by the Department of Conservation as a Wildlife Management Reserve. Fringing wetland areas in both lagoons are protected under a QEII covenant. Under the Dunedin City Council's District Plan, the area is described as a lowland lake with reed swamp, being of local and regional significance. ORC recognises the lagoon area as a Schedule 9 Regionally Significant Wetland due to:

- it being a habitat for nationally or internationally rare or threatened plant species or communities (e.g. Isolepis basilaris), and naturally uncommon plant species (e.g. Althenia bilocularis, Lilaeopsis novae-zelandiae, Myriophyllum triphyllum, Limosella lineata)
- it exhibiting a high degree of wetland naturalness
- · it being unique in Otago in terms of its ecological or physical character
- it being a regionally significant wetland habitat for waterfowl, waders and native fish (https://www.orc.govt.nz/managing-our-environment/water/wetlands-andestuaries/dunedin-district/tomahawk-lagoon).

Otago Fish & Game manages Upper Tomahawk Lagoon as a brown trout (*Salmo trutta*), rainbow trout (*Oncorhyncus mykiss*), and European perch (*Perca fluviatilis*) fishery by stocking the lake with mature trout. Perch are self-sustaining in the lake. As such, the lake is a valued sports fishery in the Dunedin region.

Over the years, the lagoons have been shaped and constrained by various activities including:

- the infilling of wet shoreline areas (especially on the south side of the upper lagoon)
- the dredging of part of the upper lagoon to increase water depth
- the installation of the weir between the two lagoons to maintain a higher water level in the upper lagoon
- · the physical constraining of the outlet of the lower lagoon by roading
- the building of houses and infrastructure on the floodplain of the lagoons.

Table 10. Background information on the Upper and Lower Tomahawk Lagoons and their catchments. Data sources: Google Maps™, the Freshwater Environments of New Zealand (FENZ) database and Marc Schallenberg's personal observations.

	Upper Tomahawk Lagoon	Lower Tomahawk Lagoon
Northing	-45.90126	-45.90066
Easting	170.55093	170.54279
Altitude (MASL)	approx. 1.0	< 1.0
Type of waterbody	Eutrophic shallow lake (sand dune formation)	Eutrophic intermittently closed estuary (sand dune formation)
Surface area (ha)	10.2	18.7
Maximum depth (m)	approx. 1	< 1.0
Catchment area (ha)	185	243
% catchment area urban	2.9	14.4
% catchment area grassland	74.1	66.1
% catchment area shrubland	3.7	0.9
% catchment area exotic forest	13.5	10.0
% catchment wetland	0	0.7
% catchment area water	5.8	8.0



Figure 28. Topographic map of the Tomahawk Lagoon system and its catchment. Upper Tomahawk Lagoon drains into Lower Tomahawk Lagoon.

# 3.1.1. Management issues

A range of management issues have been identified for the Tomahawk Lagoons (previously listed in Section 1.2). Algal blooms in the Tomahawk Lagoons have been linked to catchment nutrient loads. Land use within the catchment has been altered over time with the removal of native vegetation and an associated increased in soil erosion within the catchment. Algal blooms were reported in Upper Tomahawk Lagoon as early as the late 1960s (Mitchell 1989).

Sediment infilling was recognised as a problem by Otago Fish & Game, which deepened the upper lagoon by dredging with the aim to improve the sports fishery of the lake. In addition, some concern has been expressed regarding the proliferation of *Typha orientalis* (raupō) at the western end of the upper lagoon, which has been associated with sediment infilling upstream of the weir.

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Stormwater inflow from urban areas contains contaminants that could negatively impact the ecology of the lagoons. ORC issued a resource consent to the Dunedin City Council relating to stormwater discharge from urban areas to the lagoons. The resource consent requires measurement of the chemical composition of the stormwater effluent to the lagoons as well as the assessment of potential impacts on the lagoons of stormwater discharges.

Locals have described significant historical water level variations in the lagoons. For example, at times in the past, the Ocean Grove Domain Board Hall has been flooded. On the other hand, during dry summers, the water levels of the two lagoons can recede, such that a substantial amount of the southern end of the lower lagoon can become stranded above the normal lake lagoon water level. The presence of such water level variations has drawn attention to the regulation of water levels in the system, which is accomplished by the artificial opening of the lower lagoon's mouth when rising water levels threaten to flood land.

The above issues have prompted ORC to undertake community consultations to help identify values, issues and potential solutions. The outcomes of these consultations were summarised in three unpublished documents (ORC pers. comm.). One of the priority actions identified by the community was to undertake an ecological assessment of the Tomahawk Lagoon system. The remainder of this report provides: (1) a scientific perspective on the ecological condition of the Tomahawk Lagoons and (2) a list of recommended ecological restoration actions.

## 3.2. Tomahawk Lagoon catchment

The Tomahawk Lagoon system drains a catchment that primarily comprises hilly low intensity agricultural land, which is mainly used for sheep grazing (Figure 29). There is some exotic forestry in the catchment of both lagoons, although it is more prevalent in the catchment of the upper lagoon. Some native bush and scrub is also found in these catchments, but the dominant land cover is grassland. Urban areas cover 14% of the catchment of the lower lagoon and 3% of the catchment of the upper lagoon. Each of the lagoons has one main inflow and a number of ephemeral streams that carry water to the lagoons mainly during substantial rain events. Mean annual rainfall at the Musselburgh weather station near to the lagoons is 787 mm and exhibits no seasonality. However, strong seasonality in evaporation results in catchment run-off being generally higher in winter than it is in summer.



Figure 29. Satellite image of the Tomahawk Lagoon system and its catchment, showing variation in land cover

Drainage water from urban areas is collected by stormwater systems, which have two main discharge points, one on each of the lagoons. There are numerous smaller stormwater discharges evident along the south shore of the upper lagoon.

The low intensity agriculture in the catchment employs some fertiliser top-dressing (Marc Schallenberg, pers. obs.). In addition, piggery waste is imported and spread into the upper catchment of the upper lagoon. ORC deems this a permitted activity, although discharge regulations state that such waste cannot be distributed within 50 m of a waterbody. Presumably, Lagoon Creek qualifies as a waterbody and, therefore, discharge regulations should apply to this activity.

# 3.3. Tomahawk Lagoon palaeohistory

When developing a lake restoration plan, it is useful to determine appropriate restoration targets. To understand the range of potential restoration targets and trajectories, it can be helpful to understand the time frame and trajectory of lake degradation that has occurred. This can also reveal information on key drivers of degradation – stressors that may need to be mitigated to improve the condition of the lake. The Lakes380 research programme (led by Geological and Nuclear Sciences and Cawthron) was designed to infer the historical conditions of lakes based on information obtained from palaeoecological analysis of sediment cores. Sediment cores were obtained from both the Upper and Lower Tomahawk Lagoons. The cores

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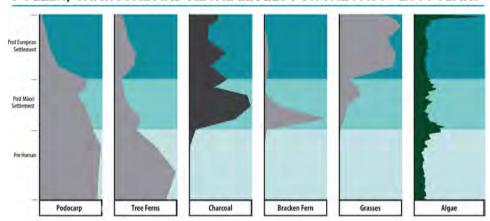
were dated using pollen preserved in the sediments as well as the radionuclides <sup>210</sup>Pb and <sup>14</sup>C. In addition, a variety of analyses were undertaken to help infer and reconstruct historical conditions in the lagoons.

This report discusses inferences based on the palaeolimnological data that reveal historical dynamics of lake productivity, submerged aquatic macrophyte occurrence over time and sediment infilling rates. Information on all three attributes is available for Upper Tomahawk Lagoon, whereas only information on the dynamics of sediment infilling is available for Lower Tomahawk Lagoon. The Lakes380 factsheet produced for the upper lagoon illustrates a pattern that was commonly observed by the Lakes380 programme in lake sediments from regions of Aotearoa New Zealand that had undergone deforestation and conversion of land cover from native vegetation to productive grassland pasture (Figure 30).

The general pattern, also illustrated by the upper lagoon in Figure 30, shows a decline in native trees (e.g. podocarps) and forest plants (e.g. tree ferns) initiated soon after the time of Māori settlement and corresponding with an increase in charcoal and bracken fern spores, which indicate that fires were common in the landscape. Subsequently, pollen from grasses becomes dominant, showing the landscape transitioned to largely agricultural areas following the arrival of European settlers. Algal pigments provide an indication of the algal productivity in the lake. However, interpretation of the algal pigment data must be carried out with caution because pigments likely degrade with age of deposition, and in lakes as shallow as Upper Tomahawk Lagoon, our analysis of algal pigments could not distinguish between the presence / abundance of phytoplankton and benthic microalgae. In Upper Tomahawk Lagoon, the algal pigments show three peaks over time: one at the sediment surface (most recent sediments), one near the beginning of the time of European settlement, and one near the beginning of Māori settlement. It is interesting to speculate why algal pigments increased during these eras, and examination of the historical dynamics of submerged macrophytes would be a useful parallel analysis.

The data in Figure 31 show the historical dynamics of four different macrophyte indicators: (1) the pollen *Potamogeton* sp., (2) the pollen of *Myriophyllum* sp., (3) the seeds of *Ruppia* sp., and (4) the oospores (propagules) of charophytes. These macrophyte indicators show two historical periods of macrophyte abundance in the lake, one period during the time of Māori settlement and one period during the period of European settlement from the 1950s to the early 2000s. The periods of macrophyte abundance occurred when algal abundance was relatively low, suggesting an alternating abundance of macrophytes and algae in the lake, with at least two long cycles of alternating states going back to the early stage of Māori settlement. Periods when macrophyte abundance was low corresponded to periods when algal pigments rose above baseline levels.

# POLLEN, CHARCOAL AND ALGAE LEVELS FOR THE PAST ~2000 YEARS



This graphic indicates the concentration of plants, charcoal or algae through time.

www.lakes380.com

Figure 30. Selected palaeolimnological data from Upper Tomahawk Lagoon, showing patterns of catchment and in-lake changes as a result of Māori and European land-use practices.

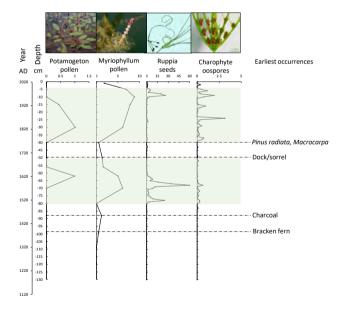


Figure 31. Submerged macrophyte indicator abundances going downcore and back in time. The abundance numbers are % of total pollen for the pollen data and seed and oospore counts per unit sample fresh mass. Green shading represents the inferred historical periods of macrophyte abundance in the lake. The dashed horizontal lines show when terrestrial plant indicator species first appeared and where charcoal and bracken ferns show substantial upward increases in the sediment record.

The most recent sediments show another peak in algal pigment concentration, which also seems to correspond with a recent decline in submerged plant indicator abundance, further supporting the hypothesis that periods of algal dominance and macrophyte dominance alternated twice in this lake over the time period represented in the sediment cores. Alternative stable states have been described for many shallow lakes in Aotearoa New Zealand (Schallenberg and Sorrell 2009) and elsewhere (Scheffer 2004) and were identified as a dynamic for Upper Tomahawk Lagoon in the late 1960s and early 1970s (Mitchell 1989).

The rate of sediment infilling in Upper Tomahawk Lagoon has increased in recent times to 5.2 mm yr<sup>-1</sup> from a prior mean sediment infilling rate of 1.1 mm yr<sup>-1</sup> (Figure 32). The recent high sediment infilling period occurred from c. 1937 to the present, whereas the mean rate is estimated to be 1.1 mm yr<sup>-1</sup> from c. 1407 to c. 1937. Prior to c. 1407, the sediment infilling rate was calculated to be 1.5 mm yr<sup>-1</sup>. This suggests an increase in sediment transport from the catchment to the lake began just before WWII. However, the estimated date of change is somewhat uncertain, and could reflect the post-war period of rapid intensification of agriculture due to the onset of top-dressing and the use of efficient tractors and other agricultural technologies. This post-WWII increase in soil erosion and fertiliser use initiated a period known as the great acceleration when anthropogenic pressures on the environment increased rapidly in Aotearoa New Zealand and in many other parts of the world (Steffen et al. 2015).

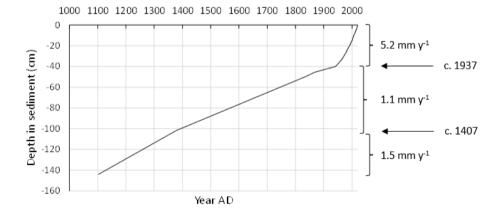


Figure 32. Age-depth model for Upper Tomahawk Lagoon showing inferred average sediment infilling rates. Rates have not been corrected for dewatering and, therefore, somewhat exaggerate increases in particulate matter deposition in recent times.

#### **Lower Tomahawk Lagoon**

Calculated sediment infilling rates in Lower Tomahawk Lagoon did not show significant changes over historical time (Figure 33). The rates calculated throughout the core were approximately the same as the rates in Upper Tomahawk Lagoon prior to c. 1937, falling between 1.0 and 1.9 mm yr<sup>-1</sup> (uncorrected for dewatering).

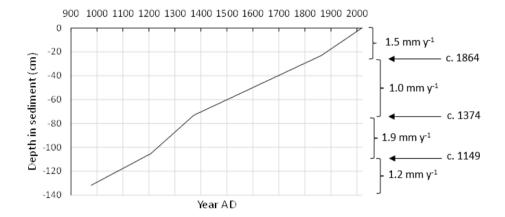


Figure 33. Age-depth model for Lower Tomahawk Lagoon showing inferred average sediment infilling rates. Rates have not been corrected for dewatering.

#### 3.3.1. Palaeohistory analyses conclusions

In summary, the palaeolimnological data seem to indicate that the upper lagoon underwent historical transitions between phases of macrophyte abundance and phases of phytoplankton or benthic algal abundance. The macrophyte phases lasted 200 to 300 years, and the earliest recorded phase in the sediment record began after Māori settlement. During the period of early European settlement, macrophyte abundance declined, but then increased again in the 1950s and has persisted until the most recent sediment stratum was deposited. In the most recent sample, the abundances of all indicators of macrophyte declined while algal pigments increased. This could signal the beginning of another shift towards algal dominance. The age-depth model suggests that following a fairly stable and low rate of infilling over many centuries, sediment infilling has increased markedly since the 1950s.

The age-depth model for the lower lagoon did not show the same recent increase in sediment infilling rate, suggesting that the increasing erosion rate affecting the upper lagoon did not impact the lower lagoon. Alternatively, the increase in infilling in the upper lagoon may reflect the result of dredging and / or land reclamation activities, which were not undertaken at the lower lagoon.

## 3.4. Current ecological condition

The assessment of the condition of the Tomahawk Lagoons benefits from a wealth of studies and monitoring that has been undertaken since the 1960s. Most of the ecological studies are components of major, multi-year research efforts (Figure 34).

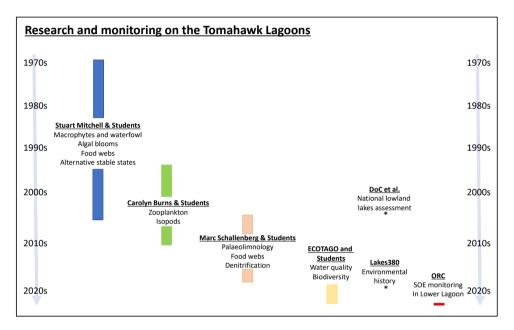


Figure 34. Historical summary of major research and monitoring programmes undertaken on the Tomahawk Lagoons. The asterisk (\*) indicates one-off sampling of the lagoons as part of multi-lake studies.

Previous studies on both the upper and lower lagoons have identified these lakes as 'nutrient enriched' (Crawshaw et al. 2018), 'hypertrophic' (Mitchell et al. 1988; Crawshaw et al. 2019) and 'highly eutrophic with frequent algal blooms' (Mitchell 1989). McKinnon and Mitchell (1994) described the trophic state of Upper Tomahawk Lagoon: 'extreme variations in apparent trophic status of Tomahawk Lagoon No. 2 (i.e. the upper lagoon) can be seen from the wide range of annual average phytoplankton chlorophyll a and euphotic depths ( $Z_{\text{eu}}$ ) in different years.' This highlights the characteristic alternation between a clear water, macrophyte-dominated state and a turbid, phytoplankton-dominated state. It is difficult to assess the ecological condition because the water quality, food webs and the influences of other stressors are affected by the large variation in macrophyte abundance that characterises the upper lagoon, and possibly also the lower lagoon (although this dynamic has not been studied as thoroughly in the lower lagoon).

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## 3.5. Water quality

ORC has not historically monitored the Tomahawk Lagoons as part of its state of the environment monitoring programme for lakes. The only available datasets for which the ecological condition of the lagoons can be compared to the ORC Water Plan guidelines and NPS-FM limits (see Table 2) is the dataset belonging to the Ecotago citizen science project. The Ecotago monitoring programme was not designed to thoroughly assess the condition of the lagoons in relation to the guidelines, but some of the attributes monitored can be used to provide an assessment against some of the guidelines. Ecotago have produced two report cards that assess data from multiple sites in both lagoons and in inflowing creeks against the NPS-FM and ORC Water Plan guidelines. The results of these assessments are reproduced in Figure 35.



# b. 2019

Results								
Site	Nitrogen*	Phosphorus	Algae	Max Algae	Turbidity	E. coli		
Creek (Site 3a)	n/a	Fail	-		Fail	Fail		
Creek (Site 6)	n/a	Fail		-	Fail	Fail		
Upper Lagoon (Site 1)	n/a	Fail	C	С	Fail	Fail		
Upper Lagoon (Site 2)	n/a	Fail	C	c	Fail	Fail		
Lower Lagoon (Site 4)	n/a	Fail	C	С	Fail	Fail		
Lower Lagoon (Site 5)	n/a	Fail	C	c	Fail	Fail		

<sup>\*</sup> Some extremely high numbers at all sites. This means that excel couldn't calculate the 80th percentile. The data was

All results were compared with the Otago Water Plan Receiving Water limits, except for Algae and Max Algae which were graded based in the the guideline values found in the National Policy Statement for Freshwater Management (NPSFM).

# c. 2018

Results								
	Nitrogen	Phosphorus	Algae	Max Algae	Turbidity	E. coli		
Creek (Site 3)	Fail	Fail	-	-	Fail	Fail		
Upper Lagoon (Site 2)	Fall	Fall	C	D	Fall	Fall		
Upper Lagoon (Site 1)	Fail	Fail	C	D	Fail	Fail		
Lower Lagoon (Site 4)	?*	Fail	c	c	Fail	Fail		
Lower Lagoon (Site 5)	2*	2**	c	C	Fail	Fail		

All results were compared with the Otago Water Plan Receiving Water limits, except for Algae and Max Algae which were graded based on the guideline values found in the National Policy Statement for Freshwater Management (NPSFM).

Report cards for the Tomahawk Lagoons and inflow creeks from data collected in 2019 Figure 35. (b) and 2018 (c). Source: https://tomahawkcitizenscience.com/results/report-cards

measured whereas limits contained in the Otago Water Plan are for Total Nitrogen.

We are unable to determine a result as Nitrate-N was \*\* We are unable to determine a result as Dissolved reactive phosphorus was measured whereas limits contained in the Otago Water Plan are for Total Phosphorus.

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These report cards show that the lagoons and creeks all breached some of the water quality guidelines in the 2 years they were assessed. All sites consistently failed to meet the *E. coli* and turbidity guideline thresholds in the ORC Water Plan. The upper lagoon failed the NPS-FM 95th percentile phytoplankton (i.e. chl-a) guideline in 2018, but both lagoons achieved the 'fair' category (i.e. C) for the annual median in both years, while the lower lagoon also achieved the fair category for the 95th percentile in 2018. For N and P, the Ecotago team measures DRP and nitrate, whereas both the ORC Water Plan and the NPS-FM guidelines stipulate thresholds for TN and P. However, the ORC Water Plan thresholds for DRP almost always exceeded the TP guideline at all sites, allowing an assessment of 'fail' against this guideline. Nitrate levels did not exceed the ORC Water Plan guidelines for TN; therefore, Ecotago was unable to assess the water quality based on TN guidelines.

Ecotago's assessments clearly support the previous qualitative work undertaken by experts, which demonstrated that these lakes exhibit signs of eutrophication. The assessments also support the ongoing efforts made by the community and ORC to develop a restoration plan for these lakes and their catchments.

### 3.5.1. Dissolved nutrients

Lagoon dissolved nutrient concentrations have been monitored in both the Upper and Lower Tomahawk Lagoons by Ecotago since 2016. Figure 36 shows the Ecotago data for DRP in the lagoons and inflow creeks. The 80th percentile of these data exceeds the ORC Water Plan guideline, especially for the lower lagoon and for the inflow streams. TP concentrations in the lakes would have been even higher than the DRP data shown; therefore, the comparison of the lake data against the guideline is a conservative assessment of the situation with regard to TP.

In the lakes, the DRP concentrations seem to peak in summer and show a relatively consistent seasonality, with no apparent trend over the entire time series. Some seasonality is also apparent in the creek data, whereby levels in winter are generally lower than levels in summer.

Ecotago's data on nitrate-N is shown in Figure 37. The ORC guideline for lakes is based on TN. Therefore, an assessment of lake levels against the guideline cannot be made because the TN levels would have been higher than the nitrate levels measured. However, the data for the inflow creeks shows that nitrate-N concentrations in the inflows far exceed the nitrate guideline for rivers (80th percentile of the data). In particular, Lagoon Creek, which drains into the upper lagoon, often far exceeds the ORC nitrate guideline, sometimes over 50-fold. In fact, nitrate-N levels in this creek sometimes exceed the NPS-FM nitrate toxicity national bottom lines (the guideline annual median is 2400 mg.m<sup>-3</sup> and the 95th percentile is 3500 mg.m<sup>-3</sup>), highlighting that nitrate levels in this creek are often extremely high. In general,

nitrate-N levels in Lagoon Creek far exceed those in the creek flowing into the lower lagoon (Figure 13).

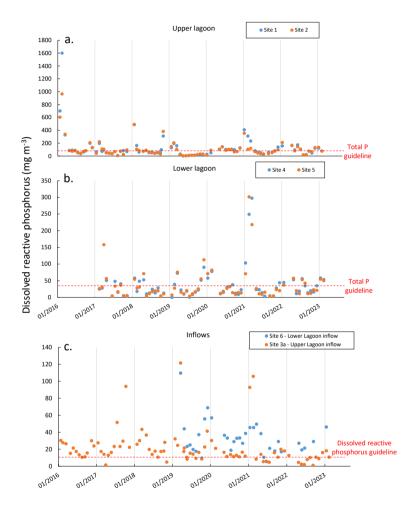


Figure 36. Dissolved reactive phosphorus concentrations in the waters of the Upper (a) and Lower (b) Tomahawk Lagoons and the inflow creeks (c). The horizontal red lines are the Otago Regional Council Water Plan guidelines (Otago Regional Council 2022) for total phosphorus (a and b) and for dissolved reactive phosphorus (c) (80th percentile). The NPS-FM total phosphorus national bottom line for these lakes is 50 mg.m<sup>-3</sup> (not shown), which is higher than the Otago Regional Council Water Plan guideline of 33 mg.m<sup>-3</sup>.

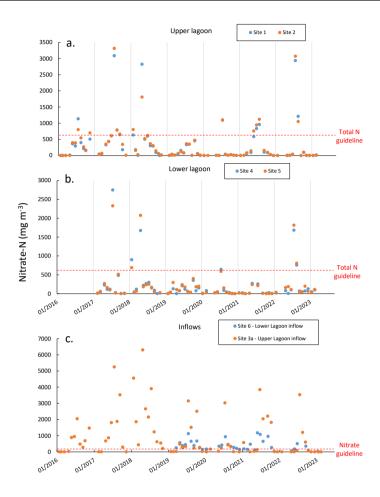


Figure 37. Nitrate-nitrogen (N) concentrations in the waters of the Upper (a) and Lower (b) Tomahawk Lagoons and the inflow creeks (c). The horizontal red lines are the Otago Regional Council Water Plan guidelines (Otago Regional Council 2022) for total N (a and b) and for nitrate-N (c) (80th percentile). The NPS-FM nitrate-N national bottom lines (toxicity) for rivers are 2,400 mg.m<sup>-3</sup> (annual median) and 3,500 mg.m<sup>-3</sup> (95th percentile). The creek flowing into the upper lagoon sometimes exceeds these values. The NPS-FM total N national bottom lines for these lakes are 750 mg.m<sup>-3</sup> for the lower lagoon and 800 mg.m<sup>-3</sup> for the upper lagoon (not shown), which are higher than the Otago Regional Council Water Plan guideline of 550 mg.m<sup>-3</sup> for these lakes.

## 3.5.2. Phytoplankton biomass

Phytoplankton biomass has been monitored as chl-*a* in both Upper and Lower Tomahawk Lagoons by Ecotago since 2016. Ecotago's data from 2016 to 2023 indeed show that between these years, phytoplankton biomass varied greatly in the

lake, with generally low levels in Upper Tomahawk Lagoon; however, for some periods, the levels did exceed the annual maximum threshold defined in the NPS-FM (Figure 38). While some samples showed elevated levels of chl-a, there was little evidence of a prolonged period of high algal biomass during this period, apart from during the spring and summer of 2019/20. At this time, there was no public notification of algal blooms, suggesting that cyanobacterial taxa were not dominant (there are no phytoplankton cell counts available for this period). However, the 2019/20 event was a seasonal bloom and did not persist for multiple years, unlike earlier reports of Upper Tomahawk Lagoon (e.g. Mitchell 1989).

Chl-a levels were generally higher in the Lower Tomahawk Lagoon than the upper lagoon, although the algal bloom did not achieve levels as high as those in the upper lagoon (Figure 38). Again, these data show no evidence of persistent blooms lasting multiple years. As shown in the Ecotago report, both lakes exceeded the NPS-FM annual maximum national bottom-line guideline in some years, but the annual median national bottom-line guideline seems to have been met in most years.

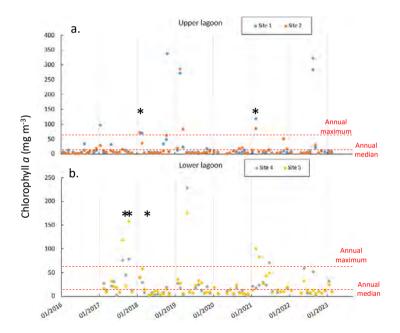


Figure 38. Chlorophyll-a concentrations in the waters of the Upper (a) and Lower (b) Tomahawk Lagoons. The horizontal red lines are the national bottom-line guidelines from the NPS-FM (Ministry for the Environment 2022). Asterisks are times when public notifications of cyanobacterial blooms were issued by the Otago Regional Council.

### 3.5.3. Water clarity

Lake clarity has been monitored as turbidity in both the Upper and Lower Tomahawk Lagoons and their inflows by Ecotago since 2016. Figure 39 shows the turbidity data time series for the upper and lower lagoons and for the inflow creeks. Turbidity exceeded the ORC guidelines at all the monitored sites. The turbidity data for the lagoons showed multi-year, alternating phases of low and elevated turbidity (e.g. mid-2017 to mid-2019 in the upper lagoon) interspersed by phases of clearer water (e.g. mid-2019 to early 2021). Turbidity in the creek entering the upper lagoon appears to have decreased markedly after 2018.

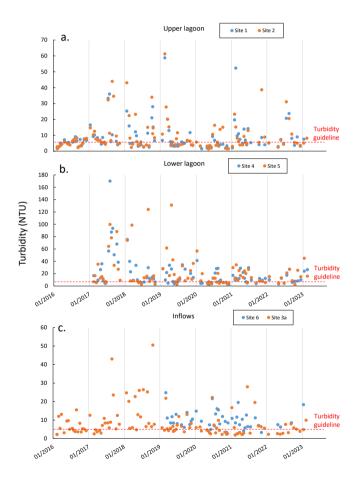


Figure 39. Turbidity in the waters of the Upper (a) and Lower (b) Tomahawk Lagoons and the inflow creeks (c). The horizontal red lines are the Otago Regional Council Water Plan guidelines (Otago Regional Council 2022) for turbidity (80th percentile).

### 3.5.4. Sediment geochemistry

Historical nutrient loads from the catchment can be deposited in the lakebed due to the binding of P to particulate matter and its sedimentation. Nutrients can then desorb or be mineralised from the sediment and may diffuse back into the water column under certain conditions (e.g. under anoxia, during microbial mineralisation, and / or under high pH conditions). In addition, bioturbation and wind-induced sediment resuspension can resuspend particle-bound nutrients and entrain nutrients dissolved in pore water. Furthermore, macrophyte roots can obtain nutrients from lakebed sediments, translocating N and P to the plant tissues. These legacy nutrients are recycled back into the water column if the plant tissues are eaten and excreted or decomposed. Thus, the bed of the lake contains a pool of nutrients that can continue to influence nutrient availability in the water column, and through such mechanisms, historically high nutrient loads may elevate lake productivity, even if external loads have reduced over time.

The surface sediment of Lower Tomahawk Lagoon was sampled by the Lakes380 programme to determine the contents of different P fractions on a per dry weight basis (Figure 40). This analysis was not undertaken for the upper lagoon.

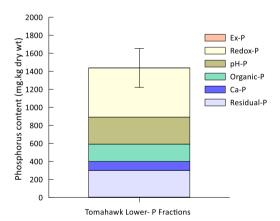


Figure 40. Sediment phosphorus (P) fractions in the surface sediment sample (0–2cm) taken in Lower Tomahawk Lagoon during the Lakes380 national-scale study. The error bar denotes a 13% error associated with analysis and sampling.

The redox-P fraction can be solubilised during anoxia, the pH-P fraction can be solubilised at high pH (e.g. over about 9.0 pH), and the organic-P fraction can be mineralised by microbial activity. Thus, in the lower lagoon, approximately 70% of the P sequestered in the sediment can potentially be resolubilised. Placing the surficial

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sediment samples in an anoxic environment releases the redox-P, and such an experiment was carried out with sediment from the lower lagoon (Figure 41). This experiment showed that the sediment P release rate under anoxic conditions was higher than the average release rate measured in the multi-lake dataset collected by the Lakes380 programme. Together, these findings show that there is a large pool of potentially soluble P in the sediment of the lower lagoon.

Figure 36 shows that peaks in DRP in the water column of the lower lagoon tend to occur in summer, when water temperatures are higher and when conditions of high pH and low DO are more likely to occur. This suggests that in some summers (e.g. 2020/21 and 2021/22), a recycling of sediment P back into the water column probably contributed to elevated DRP levels in the lake. Unfortunately, the available data do not indicate which of the many potential mechanisms are responsible for high summer DRP in the lake.

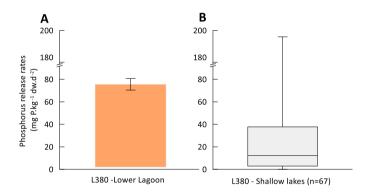


Figure 41. Phosphorus release rates determined by a slurry experiment on a single surface sediment (0–2cm) sample from Lower Tomahawk Lagoon during the Lakes380 national-scale study (A), and summary statistics (range, 25th and 75th quartiles and median) of release rates determined on 67 shallow lake sediment samples (Lakes380 dataset; B). The error bar on B is the standard error derived from the Lakes380 dataset.

# 3.5.5. Dissolved oxygen

Dissolved oxygen concentrations in the lagoons and creeks were measured on a monthly basis; however, these measurements were carried out in the daytime, when DO concentrations are often enhanced by the photosynthesis of aquatic plants. Oxygen sags are more likely to occur at night, highlighting the importance of measuring oxygen using sensors that can log DO concentrations automatically at high frequency, allowing the measurement of oxygen minima.

In 2017, Dirk Van Walt (Van Walt Ltd) loaned Ecotago an oxygen sensor, which was placed 10 cm above the lakebed of the upper lagoon. The deployment lasted from February 22 until April 17, a time of year when water temperatures are near annual highs and oxygen sags are expected. The data, presented in Figure 42, show large daily peaks and nightly sags over the time period. The NPS-FM national bottom-line guideline is also shown, indicating that DO in the lagoon did not breach this guideline. The results indicate that DO did not decrease sufficiently to allow the dissolution of iron- and manganese-bound P. However, the sags, which went below 4 mg.l<sup>-1</sup> at times, were low enough to affect some aquatic organisms, including fish (Franklin 2013; MfE 2023). This is consistent with occasional observations of common bully dieoffs, which have been observed in the upper lagoon (Marc Schallenberg, pers. obs.).

In addition to P solubilisation and oxygen stress on sensitive biota, anoxia near the sediment surface can also result in ammonium diffusion (which can be toxic if pH is high) and toxic hydrogen sulphide diffusion into the water column. The data collected from the upper lagoon between September 2022 and March 2023 as a part of ORC's new monitoring programme, indicated that ammoniacal N levels were far below the toxicity threshold during the sampling period, with the highest measurement being 197 mg.m<sup>-3</sup>. The data from the DO sensor, shown in Figure 42, indicated that sediment anoxia is unlikely to have occurred during the sensor deployment, but the significant oxygen sags measured suggest that transient anoxia might occur in this lake at times.

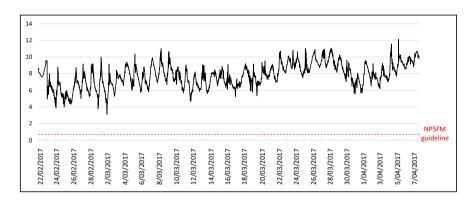


Figure 42. Dissolved oxygen concentrations (g.m-³) in Upper Tomahawk Lagoon measured at 5-minute intervals from 22 February to 7 April 2017. The sensor was 10 cm off the bottom of the lake. The NPS-FM guideline shown in red is the national bottom line for annual minimum dissolved oxygen concentration.

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#### 3.5.6. E. coli

A graphical presentation of the Ecotago data for *E. coli* was not possible because a large proportion of the samples were above the upper measurement threshold of the method (2,429.6 cells per 100 mL). This was observed for all monitored sites, indicating that the *E. coli* levels at these sites breach the NPS-FM national bottom lines and the regional council guidelines. Thus, the waterbodies in the catchment of the Tomahawk Lagoons have concentrations of *E. coli* so high that the waterbodies should not be considered safe for contact recreation.

### 3.5.7. Phytoplankton and macroalgae

Both Tomahawk Lagoons are known to exhibit cyanobacterial and dinoflagellate blooms that instigate action by ORC, including sampling to determine phytoplankton biomass and species identifications. Signs warning the public of the potential toxicity of the algal material are sometimes erected at access points to the lakes. At times, both lakes exhibit signs of severe eutrophication, including algal blooms and low water clarity, but these phases alternate with periods of higher water clarity and an abundance of aquatic plants. This ongoing dynamic means that it is challenging to assess and monitor the health of the lakes. The outcome of a lake health assessment depends on when it is carried out and the period of time over which the assessment takes place.

A detailed analysis of phytoplankton community structure is beyond the scope of this report. However, Ecotago produced monthly phytoplankton data for the two lagoons from July 2021 to December 2022. In addition, media reports of occasional lagoon closures and other observations are available to provide an overview of the key taxa that can dominate the phytoplankton in these lakes. Nuisance cyanobacterial blooms do occasionally occur in both lakes and comprise taxa such as *Dolichospermum lemmermannii* and picocyanobacteria. In addition, occasional dinoflagellate blooms occur in both lakes caused by *Gymnodinium* sp. and / or *Peridinium* sp.

Dolichospermum blooms can be toxic, resulting in signage being put up on the publicly accessible lake shores. Since 2012, two cyanobacterial blooms have been notified in the lower lagoon (one in February 2014 and one in October / November 2017). Four cyanobacterial blooms have been notified in the upper lagoon (one in December 2012 / January 2013, one in November 2013, one in February 2017 and one in January 2018).

Both lagoons can also occasionally exhibit blooms of benthic macroalgae, such as *Enteromorpha* sp. and *Ulva* sp. Filamentous algae can also be important. In March 2023, we observed the conspicuous presence of *Ulva* sp. in both lagoons, as did de Winton et al. (2023) in their macrophyte survey of June 2023.

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# 3.5.8. Macrophytes

The macrophyte cover, biomass and dynamics of Upper Tomahawk Lagoon have been extensively studied (e.g. Mitchell 1989; McKinnon and Mitchell 1994; Drake et al. 2009; de Winton et al. 2023). Macrophyte abundance and species composition have varied greatly over time in this lake, with *Ruppia* sp., *Stuckenia pectinatus*, *Myriophyllum* sp., *Potamogeton* sp., *Elodea canadensis* and charophytes appearing frequently.

In March 2023, we conducted a survey and found low amounts of macrophyte biomass but many small shoots of what appeared to be *Ruppia* sp. In June 2023, de Winton et al. (2023) carried out a LakeSPI assessment of the upper lagoon, which reported that the macrophyte community was in a moderate condition. *Ruppia polycarpa* was the dominant macrophyte species, followed by *Elodea canadensis*, which was described as sub-dominant. *Potamogeton ochreatus*, *P. cheesemanii*, *Althenia bilocularis* and the charophytes *Nitella hyalina* and *Chara globularis* were also present in small quantities.

De Winton et al. (2023) reported some *Ruppia polycarpa* in the lower lagoon, but the salinity of the lagoon was high enough to restrict the utility of the LakeSPI index. Therefore, the macrophyte status of the lower lagoon was not assessed as thoroughly as that of the upper lagoon.

Observations and studies of macrophytes undertaken in both lagoons indicate that macrophyte biomass is generally lower in the lower lagoon than in the upper lagoon (this study; de Winton et al. 2023; Marc Schallenberg, pers. obs.). *Elodea canadensis* and *Ranunculus trichophyllus* are the only non-native submerged macrophyte reported from the lagoons. These species are given an invasive impact score of 3 and 1 out of 7, respectively (Clayton and Edwards 2006), indicating that, in general, they are only moderately to mildly invasive. It is not clear whether these macrophytes threaten the native macrophyte communities of the upper lagoon. Due to its higher salinity, the lower lagoon is not likely to be impacted by these invasive species.

### 3.6. Tomahawk Lagoon food webs

# 3.6.1. Fish community

Fish surveys of the Tomahawk Lagoons have been carried out multiple times, including in 2006 (Drake et al. 2010) and, more recently, by Ecotago, who have been collecting fish data seasonally since July 2021. The New Zealand Freshwater Fish Database also contains additional entries for the Tomahawk Lagoons. All these sources have been examined to compile the species list for the two lagoons, shown in Table 11. The native species assemblage is typical of lowland South Island lakes. However, it is notable that shortfin eel are not well established in this catchment,

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having been reported only on one occasion in Upper Tomahawk Lagoon by the Ecotago team.

Fish sampling in 2006 and 2023 was undertaken with standardised sampling effort and methodology (as detailed in Drake et al. 2009), allowing for the comparison of catch rates between lakes and between sampling dates. Figure 43 shows the catch rates for fish in Lower Tomahawk Lagoon in 2006 and 2023 as well as the average catch rates for 22 South Island shallow, lowland lakes. The lower lagoon showed substantially higher catch rates of common bully, longfin eel and īnanga than have generally been reported for South Island lakes. The fish populations in the lower lagoon were quite similar in 2006 and 2023. Catch rates in Upper Tomahawk Lagoon (Figure 44) were substantially lower, but a similar species assemblage to Lower Tomahawk Lagoon was observed.

Table 11. Fish species reported for the Tomahawk Lagoons and tributaries based on multiple sources of information (see text). \* indicates non-native fish, self-sustaining population; \*\* indicates non-native fish population sustained by stocking.

Upper Tomahawk Lagoon	Lower Tomahawk Lagoon	Tributaries
Perch*	Perch	
Rainbow trout**		
	Brown trout**	
Common bully	Common bully	Common bully
Longfin eel	Longfin eel	Longfin eel
Shortfin eel		
Īnanga	Īnanga	Īnanga
	Flounder	
		Banded kōkopu
		Redfin bully
		Kōaro

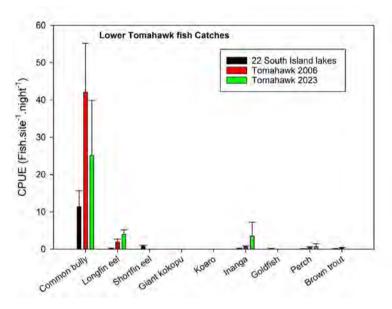


Figure 43. Fish catch per unit effort in Lower Tomahawk Lagoon in March 2006 and 2023. The average catch rates for 22 South Island lakes are also shown for comparison. Data source: Drake et al. (2009).

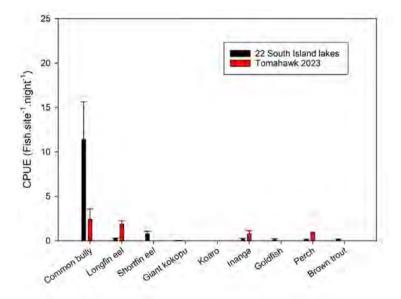


Figure 44. Fish catch per unit effort in Upper Tomahawk Lagoon in March 2023. The average catch rates for 22 South Island lakes are also shown for comparison. Data source: Drake et al. (2009).

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#### 3.6.2. Invertebrates

A thorough analysis of invertebrates of the Tomahawk Lagoons is beyond the scope of this report. Ecotago undertook some semiquantitative analyses of invertebrates, and the 2006 survey carried out by Drake et al. (2009) sampled invertebrates in the lower lagoon. Professor Carolyn Burns and Associate Professor Marc Schallenberg and their students have also undertaken studies of invertebrates, including zooplankton, in the lagoons (e.g. Dufour et al. 2007; Crawshaw et al. 2018, 2019).

High densities of the invasive *Daphnia pulicaria* and the native *D. thomsoni* are often observed in the upper lagoon. These are filter feeders and high densities of these zooplankters are often associated with high water clarity in the lagoons. Both are sensitive to salinity and are, therefore, much more important in the upper lagoon.

Freshwater crayfish / kōura (*Paranephrops* sp.) have been recorded in the lagoons and inflow streams. The lagoons also support mysids, amphipods, snails, isopods, polychaetes, caddisfly larvae, odonate larvae, chironomids and other invertebrates typical of coastal lakes and lagoons.

### 3.6.3. Waterbirds

Since February 2019, Ecotago, with the help of Mary Thompson, have been collecting information on waterbird numbers at the lagoons. Black swan numbers fluctuate between 0 and 467 birds per count. Other birds of note that use the lagoons are marsh crakes / kotoreke, white herons / kōtuku, shags, royal spoonbills / kōtuku ngutupapa, New Zealand shovelers / kuruwhengi, grey teal / tētē moroiti, Canada geese and gulls.

Otago Fish & Game monitors the number of black swans on the Tomahawk Lagoons (Figure 45). These data confirm high variations in black swan numbers over time and suggest a rise in swan numbers in the 1990s, followed by a decline in the 2010s. However, there was significant variation in counts. Black swan densities are likely to have tracked macrophyte cover in the lagoons to some extent (McKinnon and Mitchell 1994).

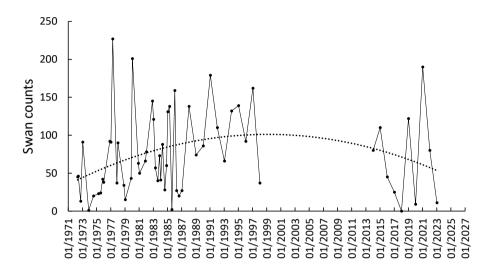


Figure 45. Swan counts at the Tomahawk Lagoons. Data source: J. Couper, Otago Fish & Game.

# 3.7. Summary of key water quality and ecology findings

The following points summarise the key water quality and ecological health findings for the Tomahawk Lagoons:

- The Tomahawk Lagoons and inflow creeks fail to achieve national and regional
  water quality guidelines for P, turbidity and E. coli. At times, the lake national
  bottom line for chl-a was also breached. The creeks breach the regional nitrate
  guideline, and it is likely that the lakes would breach TN guidelines, although only
  nitrate levels have been measured.
- The turbidity time series in the lagoons supports the previous observation that the
  upper lagoon is a flipping lake, alternating between multi-year clear water and
  turbid phases. The chl-a time series data do not appear to support this inference
  as strongly.
- The lakebed sediment in the lower lagoon has a substantial component of
  potentially mobile P, which could be mobilised by conditions of anoxia, high pH,
  high wind, and / or microbial mineralisation. When experiencing anaerobic
  conditions, lakebed sediments of the lower lagoon released substantial amounts
  of P into pore waters.
- High-frequency DO data were only available for a 6-week period but showed that
  concentrations did not breach the national bottom line, which was set to prevent
  anoxic releases of P from the lakebed. However, the DO data did show occasional
  oxygen sags below 4 mg.l<sup>-1</sup>, reaching oxygen levels likely to cause physiological
  stress to fish.

- *E. coli* counts were very high at all sites, breaching both the national and regional guidelines for contact recreation.
- Occasional phytoplankton blooms occurred in both lagoons. These blooms were
  usually due to cyanobacterial taxa that are capable of fixing N and which may
  potentially produce cyanotoxins. Picocyanobacteria, dinoflagellates and
  macroalgae also occasionally bloom in the lakes.
- Observations indicate that macrophyte biomass and cover fluctuates substantially in the upper lagoon. The lake has flipped back and forth between turbid, algaldominated and clear water, macrophyte-dominated phases for decades and possibly even centuries. Macrophytes appear to be more abundant in the upper lagoon. Elodea canadensis and Ranunculus trichophyllus appear to be the only non-native macrophytes in the upper lagoon and neither appear to be a large threat to the macrophyte community or lake health. The macrophyte community was recently assessed as being in moderate condition, but this was only based on a single assessment in June 2023.
- The fish communities in the lakes are typical of those found in other shallow South Island lakes. The lakes contain both introduced trout and perch and , for shallow, lowland lakes, unusually low numbers of shortfin eels.
- The invertebrate assemblages are also typical for shallow, coastal freshwater and brackish lakes. The upper lagoon sometimes has high densities of *Daphnia* sp., a zooplankter that is an effective grazer of algae.
- The Tomahawk Lagoons attract a wide range of birdlife. Black swan densities are
  highly variable and can reach high densities at times, which may result in
  significant grazing on macrophytes as well as nutrient cycling. If swans also feed
  on pasture grasses, their use of the lagoon may also increase external loads of
  nutrients to the lagoons.

# 3.8. Tomahawk Lagoon management options

A conceptual model of how shallow lakes undergo eutrophication is presented In Figure 2. In assessing the data on the Tomahawk Lagoons, both stressors (e.g. nutrients, turbidity) and responses (e.g. phytoplankton biomass, fish communities) were considered, as well as factors that mediate lake responses to stressors (McDowall et al. 2018). These mediators increase or decrease ecological resistance and resilience to eutrophication, potentially shifting tipping points and altering hysteresis in the lake systems. Some of the stressors and mediators can potentially be managed by mitigations (e.g. reducing contaminant inputs) or interventions (e.g. intervening in the lake food web).

# 3.8.1. Management Goal 1: reducing contaminant stressors

### **Catchment nutrient loads**

Run-off from the catchment results in significant nutrient loads to the lakes. Catchment models (based on land cover) together with lake input / output models can be used to estimate nutrient loads from the catchment to the lakes. The results of these models can help define the nutrient load reductions required to meet lake nutrient concentration guidelines in the NPS-FM and the ORC Water Plan (Table 13).

Table 12. Estimated mean annual inflow concentrations from catchment models to Upper Tomahawk Lagoon, predicted mean annual in-lake concentrations from input-output models, and estimated nutrient load reductions required to meet the NPS-FM lake national bottom lines for total nitrogen (N) and total phosphorus (P) concentrations.

	Inflow concentrations			urrent in-lake trations	Estimated reductions in loads to meet the NPS- FM national bottom-line lake concentrations	
	Total N (mg.m <sup>-3</sup> )	Total P (mg m <sup>-3</sup> )	Total N (mg.m <sup>-3</sup> )	Total P (mg.m <sup>-3</sup> )	Total N (%)	Total P (%)
CLUES V10.6 catchment model	1,195	102	1,348	75	41	34
NIWA NZ River Maps model	947	49	1,069	43	25	-17

The calculated load reductions required differ somewhat depending on which catchment model is used. The CLUES and NZ River Maps models indicate that the N load reductions required are between 41% and 25%, respectively. Using the CLUES catchment model suggests that P loads also need to be reduced by 34%, but using the NZ River Maps catchment model indicates that P loads are currently adequate to meet the lake NPS-FM national bottom line for lake TP concentration. Unfortunately, these estimates cannot be compared or validated with the Ecotago water quality data because total nutrient concentrations were not measured in the lakes. ORC has begun to measure TN and TP in the upper lagoon, but there is not enough data to estimate mean annual concentrations of these attributes at this time.

Some further insights can be gained from the Ecotago data on nutrient and turbidity levels in the inflow creeks. These data show generally elevated levels of turbidity (i.e. suspended sediment), P and N in the creeks, particularly in Lagoon Creek, which drains into the upper lagoon and has nitrate levels that are extremely high for this type

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of low intensity agricultural and forestry catchment. Given that Lagoon Creek is the only creek feeding the upper lagoon, the high nutrient levels coming out of the creek likely influence the lagoon's eutrophic status.

Reducing the high external nutrient loads should result in improvements to the water quality of the lakes; however, because of legacy nutrients, time lags and hysteresis, the improvements will likely occur gradually over the time scale of years to decades. Actions that can be undertaken to reduce external nutrient loads should focus on mitigating N and P mobilisation to the inflow creeks.

From a planning perspective, the Tomahawk catchment could be viewed as a nutrient-sensitive zone. In recognition of this, regulations and public education regarding land-use practices in the catchment could be employed specifically to reduce nutrient inputs to the land. For example, the discharge of piggery waste in the upper catchment of Lagoon Creek might be reviewed an activity that is not consistent with land uses permitted in a nutrient-sensitive catchment. Similarly, compliance with the National Policy Statement for Plantation Forestry could be mandated with regard to the management of forestry blocks in the catchment.

Pine forestry has been shown to limit water yields. Therefore, forestry blocks in the catchment may reduce the hydrological flows through the catchment and lakes, thereby slowing down the flushing of legacy nutrients from the lakes. While this land use change is likely to reduce nutrient loads, there will be a trade-off between reduced nutrient loading and reducing the water yield and flushing potential. If substantial new forestry blocks are developed in the catchment, some careful consideration of these effects would be warranted.

Other options include fencing off and / or planting of riparian buffer zones along creeks in the catchment and around the lake margins where stock can access the lakes. Appropriate riparian margins can help intercept overland flow, reducing sediment and P mobilisation to waterways during floods. These margins may also help attenuate the N mobilisation to creeks via shallow groundwater, where and when this occurs.

Protecting and reinstating wetlands in the catchment may also help reduce nutrient and sediment mobilisation to creeks and lakes. A land survey could be undertaken to identify potential wet areas in the catchment. If such areas are identified, the council could work with landowners (possibly by assisting with the development of farm environment plans) to facilitate an increase in the extent of wetland areas in the catchment.

In addition, a wetland could be engineered where Lagoon Creek enters the upper lagoon (Figure 46). The lake shallows near the inflow could be converted to wetlands by creating a bund to trap water and sediments and to protect the new wetland from

wave action. The area could be planted with appropriate wetland plants (e.g. raupō). Once established, this area could act as a sediment trap, also attenuating N and P as well as facilitating denitrification of the inflowing waters. This type of intervention is likely to have a more immediate impact on the nutrient status and condition of the upper lagoon than mitigations distributed throughout the catchment.



Figure 46. Bund location for potential constructed wetland at the inflow to Upper Tomahawk Lagoon.

### Internal legacy nutrient loads

Historical nutrient loads probably continue to contribute to nutrient availability in the lagoons due to internal nutrient loading facilitated by wind-induced sediment resuspension, microbial mineralisation, hypoxia / anoxia at the sediment—water interface, and elevated pH during algal blooms. Thus, by mediating the internal load of nutrients to the water column, these mechanisms result in hysteresis in the eutrophication response, if restoration actions are solely aimed at reducing external nutrient inputs to the lagoons. Nevertheless, over decades, reducing external loads should produce a durable reduction in the trophic state of the lagoons, as the internal pool of nutrients is decreased over time due to flushing, denitrification and deep burial in the lakebed.

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A number of options could be explored for reducing the recycling of legacy nutrients and sediments from the lakebed to the water column. Two options are dredging sediments out of the lakes and using P binding and capping agents. From anecdotal information supplied by Otago Fish & Game, an attempt was made decades ago to deepen the upper lagoon by dredging a section of the lakebed. However, it is not known how successful this was in terms of deepening the lake or improving the fishery. The site of dredged sediment has now filled in.

Some disadvantages of dredging include the disruption of the lakebed and organisms living in it, difficulties disposing of dredge spoil in an acceptable and appropriate way, and dredged sediment being replaced over time by sediment resuspension and new sediment inputs. For these reasons, dredging (particularly if not done over the entire lakebed) is unlikely to result in durable improvements to the lakes.

Phosphorus binding and capping agents are chemicals applied to the lake to lock P into the sediments (Hickey and Gibbs 2009; Gibbs and Hickey 2018). Alum and phoslock are examples of materials that have been used to reduce P availability in lakes. However, given that the Tomahawk Lagoons are shallow lakes, often with dense macrophyte beds and frequent wind-induced sediment resuspension (Hamilton and Mitchell 1997), it is unlikely that such agents would provide durable improvements to the water quality of these lakes.

Thus, few appropriate options exist for managing legacy sediments and nutrients in the beds of these lakes, highlighting the importance of reducing sediment and nutrient loads to these systems.

### Stormwater and heavy metals

Measurements of the heavy metal concentrations in the lakebed sediments of the lagoons by Cawthron scientists similarly showed that heavy metal contents (lead, copper, cadmium, zinc) are generally elevated in the lagoons compared to average contents in a sub-set of other Aotearoa New Zealand lakes. Lead (lower lagoon) and zinc (upper and lower lagoons) contents exceeded the default guideline lower trigger for sediment quality (ANZECC and ARMCANZ 2000; Figure 46), which represents the concentration below which there is a low probability of biological effects (Batley and Maher 2001). While these heavy metal contents measured in the lagoons are higher than in many other shallow lakes, elevated levels were also found in other lakes that receive urban stormwater.

The Spencer Street stormwater outfall is a consented outfall near the shore of the lower lagoon. The stormwater is derived from the urban area to the west of the lower lagoon. The outfall discharges 25 m from the edge of the lagoon to an area fitted with stormwater baffles, which lower water velocity, and a reno mattress, which helps infiltration of the stormwater into the soil. The area has been vegetated with native plants. Little data are available on the water quality of the stormwater discharging at

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this site; however, one sampling of the outfall during a minor flood event indicated slightly elevated levels of zinc and copper (Denmead 2021). It is not known to what extent this outfall impacts the concentration of heavy metals in the lower lagoon. Although prior to the installation of the infrastructure at this site, it is likely that stormwater would have had a greater impact on the lagoon.

There are numerous small stormwater outfalls to the upper lagoon, which appear to come from houses, but there is one larger outfall directly entering the upper lagoon at the domain. Denmead (2021) was unable to sample the outfall directly but did sample water from the lagoon in the vicinity of the outfall during the same minor flood event. Analyses did not definitively indicate contamination from the stormwater, although the electrical conductivity of the sample was very high, indicating either high salinity or significant (unidentified) contamination. More data on the contamination levels in these stormwater outfalls are required to assess the potential effects on the lagoons.

At this stage, insufficient information exists to assess the impacts of contaminants from stormwater discharges to the lagoons. Further research is needed before the importance of end-of-pipe treatment or diversion of stormwater discharges can be assessed. However, initiatives to reduce stormwater flows from urban areas are likely to decrease the harmful effects of stormwater entering the lagoons.

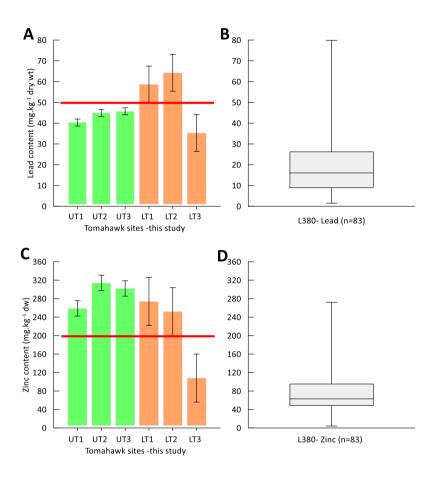


Figure 46. Heavy metal contents in the surface (0–2 cm) sediments of the Tomahawk Lagoons. Plots A and C show the lead and zinc contents, respectively, of samples analysed during this study in the Upper (UT – green bars) and Lower (LT – orange bars) Tomahawk Lagoons. The red lines represent the ANZECC lower trigger values for sediment quality. Plots B and C show summary statistics (range, 25th and 75th percentiles and median) for lead and zinc contents, respectively, of surface sediments from 83 shallow lakes, analysed as part of the Lakes380 national-scale study.

### 3.8.2. Management Goal 2: lagoon water level management

Active water level management is a current hydrological feature of both lagoons. The water level of the upper lagoon is constrained by a weir, which maintains water levels in the lagoon during dry periods. The water level of the lower lagoon is managed by artificial openings across Tomahawk Beach. Managed lagoon openings are facilitated by sand mining at Tomahawk Beach, whereby a contractor is consented to remove up

to 7,100 m<sup>3</sup> of sand per year in the vicinity of the outlet of the lagoon. In recent years, the contractor has been removing < 50% of the consented amount of sand from the beach (Figure 47).

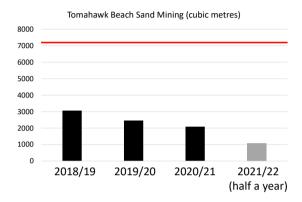


Figure 47. Consented extent of sand removal from Tomahawk Beach. The bars are the actual removal per year. The red line is the consented annual sand take. Source: Otago Regional Council.

The ecological effects of the weir between the lagoons are likely to be beneficial to the ecology of the upper lagoon because significant dewatering of the lagoon can occur in dry, hot summers. Maintaining water level during such times undoubtedly benefits fish, macrophytes and waterfowl. However, the presence of the weir probably elevates flood risk, and floods have occurred at the upper lagoon, damaging buildings near the lake edge. The weir may also inhibit the migration of aquatic organisms between the lagoons.

In contrast, the artificial openings of the lower lagoon are employed to prevent flooding of the lagoons and damage to property such as dwellings and roading infrastructure. The openings are dependent on water levels in the lagoon and have been reported on a quarterly basis since 2020 (Figure 48).

20	20		20	21			20	22	
Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	
0	1	0	1	2	1	0	0	0	

Figure 48. Artificial openings of Lower Tomahawk Lagoon reported by quarter. Source: Otago Regional Council.

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The imperative to protect property and infrastructure undoubtedly affects the ecology of the lagoons via higher water levels, greater water level variation, and the reduced frequency of periods of marine influence. The natural opening regime would increase the time-averaged depth and reduce the time-averaged salinity of the Tomahawk system. Coupled with the sand accretion occurring at Tomahawk Beach, the lagoons would naturally become a larger, more freshwater dominated system (less saline influence), being increasingly separated from the sea by a growing sand dune barrier.

Despite the obvious effects of water level management on the 'natural' condition of the lagoons, the proximity of housing and roading to the lagoons necessitates flood protection by maintaining drainage to the sea. Artificial water level management is also carried out on many similar lagoon systems along the east coast of the South Island (e.g. Waituna Lagoon, Kaikorai Lagoon, Wainono Lagoon, Lake Ellesmere / Te Waihora, Lake Forsyth / Wairewa). Thus, the ability to allow a more 'natural' water level and flushing regime in these lagoons is highly constrained by asset management.

It appears the options to alter the opening regime of the Tomahawk Lagoons are limited, even if there is a focus on improving ecological values. However, rising sea levels may increase marine connectivity of this system, potentially raising water levels, although this outcome is also dependent on the management of sand accretion at Tomahawk Beach. Assuming the regional council will continue to mine sand and open the lagoons to maintain the current water level regime, the marine influence will likely increase over time in these lagoons as the sea level rises.

# 3.8.3. Management Goal 3: swans

Black swans are undoubtedly a key factor influencing the water quality of the Tomahawk Lagoons. With their long necks, swans can forage on macrophytes down to approximately 1 m depth, which enables grazing across the total surface area of both lagoons. Their occasional very high densities on the lagoons means that they have the potential to harvest a large amount of macrophyte biomass. Their faeces can also provide a nutrient stimulus to phytoplankton and add detritus to the lake, which consumes oxygen as it decomposes. If they are mainly feeding on the macrophytes, this increases the nutrient cycling and the transfer back into the water column of some nutrients taken up from the sediments by macrophytes. If the swans also feed on pasture grasses (which they often do), this represents an additional input of nutrients from the catchment into the lake. Thus, swans can be a strong mediator of eutrophication, specifically by facilitating the shift from a state of nutrient enrichment of abundant macrophytes to a state in which phytoplankton biomass is likely to prevail over macrophyte biomass. In the context of the flipping behaviour noted in Upper Tomahawk Lagoon (and possibly also occurring in the lower lagoon), substantial grazing of macrophytes by swans could initiate a flip to an algal-dominated state.

McKinnon and Mitchell (1994) showed that swan densities at Upper Tomahawk Lagoon were positively correlated with macrophyte biomass in the lagoon ( $R^2$  = 0.63), suggesting that high macrophyte biomass attracts swans to the lagoon. Furthermore, Mitchell (1989) calculated that swans could consume 20% to 50% of the annual macrophyte production in the lagoon.

The maximum swan density reported by McKinnon and Mitchell (1994) was approximately 6.5 swans per ha (the lagoon is 10.2 ha in surface area). However, swan counts undertaken by Otago Fish & Game and Ecotago show that swan densities are often much higher than that in the lagoons (e.g. often over 15 swans per ha and up to 47 swans per ha). Thus, the figures produced by Mitchell (1989) on swan grazing are likely to be very conservative estimates in relation to the grazing that can occur in the lagoon at high, often observed, swan densities.

The interactions between swans and water quality described above are complex. A hypothesis of how swans could affect water quality in the Tomahawk Lagoons is presented in Figure 49.

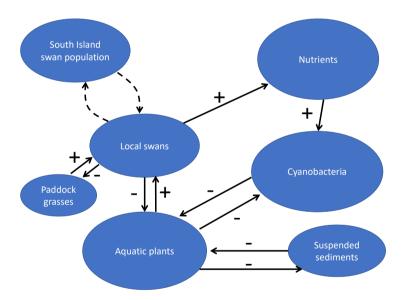


Figure 49. A hypothesis of swan interactions with water quality in the Tomahawk Lagoons. The solid arrows show hypothesised causal relationships. + indicates a positive effect. – indicates a negative effect. The dashed arrows indicate exchange of swans between the local and larger South Island populations.

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Paddock grasses and the presence of macrophytes in the lagoons attracts swans to the area, where they forage and set in motion the various interactions illustrated and discussed above. This conceptual model suggests that by controlling swan numbers, the macrophyte biomass and water quality of the lagoons could be improved. However, Otago Fish & Game have undertaken swan culls at Lake Waihola and other locations and have reported that local culls do little to reduce swan populations because of the much larger surrounding swan population that rapidly replaces the culled swans. Thus, swans appear to be a major mediator of water quality that is difficult to control or manage. Furthermore, waterfowl are identified as an important key value of the Tomahawk Lagoons and, therefore, swan culls or swan deterrents may not be feasible or acceptable to the community.

#### 3.8.4. Management Goal 4: invasive species

#### Daphnia pulicaria

The Tomahawk Lagoons are host to a number of invasive species that have the potential to mediate the symptoms of eutrophication. The invasive zooplankter, *Daphnia pulicaria*, has colonised the upper lagoon and often reaches very high densities. *D. pulicaria* is an effective grazer of algae and anecdotal evidence suggests that high densities of *D. pulicaria* in the lagoon are associated with clear water phases. Thus, this invasive species potentially confers some resilience and resistance to eutrophication due to its ability to graze on algae.

### European perch

The Ecotago data indicate that European perch can also reach high densities in Upper Tomahawk Lagoon. Perch have been associated with poor water quality in some Aotearoa New Zealand lakes, where juveniles feed on *Daphnia* (Persson and Hansson 1999) and thereby appear to suppress grazing on algae (Hicks et al. 2013). Perch recruitment is also known to be changeable, showing high year-to-year variations in some lakes (Farmer 2013). Although no work has been done on perch-*Daphnia*-algae interactions in the Tomahawk Lagoons, it is possible that perch may mediate the eutrophication response, such that algal blooms are also influence by perch recruitment success as well as by nutrient availability in the upper lagoon.

The hypothesised interactions between perch, *Daphnia* and algae in shallow lakes suggest that if juvenile perch numbers could be controlled in Upper Tomahawk Lagoon, there may be a reduction in phytoplankton biomass due to resulting increases in *Daphnia* biomass. The small size of the lagoon could make the intensive netting of small perch a feasible management action; however, data are currently insufficient to assess to what extent perch removals could improve the ecological condition of the lagoon. Furthermore, when macrophyte biomass and cover is high, the efficiency of attempts to remove a substantial proportion of the juvenile perch by netting will be greatly reduced.

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Another option to reduce perch recruitment could be to temporarily introduce perch spawning substrates to attract perch egg-laying. These substrates could then be removed after the perch spawning season is over and before the eggs hatch. Pilot studies could be used to fine-tune the parameters of such an approach and assess its likely effectiveness at reducing perch recruitment.

Finally, perch are considered a game fish by Fish & Game New Zealand, and they would need to approve any proposed intervention to reduce perch numbers.

### Elodea canadensis

The invasive macrophyte *Elodea canadensis* is found in Upper Tomahawk Lagoon. Anecdotal evidence indicates that this species can constitute a large proportion of the macrophyte biomass. While *E. canadensis* may have negative impacts on macrophyte native biodiversity (Kelly and Hawes 2005), its presence in the lagoon may make the lagoon more resilient to flipping. However, this will depend on whether *E. canadensis* enhances biomass and cover or whether it merely replaces native macrophytes in the lake. *Elodea canadensis* is not as invasive as many other problematic invasive species, but its potential to proliferate should also be considered in any project to manage macrophytes in Upper Tomahawk Lagoon. At present there is inadequate information to assess the impact of *E. canadensis* on water quality in the lake.

More information on macrophytes would facilitate the assessment of whether *E. canadensis* is an asset or a threat to the ecological condition of Upper Tomahawk Lagoon.

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### 4. CONCLUSIONS AND RECOMMENDATIONS

Lake Tuakitoto and the Tomahawk Lagoons are highly valued coastal lakes, having significant wildlife, biodiversity, and recreational resources and amenities. However, these values are currently being compromised by degradation in water quality, which significantly impacts the ecological health of the lakes.

Management options for Lake Tuakitoto are summarised in Table 13. The trend of increasing total nitrogen (TN) and total phosphorus (TP) concentrations in the lake is contributing to extensive macroalgae and phytoplankton blooms, and phytoplankton now exceed the National Policy Statement for Freshwater Management (NPS-FM) national bottom lines for the protection of ecosystem health. Undesirable ecological feedback processes appear to have become established in the lake, driven by high primary productivity of macroalgae in summer. These processes appear to result in internal nutrient loads from lake sediments, high water column pH and possibly dissolved oxygen (DO) sags (DO data are insufficient to carry out a comprehensive evaluation). We suspect that poor water quality conditions have flow-on effects to sensitive biota such as native fish (e.g. īnanga, common bullies) and possibly juvenile kākahi, which have declined by 85% in biomass since kākahi surveys were first carried out in the 1990s. It is concerning that the important ecosystem services kākahi provide to the lake by filtering lake water and removing algae are declining, and this will likely continue without management intervention. There is some uncertainty around the necessary nutrient load reductions to improve these conditions in the lake. However, catchment models suggest that to achieve national bottom lines, N load reductions in the range 32-56% are needed (mostly via reducing N in inflows) and P load reductions of around 59% are required (mostly by reducing internal nutrient load sources).

Monitoring data for the Tomahawk Lagoons collected since 2016 indicate that both lagoons and their inflow creeks breach regional and national water quality guidelines. This situation confirms the submissions by members of the local community to the Otago Regional Council (ORC) advocating for the restoration of the lagoons. Both lagoons are subject to occasional algal blooms, often caused by cyanobacterial species that potentially produce toxins harmful to people and animals, especially dogs. Historical data from the 1960s and 1970s show that Upper Tomahawk Lagoon underwent repeated shifts between a macrophyte-dominated state and a phytoplankton-dominated state. Recent turbidity and chlorophyll-a data, together with anecdotal evidence, suggest that these regime shifts continue to occur in the lagoons. However, the triggers that shift the lake condition towards algal blooms are not confirmed, but it is likely that black swans, which feed on macrophytes, play a role in driving this unusual dynamic.

The inflow creeks contain high concentrations of nitrate, dissolved reactive phosphorus (P) and suspended sediment (measured as turbidity). In particular,

Lagoon Creek, which flows into the upper lagoon, has extremely high nitrate concentrations. The use of empirical catchment and lake models suggests that nitrogen (N) loads will need to be substantially reduced in order for the lagoons to meet regional and national guidelines for TN.

Analyses of sediment P fractions indicate that the bed of the lower lagoon contains substantial amounts of P. This can be mobilised to the water column by sediment resuspension, anoxic conditions, high pH conditions and microbial organic matter mineralisation. The P in the sediment is likely a legacy from historically higher P loads to the lake, suggesting that attempts to improve water quality will encounter some hysteresis and time lags between the reduction of external loads and the improvement of water quality in the lagoons.

The water levels of the lakes are managed to protect low-lying dwellings and infrastructure around the shore of the lagoons. While this contributes to the lagoons departing from their natural condition, it is not feasible to allow water levels to rise naturally due to the constraint of flood management. The presence of a self-sustaining population of perch in the lagoons may also mediate water clarity because of the zooplanktivorous diet of juvenile perch.

# 4.1. Summary of rehabilitation options - Lake Tuakitoto

We recommend a range of management options aimed at reducing nutrient loads to the lake (the most important action), managing legacy (internal) loads, improving kākahi populations and rectifying fish passage issues.

The greatest priority for managing ecosystem health in Lake Tuakitoto is the reduction of nutrient loads to the lake, which would have flow-on effects for several of the other management priorities (e.g. kākahi, macroalgae). Directing inflows through the existing wetland could harness the existing ecosystem services of the wetland for attenuating sediment and nutrients before they flow into the lake. The inclusion of flows from Stony Creek, which has high loads of nutrients, into the diversion to the wetland could also be beneficial. If this were undertaken, then flood mitigation around farmland bordering the lake is required.

Alternatively, the diversion race to the lake could be realigned to discharge to the outlet canal, thereby bypassing the lake. Catchment stream care initiatives focused on improving riparian areas and developing farm plans in agriculturally dominated catchments are also needed to reduce loads to inflow streams.

The control of internal loads should be investigated to try to minimise the negative effects of macroalgae on the lake, particularly in summer. This would involve testing sediment-capping agents that bind P in lakebed sediments. Mechanical harvesting of

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macroalgae is another option, possibly initially focusing on the floating rafts of decaying macroalgae that occur over the lake. Management of macroalgae is a complex and emerging problem (Vadeboncoeur et al. 2021). The design of these interventions would therefore be more experimental and should first be trialled at small scales to better understand their effectiveness.

The age structure of the kākahi population suggests that there has been limited recruitment (breeding success) in Lake Tuakitoto for considerable periods (possibly decades). We suggest that limited native fish hosts for kākahi glochidia larval stages is likely to be an important contributor to poor recruitment. While water quality improvements could rectify this by improving fish habitat, European perch in the lake could have a negative effect on common bully populations, which are potential hosts for the parasitic larvae of kākahi. Management of perch abundances could be another way of aiding the recovery of kākahi by improving native fish populations and biodiversity values.

Fish passage was previously identified as an issue for Lake Tuakitoto and is related to the hydrological control structures at the lake outlet sill and the Kaitangata locks. Native fish species that possess poorer climbing and swimming abilities are currently observed at unusually low abundances in the lake. The extent to which these structures are, or could be, operated to facilitate better fish passage is uncertain and should be investigated. Furthermore, a fish passage management plan should be developed.

Table 13. Catchment and in-lake management options for improving ecological health of Lake Tuakitoto.

Goal	Management action	Priority	Timing	Uncertainty
Reducing stream nutrient loads in inflows	Divert more flows from Lovells / Frasers Creek to drain to wetland to increase nutrient removal before entering Lake Tuakitoto	Highest	Immediate	Low – monitor flow rates to evaluate nutrient removal and hydrology
	Evaluate adding Stony Creek inflow to wetland diversion or realignment of diversion race bypassing the lake to the outlet channel	Medium	Long term	Intermediate – hydrological uncertainties regarding diversions
	Riparian enhancement and farm plans in Upper Lovells and Stony Creeks to reduce catchment nutrient losses from agricultural land and forestry	High	Immediate	Low – good stream water quality data to suggest problem catchment areas
Controlling internal phosphorus loading	Apply phosphorus binding / capping agents (e.g. alum, Phoslock) to the lakebed to reduce phosphorus recycling	Trials needed	Immediate	Uncertainty on mechanism and spatial extent of P-recycling in the lake. Effects on kākahi
	Mechanical harvesting of macroalgal mats to reduce dissolved oxygen and pH variation that drive internal loads	Trials needed	1–3 years	High – mats could regrow rapidly. Understanding of accrual and seasonal dynamics needed
Improving kākahi recruitment	Pest fish control to reduce perch populations and spawning and enhance native fish that could serve as hosts for kākahi larvae	Medium	1 year	Medium – need to scope flow rates to evaluate if wetland residence time is long enough to be effective for nutrient removal
Fish passage	Monitoring of fish passage at outlet channel sill and Kaitangata locks to assess passage and operational requirements	High	Immediate	Low – can assess passage requirements with acoustic monitoring and design operational requirements or modify structures to allow passage

# 4.2. Summary of rehabilitation options – Tomahawk Lagoon

Restoration options for the Tomahawk Lagoons are somewhat constrained due to the encroachment of urban areas and the fact that the lagoons are managed as a wildlife reserve. Nevertheless, several restoration actions have been identified and assessed

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within the broad categories of reducing contaminant loads, and managing water levels, black swans and invasive species (Table 14).

High nutrient and sediment concentrations in the inflow creeks highlight the need for reductions in contaminant flows from land to waterways. The catchment of the Tomahawk Lagoons can be considered a nutrient-sensitive zone. Therefore, land-use practices in the catchment should strive to minimise nutrient and sediment losses from land to water. This could be achieved by fencing and planting riparian buffer zones along waterways, by ensuring forestry blocks provide an adequate buffer zone along waterbodies, and by encouraging wetland protection and enhancement in the catchment. In addition, we suggest that the shallow lake area near the inflow from Lagoon Creek could be engineered to be a wetland, where water could be held inside a bund in an area vegetated with wetland plants before being allowed to enter the lagoon. This modification would remove sediment and P from inflowing waters, and allow P and N uptake by plants and denitrification by microbes.

The internal loads of nutrients from the lakebeds to the water column are more difficult to control, as dredging and P capping / binding are likely to be ineffective in these lakes.

Evidence suggests that stormwater inputs to the lagoons may be associated with elevated heavy metal concentrations in the lakebed. More information on contaminant levels in stormwater outfalls is needed before we would recommend large investment in stormwater treatment. However, reducing catchment run-off from urban areas should be investigated.

Although artificial openings of the sand barrier between the lower lagoon and Tomahawk Beach alter the hydrology of the lagoons, the need for flood management to protect houses and roading infrastructure is a priority. Altering the water level regime of the lagoons to favour their ecology is currently not a feasible option.

Black swans may mediate the shift between a macrophyte-dominated clear water state and a turbid, phytoplankton-dominated state through their ability to graze macrophytes across the entire bed of both lakes. However, when swan culling has been undertaken in other areas by Fish & Game New Zealand, recolonisation by swans from the larger South Island population has been rapid. Furthermore, obtaining approval for swan culling would likely be difficult given that the Tomahawk Lagoons are a wildlife refuge and the shore of the upper lagoon is close to urban areas.

The presence of European perch in the lagoons may impact water quality due to the zooplanktivory of juvenile perch, releasing algae from the grazing pressure of *Daphnia*. Thus, methods for reducing perch recruitment in the lagoons could benefit water quality, but more research is needed to confirm the efficacy of this intervention.

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Table 14. Summary of management actions considered for the improvement of the ecological health of the Tomahawk Lagoons.

Goal	Management action	Priority	Timing	Uncertainty
Reducing contaminants in the lagoons	Explore the possibility of zoning the catchment as a nutrient-sensitive zone in the Otago Regional Council Land / Water Plan	Highest	Immediate	Appropriate planning tools may not be available
	Undertake fencing and riparian planting; buffers in forestry areas	Highest	Long term	Getting buy-in from landowners
	Enhance existing wetlands in the catchment	High	5 to 10 years	Educating and getting buy-in from landowners
	Construct a wetland at the outlet of Lagoon Creek	Medium	Immediate	Getting buy-in from DOC, Fish & Game and the community
	Dredging to remove legacy phosphorus in lakebed sediment	Not recommended		Disruptive to lakebed plants and animals; likely to fill in again
	Use phosphorus capping agent such as Phoslock, Alum	Not recommended		Likely to be of low cost- effectiveness due to shallowness, macrophyte beds
	Stormwater treatment	Not recommended		More data on stormwater quality and impacts needed
Change water level regime	Alter management of the weir between the lakes to be more ecologically beneficial	Not recommended		Raising of water levels could enhance flood risk, endangering dwellings and infrastructure
	Alter management of lower lagoon openings	Not recommended		Raising of water levels could enhance flood risk, endangering dwellings and infrastructure
Black swan management	Culling black swans	Not recommended		Would negatively impact wildlife values; not likely to be accepted by locals
Invasive species management	Reduction of juvenile perch numbers	Not recommended		Uncertainty as to the strength of control that juvenile perch exert on Daphnia
	Control of <i>Elodea</i> canadensis	Not recommended		Macrophyte dynamics uncertain for E. canadensis

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# 4.3. Further monitoring to assist decisions on options

A number of recommendations that are made in the report would benefit from increased monitoring data to aid in decision-making around the design and implementation of management interventions.

The following monitoring recommendations are made for Lake Tuakitoto catchment:

- inflow monitoring of nutrient loads by major tributaries (lower tributary sites only) to update information on current nutrient inflows to the lake and validate load-reduction targets (minimum 1 year)
- monitoring of water column nutrients and physico-chemical conditions (DO, pH) within the wetland flow path to the lake to better understand potential nutrient removal by the wetland (1 year, monthly – ideally using continuous nitrate sensors)
- monitoring of seasonal dynamics of macroalgal cover, species composition, biomass and tests for saxitoxin
- 4. monitoring of continuous mid-lake pH and DO (monitoring buoy surface and bottom depths) to understand effects on sensitive species and timing of potential internal nutrient loading, as well as profiling through algal mats with microelectrodes if possible
- kākahi recruitment study to improve understanding of the drivers of recruitment success / failure, including water quality, habitat destruction (macroalgae smothering) and glochidia host availability
- native fish monitoring over a 3-year period to understand population dynamics, and to assess kākahi host availability in the lake and fish passage around the Kaitangata lock and outlet weir structures (using underwater acoustic video)
- waterbird monitoring and, possibly, experiments to better understand the importance of swan grazing as a factor in controlling macrophyte establishment (e.g. waterbird exclusion plots, macroalgal exclusion), including undertaking eDNA analysis of faecal pellets to determine if macroalgae are consumed.

The following monitoring recommendations are made for the Tomahawk Lagoon catchment:

- 1. undertaking monthly monitoring of lower lagoon water quality
- 2. installing DO sensors near the lakebed in both lakes
- 3. continuing monitoring of macrophytes in both lagoons
- 4. monitoring heavy metals and nutrients in stormwater inflows.

In conclusion, we hope this report is useful in updating ORC regarding the ecological condition and stressors of Lake Tuakitoto and the Tomahawk Lagoons. We would be

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happy to provide further discussion on these recommendations and work with ORC to implement management actions.

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### 7. APPENDICES

# Appendix 1. Sites for field surveys March 2023

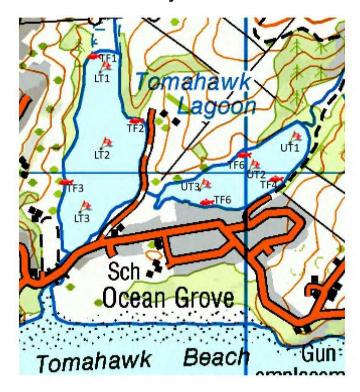


Figure A1. Sites sampled as part of the 2023 field surveys on 23–25 March 2023. Site coordinates and samples collected are shown in Table A1.

AUGUST 2023

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Table A1. Site coordinates and samples collected at Tomahawk Lagoon 23–25 March 2023. Coordinates are in NZTM.

Lake	Sample	Site	Easting	Northing	
Lower Tomahawk	Sediment	LT1	1409395	4914100	
Lower Tomahawk	Sediment	LT2	1409395	4914100	
Lower Tomahawk	Sediment	LT3	1409307	4913834	
Upper Tomahawk	Sediment	UT1	1410191	4914126	
Upper Tomahawk	Sediment	UT2	1410005	4914012	
Upper Tomahawk	Sediment	UT3	1409810	4913927	
Lower Tomahawk	Fish	TF1	1409362	4914490	
Lower Tomahawk	Fish	TF2	1409243	4913961	
Lower Tomahawk	Fish	TF3	1409539	4914219	
Upper Tomahawk	Fish	TF4	1355371	4875849	
Upper Tomahawk	Fish	TF5	1355582	4875370	
Upper Tomahawk	Fish	TF6	1355259	4874861	

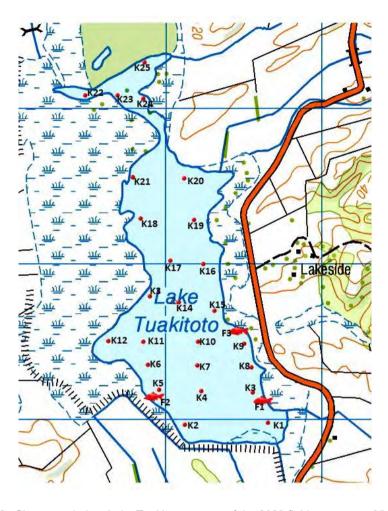


Figure A2. Sites sampled on Lake Tuakitoto as part of the 2023 field surveys on 25–28 March 2023. Sites coordinates and samples collected are shown in Table A2.

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Table A2. Site coordinates and samples collected at Lake Tuakitoto 25–28 March 2023. Coordinates are in NZTM.

Lake	Sample	Site	Easting	Northing
Tuakitoto	Sediment	K2	1355659	4874978
Tuakitoto	Sediment	K4	1355232	4875181
Tuakitoto	Sediment	K7	1355207	4875346
Tuakitoto	Sediment	K11	1354860	4875498
Tuakitoto	Sediment	K14	1355088	4875752
Tuakitoto	Sediment	K17	1355016	4875998
Tuakitoto	Core	K14	1355088	4875752
Tuakitoto	Fish, macrophyte	F1	1355371	4875849
Tuakitoto	Fish, macrophyte	F2	1355582	4875370
Tuakitoto	Fish, macrophyte	F3	1355259	4874861
Tuakitoto	Kākahi	K1	1355127	4874965
Tuakitoto	Kākahi	K2	1355659	4874978
Tuakitoto	Kākahi	K3	1355562	4875172
Tuakitoto	Kākahi	K4	1355232	4875181
Tuakitoto	Kākahi	K5	1354962	4875189
Tuakitoto	Kākahi	K6	1354890	4875350
Tuakitoto	Kākahi	K7	1355207	4875346
Tuakitoto	Kākahi	K8	1355554	4875333
Tuakitoto	Kākahi	K9	1355507	4875486
Tuakitoto	Kākahi	K10	1355211	4875498
Tuakitoto	Kākahi	K11	1354860	4875498
Tuakitoto	Kākahi	K12	1354636	4875503
Tuakitoto	Kākahi	K13	1354902	4875790
Tuakitoto	Kākahi	K14	1355088	4875752
Tuakitoto	Kākahi	K15	1355317	4875697
Tuakitoto	Kākahi	K16	1355245	4875998
Tuakitoto	Kākahi	K17	1355016	4875998
Tuakitoto	Kākahi	K18	1354843	4876290
Tuakitoto	Kākahi	K19	1355185	4876281
Tuakitoto	Kākahi	K20	1355160	4876510
Tuakitoto	Kākahi	K21	1354792	4876557
Tuakitoto	Kākahi	K22	1354487	4877081
Tuakitoto	Kākahi	K23	1354694	4877081
Tuakitoto	Kākahi	K24	1354859	4877060
Tuakitoto	Kākahi	K25	1354868	4877293

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# Appendix 2. Lakes380 research programme sediment core analyses methods

#### Core sampling and sub-sampling

A sediment core was retrieved from the deepest point of Lake Tuakitoto on 14 June 2020 using a Uwitec gravity corer. After retrieval, the core was sealed and stored at 4 °C and in darkness until sub-sampling. The core was split, and sub-samples taken from the centre of the half-core using a sterile spatula at various depths for DNA (stored frozen) and pollen and charcoal analysis.

#### Pollen analysis

Pollen species were identified using microscopy as described in Short et al. (2022). Pine (*Pinus* spp.) and other non-native taxa (e.g. *Macrocarpa* spp.) were introduced by Europeans and are used to mark European activity in the region in this report.

#### Hyperspectral and Itrax scanning

The core was scanned using a hyperspectral scanner at GNS Science, with the spectral data from the RABD660-670 index used as a proxy for chlorophyll-a and its degradation products. Elemental abundance data were obtained using a Itrax  $\mu$ -XRF Core Scanner at the University of Otago. The ratio of manganese (Mn) to Iron (Fe) was selected for plotting as a proxy for bottom-water oxygenation in the lake.

#### **Environmental DNA analysis**

DNA was extracted from the sediment and a region of the bacterial 16 S rRNA gene was amplified and analysed as described in Pearman et al. (2020). The cyanobacteria component of the data was extracted for plotting. The functional profiles of the bacterial community were inferred using the software paprica (Bowman and Ducklow 2015). Enzymes related to denitrification, dissimilatory nitrate reduction to ammonia and sulphate reduction were selected for plotting.



# Cultural Values Statement: Waiwhakaata



# Mō tātou, ā, mō kā uri a muri ake nei.

For us, and for our children after us.

Aukaha (1997) Ltd. 268 Stuart Street, P O Box 446, Dunedin 9054, New Zealand Phone – 03 477 0071 www.aukaha.co.nz

This report has been prepared by Aukaha (1997) Ltd., for Otago Regional Council on behalf of Te Rūnanga o Moeraki, Kāti Huirapa Rūnaka ki Puketeraki, Te Rūnanga o Ōtākou, and Hokonui Rūnanga.

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#### Acknowledgement:

The preparation of this report was undertaken with assistance from the following rūnaka:

- Te Rūnanga o Moeraki
- Kāti Huirapa Rūnaka ki Puketeraki
- Te Rūnanga o Ōtākou
- Hokonui Rūnanga

Front cover photo: Lake Hayes Estate from the Remarkables.<sup>2</sup>

#### Version (final): 14 June 2023

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	Report 1 of 1			
	Otago Regional Council			

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<sup>&</sup>lt;sup>2</sup> References for all images are provided in Appendix 3.

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## Toitū te Mana, Toitū te Whenua: Kā Rūnaka

This report is presented on behalf of four of the seven papatipu rūnaka with shared authority in the area surrounding Waiwhakaata Lake Hayes, being:

- Te Rūnanga o Moeraki
- Kāti Huirapa Rūnaka ki Puketeraki
- Te Rūnanga o Ōtākou
- Hokonui Rūnanga.

In the context of this report, the four papatipu rūnaka are collectively referred to as Kā Rūnaka or mana whenua.

#### Te Rūnanga o Moeraki

The takiwā of Te Rūnanga o Moeraki centres on Moeraki and extends from the Waitaki to the Waihemo, and inland to the Main Divide. The interests of Te Rūnanga o Moeraki are concentrated on the Moeraki Peninsula area and surrounds, including Rakahineatea Pā, Koekohe, and Te Kai Hīnaki with its boulders. In addition, the interests of the rūnaka extend north and south of the Moeraki Peninsula to the boundaries of their takiwā.



#### Kāti Huirapa Rūnaka ki Puketeraki

The takiwā of Kāti Huirapa Rūnaka ki Puketeraki centres on Karitāne and extends from the Waihemo to Purehurehu, north of Heyward Point. Their takiwā extends inland to the Main Divide, sharing interests in the lakes and mountains to Whakatipu-waimāori.



#### Te Rūnanga o Ōtākou

The coastal rūnaka of takiwā of Te Rūnanga o Ōtākou centres on Ōtākou on the Otago Peninsula and extends from Purehurehu to Te Mata-au. The inland reaches of their takiwā includes shared interests in the lands and mountains to the western coast with rūnaka to the north and south.



#### Hokonui Rūnanga

The takiwā of Hokonui Rūnanga centres on the Hokonui region and includes shared interests in the lakes and mountains between Whakatipu-waitai and Tawhititarere with other Murihiku rūnaka, and those located from Waihemo south.



#### 1.0 He Reo Arataki: Introduction

Ka ora te wai, ka ora te whenua, ka ora ai te tākata. When the water is healthy and the land is healthy, then the people are healthy.

This statement is a wero laid down for the restoration of the mauri of Waiwhakaata. As it currently stands, the wellbeing of the lake is not supported by human activity and land usage practices in the catchment. For the mana and mauri of Waiwhakaata to be restored, this context needs to change.

The name that was given to the lake by tīpuna references Waiwhakaata as a place of reflection, a mirror lake, indicating a mauri of clean, clear waters of such clarity and quality that they reflected the surrounding landscape. It is a source of great mamae for Kā Rūnaka to think that tīpuna would not recognise Waiwhakaata today due to its degraded state.

For Rūnaka to fulfil their duties as kaitiaki, a function of rakatirataka, they seek the regeneration of Waiwhakaata so that mokopuna might experience the lake as was done by their ancestors. For this to occur, it is crucial that activities and practices in the surrounding community actively and intentionally work to protect the mana and the mauri of the lake. This include recognising the interconnectedness of our environment and the wider Mata-au catchment, ki uta ki tai.

#### 1.1 Report background and scope

In 2021, the Waiwhakaata Lake Hayes Rehabilitation project was funded under the ORC LTP 2021-2031.<sup>3</sup> The project's overall objective is the protection of the lake and its environmental, ecological, recreational, and landscape values. Consequently, a strategy group was established with two primary aims:

- 1. To coordinate existing policy and actions to improve water quality in Waiwhakaata.
- To oversee the development and propose a governance model for the ongoing implementation of the 2021-2026 Waiwhakaata/Lake Hayes Strategy.<sup>4</sup>

The group comprises representatives from Kā Rūnaka, Friends of Lake Hayes, DOC, QLDC, and ORC. Group members are required to provide leadership, representation, and communications on behalf of their relative communities.

The two Rūnaka representatives for mana whenua are Gill Hopkins and Jana Davis, representing the seven papatipu Rūnaka with shared authority in the area. The cultural values statement will support their mahi as the representatives of mana whenua by providing clear direction and knowledge to guide them. Furthermore, this will provide the tools and information to educate whānau and rakatahi, and others, on mana whenua values, aspirations, and intentions for Waiwhakaata.

#### 1.2 Waiwhakaata: an environmental history

Waiwhakaata is a small, relatively shallow, glacial lake in the Whakatipu Basin with a maximum depth of 33m and a surface area of 2.76km<sup>2</sup>. Water flows into the lake from the north, primarily via Mill Creek as well as other small tributaries, by springs at the northern end of the lake, and from overland flows from the surrounding countryside. Water then exits the lake via a wetland area to the south, feeding Hayes Creek before entering the Kawarau River, ultimately converging with the Mata-

<sup>&</sup>lt;sup>3</sup> See Appendix 2 for a complete list of acronyms and abbreviations used in this report.

<sup>&</sup>lt;sup>4</sup> Waiwhakaata Lake Hayes Strategy Group, 2021, Terms of Reference [unpublished material].

<sup>&</sup>lt;sup>5</sup> LAWA, 2023a.

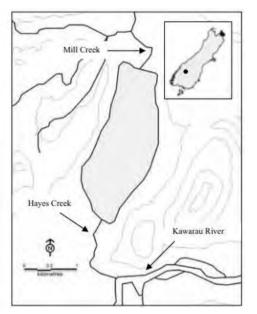
au at Cromwell. $^6$  Hayes Creek is piped under the road from an outfall at the southern end of the lake. $^7$ 

Waiwhakaata was likely formed by the ancient Whakatipu Glacier, which scoured out the bed of what is now Whakatipu-waimāori, followed by separation from the larger lake by outwash from the Kimiākau.<sup>8</sup> The major inflow for the lake is Mill Creek (see Whakaahua 2 below), which is fed by numerous high-country streams from the north and west, including O'Connell Creek, Station Creek, and McMullan Creek. The catchment was most likely forested with kahikatea with an extensive wetland across the western reaches of Mill Creek. Small wetlands were scattered to the west and north of the lake, with extensive riverine marshes located along the banks of Mill Creek and smaller streams.<sup>9</sup>

Whakaahua 1: Characteristics of Waiwhakaata

Lake characteristics	
Lake type	Glacial
Lake area (km²)	2.76
Inlet	Mill Ck
Outlet	Hayes Ck
Max depth (m)	33
Catchment area (km2)	44





The first human interactions with the environment surrounding Waiwhakaata can be linked back to the tīpuna Rākaihautū, who is credited with digging the lakes of Te Wai Pounamu. He used his kō, Tūwhakarōria to carve out the basins of many waterways, including nearby Whakatipu-waimāori.

Tūpuna had strong associations with the area, with archaeological evidence showing that whānau were present during the moa-hunting period, 500-800 years ago. <sup>10</sup> Indeed, the area surrounding Waiwhakaata would have supported many of the ecological services and characteristics that were sought out by whānau, including significant wetland areas that supported diverse, healthy ecosystems.

<sup>&</sup>lt;sup>6</sup> Davis, 2022.

<sup>&</sup>lt;sup>7</sup> Ibid.

 $<sup>^{8}</sup>$  ORC & QLDC, 1995. See Appendix 1 for a glossary of Māori words and phrases.

<sup>&</sup>lt;sup>9</sup> Schallenberg & Schallenberg, 2017.

<sup>&</sup>lt;sup>10</sup> NZAA, 2023, F41/1.

Mahika kai practices were central to whānau associations with the area, encompassing a broad range of activities, including:

- Food and resource gathering
- Food preservation, storage, and transportation
- Tool-making activities
- · Trading and commerce
- Knowledge transfer
- The practice of mātauraka.

Under tikaka Māori, interactions with the environment are based on tenets of respect, balance, and correct procedure; the right to take resources has to be balanced with the duty to protect and give back. As a result, activities that fundamentally changed the environment were avoided in preference for practices that enhanced, and leveraged off, natural processes.

Whakaahua 2: Waiwhakaata in 1903



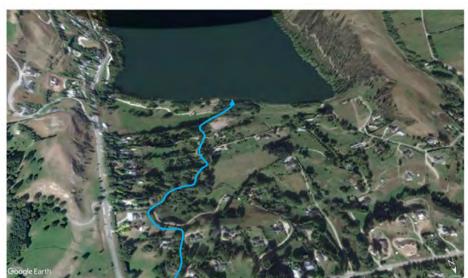
For example, land clearance was often undertaken to promote growth of a resource, emulating the natural processes brought about following a forest fire. The practice was used extensively in the processing of kāuru from tī kōuka, given the tree is well-known for its vigorous regrowth upon felling. Sections of tī kōuka were clear-felled annually for processing in umu tī; the following year, whānau would move to another location, leaving the tract from the previous year to regenerate, thus providing whānau with a sustainable harvest within the natural polyculture of native forest, bush, and wetland, which protected mahika kai values for birding, fishing, and toolmaking.

Wetlands were prized for their ecological services, so the focus was on maintaining the natural character and mauri of the waterway. Each season, waterway and ecosystem attributes were

assessed by observing water quality and quantity, and the abundance and health of species, for example. If deemed necessary, steps were put in place to allow the mauri to recover and regenerate. For example, a rāhui could be placed over an area or a resource restricting access until the mauri had been restored.

Deforestation of the catchment became a permanent state for the area once European settlers and miners arrived, as they sought timber for shelter and firewood. Consequently, at the time of the gold rush in the 1860s, the catchment comprised mostly native tussock grassland in the highlands, and lowland areas scattered with swamps and wetlands. Wetlands provided a range of ecological services including by providing a native habitat, flood mitigation, and a sediment and nutrient sink. <sup>11</sup>

Settler archaeology in the area indicates that farming started in the catchment shortly after gold was found in the Haehaenui in 1858. Early land usage in the areas appears to have consisted mainly of sheep and possibly wheat cropping for the nearby flour mills.<sup>12</sup>



Whakaahua 3: Mill Creek entering Waiwhakaata from the north

Through the early to mid-1900s, land usage practices in the catchment saw increasing conversion to sheep pasture, followed by further conversion to cattle and dairy farming. In the 1950s, the introduction of artificial phosphate fertilisers led to the intensification of cattle and dairy farming, supported by the application of phosphate through aerial top-dressing, including the area directly surrounding the lake. Other activities in the area from 1912 to 1955 included the release of whey effluent from a cheese factory to the north of the lake, with a phosphorous load of approximately 1000kg per year. <sup>13</sup>

Major drainage and channelling works began in the early 1960s, which saw the wetlands drained and the artificial channelisation of waterways through what was previously 80-120ha of wetland areas, and which would soon be replaced with high producing exotic grasslands. The result was the

<sup>&</sup>lt;sup>11</sup> NZAA, 2023, F41/1.

<sup>&</sup>lt;sup>12</sup> NZAA, 2023.

<sup>&</sup>lt;sup>13</sup> ORC, 2009.

inflow of significant amounts of sediment into the lake, with the first recorded sightings of brown water flowing into the lake occurring in  $1961.^{14}$ 

Arrow onicke structure

Arrow

Whakaahua 4: The natural extent of the Waiwhakaata catchment

Over the past 70 years, changes in land usage have contributed to higher levels of nutrients entering the lake. This has led to the degradation of the waterway, mainly due to human activities such as fertiliser application, industry development, septic tank effluent, and the removal of wetlands and riparian plantings.<sup>15</sup>

As a result, the physical characteristics of the land cause runoff from the surrounding areas to quickly drain into the lake, which remains there for a period of months or even years, before exiting via Hayes Creek and flowing into the Kawarau. This process drives a build-up of phosphorous to accumulate in lake-bed sediments.

In summer, Waiwhakaata becomes thermally stratified, that is, a warmer surface layer of water forms above a layer of colder water at the bottom of the lake. This causes the colder layer to become oxygen depleted, allowing phosphorous to be released into the water column, feeding algal blooms. At times, these blooms can become toxic, causing rashes and nausea, and possibly being deadly to dogs if ingested. Consequently, Waiwhakaata is considered a eutrophic lake; that is, the lake has significant accumulations of nutrients that support dense growth of algae and other organisms, the decay of which depletes oxygen in summer resulting in death of animal life. <sup>16</sup>

This combination of waterway modification and land usage changes has led to the significant degradation of water quality in the lake, with a record of poor water quality dating back to the 1960s. For Kā Rūnaka, the loss of the waterway's natural form, and its inability to manage itself

<sup>&</sup>lt;sup>14</sup> Schallenberg & Schallenberg, 2017.

<sup>&</sup>lt;sup>15</sup> ORC, 2021a.

<sup>&</sup>lt;sup>16</sup> LAWA, 2022.

through its natural processes, are indicators that the mana and mauri of Waiwhakaata has been significantly degraded. Consequently, the restoration and regeneration of the lake is a significant aspiration and intention for K $\bar{a}$  R $\bar{u}$ naka. <sup>17</sup>

Whakaahua 5: Aerial photo of Waiwhakaata in 1956



<sup>&</sup>lt;sup>17</sup> ORC, 2021a.

#### 2.0 He Kaupapa Mahi: Methodology

In 2021, ORC identified the rehabilitation of Waiwhakaata Lake Hayes as a priority work programme under the Long-term Plan 2021-2031. The project is being led by the Waiwhakaata/Lake Hayes Strategy Group, which is made up of mana whenua representatives, Councils, DOC, and members of the Friends of Lake Hayes group. In order to support this work, mana whenua representatives for the seven papatipu rūnaka with shared authority in and around Waiwhakaata have requested the delivery of a cultural impact assessment to guide their work in the Strategy Group.

The key elements of the project methodology are set out below.

#### 4.1 Review of literature

A desktop review of the project area was undertaken, focusing on detailed documentary research, to inform the drafting of a cultural values statement related to the proposed activities. Reference material has been derived from the following key sources:

- a. The Kāi Tahu ki Otago NRMP<sup>20</sup>
- b. Kā Huru Manu, the Ngāi Tahu cultural maps and related primary sources<sup>21</sup>
- c. District wāhi tīpuna mapping
- d. Recorded archaeological sites via ArchSite, 22 and
- e. Available ecological and environmental monitoring data and reports.

Other relevant policies, plans, government and industry literature and reports, and academic research publications were identified as further source material during the review of literature.

These sources form the basis of a literature review material presented in sections 3, 4, and 5. Mana whenua cultural experts have provided leadership and direction on the contents of the literature review, and final approval of its contents.

#### 4.2 Cultural values statement

A cultural values assessment identifies key mana whenua values in the area affected by the proposed activity, particularly focused on the affected waterways, and the area related to proposed tunnelling and construction. While some of the base information is sourced from the literature review material, the primary and paramount source for identifying cultural values is mana whenua themselves. Their mātauraka and leadership provides the basis of section 3.0, Ko te Manawa Kāi Tahu, supported by the review of literature.

The cultural values statement provided below was drafted by Aukaha staff members, and presented to mana whenua representatives for review, comment, and amendment. All material released by Aukaha has been assessed and approved by mana whenua, to ensure that the final statement accurately reflects the position of Kā Rūnaka.

<sup>&</sup>lt;sup>18</sup> ORC, 2021b.

<sup>&</sup>lt;sup>19</sup> Waiwhakaata/Lake Hayes Strategy Group, 2021 [unpublished material].

<sup>&</sup>lt;sup>20</sup> KTKO, 2005.

<sup>&</sup>lt;sup>21</sup> TRONT, 2022.

<sup>&</sup>lt;sup>22</sup> NZAA, 2022.

#### 4.3 Statement of Expectation

The compiled findings of the literature review and cultural values statement form the basis of a statement of intention presented in section 6. This statement sets out the key intentions and strategiec priorities that Rūnaka hold for the restoration of Waiwhakaata. The aim is to provide touchstone points to inform and guide the work of the Kāi Tahu representatives to the Strategy Group, establishing a sound basis from which they can advocate for, and advance, the the vision and intention of Kā Rūnaka and the aspirations of whānau.

The statement outlines the expectations that Kā Rūnaka hold for the restoration of Waiwhakaata. This statement does not stand in isolation, nor does it nullify anything other statement mandated by Rūnaka with shared authority. As such, this statement resides within the context of other relevant Kāi Tahu and Rūnaka policies, plans, statements, and reports.

#### 3.0 Ko te Manawa Kāi Tahu: Mana whenua values, associations, and practices

Mana whenua values provide a cultural frame for whānau to identify and communicate te ao Māori perspectives. Values are used by mana whenua as a tool for assessing the impact of an environmental event or activity, or, as in this case, as a means of identifying the values associated with a natural feature or resource.<sup>23</sup>

Mātauraka underpins the definitions of mana whenua values. Every iwi, every hapū, every Rūnaka, has its own understanding of these values and their application, based on the mātauraka handed down to them through whakapapa.

Kā Rūnaka have identified the following values in relation to Waiwhakaata, referencing the stories, knowledge, and experience of their tīpuna. This section provides an overview of each value based on mātauraka Kāi Tahu, with a summary of how these values are linked to Waiwhakaata within the context of Kāi Tahu history and associations in the wider cultural landscape. These values build on those identified in the context of the QLDC Spatial Plan (see section 5.4 below).

#### 3.1 Whakapapa

Kāi Tahu are bound to the land, water and all life supported by them by whakapapa. The word whakapapa references the laying down of layers, a metaphor for the layering of generations from the past to the present, and into the future. The following account of Kāi Tahu whakapapa and creation stories is sourced from the words of the famed Kāi Tahu leader, Matiaha Tiramōrehu:

Nā Te Pō, ko Te Ao
Nā Te Ao, ko Te Ao Marama
Nā Te Ao Marama, ko Te Ao Tūroa
Nā Te Ao Tūroa, ko Te Koretewhiwhia
Nā Te Koretewhiwhia, ko Te Koreterawea
Nā Te Koreterawea, Ko Te Koretetamaua
Nā Te Koretetamaua, ko Te Korematua
E moe ana Te Mākū i Mahoranuiātea

Ka puta ko Raki Tuatahi e moe ana Raki i Pokoharuatepō Tuarua, e moe ana Papatūānuku.<sup>24</sup> From the night came the day From the day, the bright day

From the bright day, the longstanding day
From the longstanding day, the unattainable void
From the unattainable void, the intangible void
From the intangible void, the unstable void
From the unstable void, the parentless
Te Mākū, the damp, lay with Mahoranuiātea, the

great expanse of light And the Raki the Sky was born First, Raki lay with Pokoharuatepō Next, he lay with Papatūānuku the earth.

Wai is a central element in Kāi Tahu creation traditions and is present very early in the whakapapa of the world. In this korero, darkness gives rise to the light, and through an abyss of nothingness, moisture materialises as the first iteration of wai.

The whakapapa continues down to Rakinui and his wives, Pokoharuatepō and Papatūānuku. The children of Rakinui and his wives created the elements of te taiao, including mountains, rivers, forests, and seas, and all living things.

Kāi Tahu claim the same descent from Raki and his wives and are therefore connected to all things by whakapapa. Kāi Tahu tribal whakapapa thus links the cosmological world of the atua to present

<sup>&</sup>lt;sup>23</sup> Harmsworth, Awatere, & Robb, 2016.

<sup>&</sup>lt;sup>24</sup> Tiramōrehu, Van Ballekom, & Harlow, 1987.

and future generations, giving rise to a spiritual relationship with te taiao and a respect for the mauri of that environment.

Similarly, whakawhanaukataka is expressed in the resource management approach "Ki Uta Ki Tai", emphasising the holistic management of the interrelated elements within the natural environment. Water released by Raki makes its way into rivers, which in turn connect the entire landscape from the mountains to the sea. From the sea, water evaporates, condenses, and falls again on Papatūānuku, an eternal holistic cycle. The wai māori of Waiwhakaata contributes to the whakapapa of the catchment, flowing from the mountains to the lake through Hayes Creek to the Kawarau, which in turn becomes a major tributary of the Mata-au.

Whakapapa links whānau of today with Waiwhakaata through the actions of tīpuna in the past. Some kōrero link the lake with Hakitekura, a tipuna known for her feats of strength and bravery in the wider area. From the stories of the shaping and naming of the land by Rākaihautū, to the mātauraka gained over generations, the connection to Waiwhakaata continues.

#### 3.2 Mauri

Mauri flows from our living world and down through whakapapa, linking all aspects of our world. The mauri of water represents the essence that binds all things, acting as a life-giving force, and connecting the environment, from the mountains to the sea.

Mauri is an observable measure of environmental health and well-being. Waterbodies with an intact and strong mauri are characterised by good quality waters that flow with energy and life, sustain healthy ecosystems and support mahika kai and other cultural values. The primary resource management principle for Kāi Tahu is the protection of mauri. Concepts such as tapu, noa and rāhui are therefore applied by mana whenua to protect the mauri of a resource.

However, the mauri of a waterway is unable to protect itself against unnatural actions and interventions such as damming, diversions, altered flow regimes, discharges, and activities that impact on the riverbed. When the mauri of wai is degraded, there are multiple impacts. Physical effects may be noticeable in the environment, through changes in the āhua of the water, such as appearance, smell, colour, or taste. Changes in chemical composition or flow of water may also be present. These physical changes are likely to affect animal and plant species that live in surrounding ecosystems. Impacts might include the decline of species, usually natives, and over-population of other species, often those that are introduced. In turn, this alters the connection of mana whenua with a waterway, as mahika kai uses may become unsustainable if the mauri continues to degrade. From here, a loss of knowledge can occur, as the opportunities to share the stories, practices, and histories associated with a waterway diminish due to the lack of connection.

Kā Rūnaka have seen this pattern take place over and over throughout the history of European settlement in Te Waipounamu, with many behaviours and actions that undermine and degrade the mana and the mauri of our waterways still in evidence today. For Waiwhakaata, this history is tied to land usage practices in the catchment that have contributed to increased nutrient-loading and culminated in the existing water quality issues. The mauri of the lake is in stark contrast to the image evoked by the name Waiwhakaata; a lake of such clarity that it was likened to a mirror.



Whakaahua 6: Waiwhakaata from the Queenstown Trail

#### 3.3 Rakatirataka and Kaitiakitaka

Rakatirataka refers the exercise of mana in order to give effect to Kāi Tahu culture and traditions. In the management of the natural world, rakatirataka is underpinned by the obligations placed on mana whenua as kaitiaki. Kaitiakitaka is an expression of rakatirataka. Wai māori is a taoka that is governed under the domain of rakatirataka, in accordance with Kāi Tahu tikaka and the principles of kaitiakitaka.

The whakapapa connection with te taiao imposes a kaitiakitaka obligation on mana whenua to protect wai and all the life it supports, in accordance with customs, knowledge, and mātauraka developed over many generations. The duty of kaitiakitaka is not merely about guarding or caretaking; it involves acting as an agent for environmental protection and decision-making, on behalf of tīpuna and mokopuna. The focus of kaitiakitaka is to ensure environmental sustainability for future generations, as expressed in the whakataukī, 'Mō tātou, ā, mō kā uri a muri ake nei.'

For tīpuna, the state of the environment and the bounty of resources were significant measures of the mana of the people. Consequently, the current state of Waiwhakaata is a significant mamae to mana whenua. Under the tenets of kaitiakitaka, mana whenua consider it their duty to strive for the restoration of Waiwhakaata as an expression of their mana, and in the fulfilment of rakatirataka and kaitiakitaka roles.

#### 3.4 Mahika Kai

Mahika kai practices underpin the Kāi Tahu relationship with Otago's rivers, lakes, wetlands, moana, and the broader environment. The cultural identity of whānau and hapū is tied to their resources. Fundamental to Kāi Tahu culture is the ability to learn and practise customary gathering of food and other resources, to put kai on the table at the marae and at home, and to ensure that the knowledge of customary practices is passed on from generation to generation.

The inland lakes and waterways of the Otago region once supported rich and healthy mahika kai resources. The lakes, waterways and their surrounds attracted whānau who would travel inland from the coast to camp at nohoaka. These were often located adjacent to lakes and waterways to allow easy access to mahika kai activities.

For mahika kai to be sustained, populations of species must be present across all life stages and must be plentiful enough for long term sustainable harvest. Safe access to mahika kai sites must be available, kai must be safe to gather, safe to harvest and safe to eat and management and harvesting practices must be able to be carried out in accordance with tikaka.

Tūtohi 1: Mahika kai species associated with the Waiwhakaata area

Birds	Freshwater species	Plants
Weka	Tuna	Tī kōuka
Moa	Kōura	Taramea
Koreke	Kanakana	Āruhe
Manu kāhere		Raupō

The transmission of mātauraka necessitates whānau being able to access healthy mahika kai to carry out customary practices; however, this opportunity is extremely limited at Waiwhakaata. The historic degradation of the lake, and the continuation of damaging land-based activities on the surrounding whenua is continuing to exacerbate water quality issues. The impact is that the lake no longer supports many of the mahika kai practices that were known to be there in the past. Despite this, recent evidence suggest that tuna and koura are still present in Waiwhakaata. It is important that these taoka and indigenous species are protected through restoration and regeneration of their habitat.

Historical vegetation records and research indicates that the flora of area was most likely dominated by native scrub, shrub and tussock grasslands interspersed with isolated stands of tawai and tawairauriki. Small glades of native podocarp species kahikatea, mataī, and tōtara clustered along the banks of the Kawarau (see Whakaahua 7 below).

Native beeches like tawai and tawairauriki provide an important habitat for the beech scale insect or honeydew, a native species of aphid that is a vital food source for many native birds and insects. It lives in the bark of most types of native beech, providing a high-sugar, high-energy food source for  $t\bar{u}$ , korimako, and  $k\bar{a}k\bar{a}$ .

Podocarps like the kahikatea are members of the conifer family; they produce small berry-like cones that are highly attractive to forest bird species like  $t\bar{u}\bar{\imath}$ ,  $k\bar{a}k\bar{a}$ , and kea, species that are recorded as mahika kai species in the area. <sup>27</sup>

Certain mahika kai species were crucial to ensuring food security for southern Māori. The wider area is recorded as having been a source of kāuru, weka, kanakana, and tuna, which are referenced throughout the district as significant and plentiful food sources. These species were particularly suitable for preservation using several processes such as drying, baking, or storing in rendered fat, allowing medium to long-term storage over the cold, winter season in the south.

Wetlands surrounding the lake provided significant services to whānau in the past, as sources of food, fibre materials for weaving and construction, and fresh water filtered by the surrounding swamps and wetlands to the north and west of Waiwhakaata.

Indigenous biodiversity known to have been present in the area is listed in Tūtohi 2 below. Six of these species are considered threatened, including three native freshwater fish, the declining koaro and tuna, and the nationally endangered Central Otago roundhead galaxiid. 28 Two further species

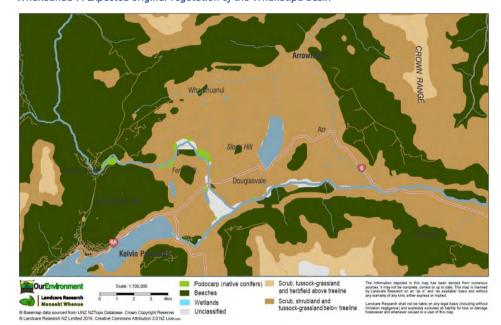
<sup>&</sup>lt;sup>25</sup> Davis, J., 2023, personal communication.

<sup>&</sup>lt;sup>26</sup> DOC, 2022; Orwin, 2007.

<sup>&</sup>lt;sup>27</sup> DOC, 2023a; TRONT, 2023.

<sup>&</sup>lt;sup>28</sup> Davis, 2018; QLDC, 2022.

associated with the area that are now extinct have not been included in this list; the moa, and the koreke.



Whakaahua 7: Expected original vegetation of the Whakatipu Basin

#### 3.5 Wāhi Tūpuna

Wāhi tīpuna are interconnected ancestral places, landscapes and taoka that reflect the history and traditions associated with the long settlement of Kāi Tahu whānui in Otago. Wāhi tīpuna are characterised not only by natural and physical aspects, but also by the place names and associated traditions and events that bind mana whenua to the landscape, just as the landscape itself is a part of Kāi Tahu identity. Such landscapes are linked by whakapapa in creation traditions, underpinning mana whenua status, and breathing life into mātauraka and tikaka. These are treasured places that transcend the generations.

Recorded archaeological sites in the wider area provide further evidence of the mana whenua associations in the upper lakes. Findspots indicate a collection of activities being undertaken, including mahika kai practices associated with food-gathering and toolmaking. The fires of occupation are also referenced in the presence of burnt and fire-shattered stone. The presence of moa bone in middens and ovens demonstrates that this area has a long history of occupation and use, including a period before the extinction of the moa over 500 years ago.

Tūtohi 2: Extant indigenous species associated with the Waiwhakaata area.

Name	Conservation status
Kautuku	Threatened – Nationally critical
Australasian bittern	
Kōtuku	Threatened – Nationally critical
White heron	
Central Otago roundhead galaxias	Threatened – Nationally endangered
Galaxias anomalus	
Kārearea	Threatened – Nationally vulnerable
Eastern falcon	·
Pāteketeke	Threatened – Nationally vulnerable
Great crested grebe	
Pārera	Threatened – Nationally vulnerable
Grey duck	
Kōaro	Threatened – Declining
Galaxias brevipinnis	
Kawau pū	At risk - Relict
Black shag	
Kōkōreke	At risk - Declining
Marsh crake	
Kōura	At risk - Declining
Freshwater crayfish	
Tuna	At risk - Declining
Eel	_
Upland bully	Not threatened
Gobiomorphus breviceps	
Tuna	Not threatened
Long-fin eel	
Kowhai	Not threatened
Sophora species	
Pūtakitaki	Not threatened
Paradise shelduck	
Kuruwheki	Not threatened
NZ shoveler	
Pāteke	Not threatened
Grey teal	
Pāpako	Not threatened
NZ scaup	
Matuku moana	Not threatened
White faced heron	
Pūkeko	Not threatened
Swamp hen	
Kōtare	Not threatened
NZ kingfisher	
Mikimiki	Not threatened
Coprosma areolata	
Tupare	Not threatened
Olearia colensoi	
Hakeke	Not threatened
Olearia ilicifolia	
Raupō	Not threatened
Typha orientalis	
Akiraho	Not threatened
Olearia paniculata	
Makura	Not threatened
Makara	

Tūtohi 3: Wāhi Tūpuna in the Waiwhakaata area

Name	Description	
Waiwhakaata	A small lake situated near the junction of the Kimiākau and the	
(Lake Hayes)	Kawarau.	
Kā-muriwai	The pākihi at Haehaenui in Central Otago, formerly known as Arrowtown Flat.	
Haehaenui	A river that rises in the Harris Mountains and flows in a southern	
(Arrow River)	direction past Waiwhakaata and into the Kawarau.	
Kawarau	A traditional travel route providing direct access between Whakatipu-waimāori and the Mata-au.	
Puahuru	The junction of the Kimiākau and the Kawarau in Central Otago	
Pōtiki-whatu-rumaki-nao	A natural rock bridge spanning the Kawarau and allowing people to cross the river.	

Tūtohi 4: Recorded Māori archaeological sites in the Waiwhakaata area

Name	Description
F41/1 Midden	Small pieces of moa leg bones and vertebrae Two dozen small quartz pebbles Three small flakes of silcrete Part of a blade of grey porcellanite A large thin silcrete blade snapped and retouched
F41/66 Oven (intact)	Cut and worked moa bone Burnt and fire-shattered quartz Artefacts of porcellanite and silcrete Silcrete blade
F41/67 Artefact - cache	Several intact and broken toki One whao 1 irregular flake of graywacke Associated with a shell midden
F41/442 Artefact - adze Toki Fragments of moa bone	

The nearby rivers of Haehaenui and Kawarau are recognised as wāhi tīpuna with values associated with ara tawhito, mahika kai, and nohoaka. Archaeological values are also recorded in relation to the Kawarau.<sup>29</sup> Ara tawhito enabled regular seasonal heke to the area surrounding Waiwhakaata as a destination that enabled access to significant resources including food and raw materials. Today, these values have been significantly eroded due to the continued degradation of the waterway.

# 3.6 Wāi Māori

Wai is an integral and enduring aspect of wāhi tīpuna. The Otago landscape is criss-crossed by many and varied waterbodies, from many sources, including lakes, awa and their tributaries, puna, and groundwater. Water is the lifeblood of the environment and of the many life forms that depend on it. Water, as a result, is of high significance for Kāi Tahu, both for its practical applications and for the spiritual meaning it embodies. Rivers are a symbol of permanence and a source of spiritual meaning.

<sup>&</sup>lt;sup>29</sup> QLDC, 2023.

Water was, and is, used extensively by mana whenua for spiritual and common uses. Wai is used to remove tapu, and in ceremonies. The indigenous flora and fauna supported by waterways like Waiwhakaata provided significant resources for whānau in the past, acting as a vehicle for the transmission of mātauraka related to mahika kai and other cultural practices across generations.

The wai that descends from the mountains to the great inland lakes is a taoka, reflecting the mana of the mountains and carrying an intact mauri. At Waiwhakaata in the past, the sediment-laden waters of its upper catchment entered at the lake having been filtered through many layers of wetland and swamp. The result was lake with water so pure that it was named Waiwhakaata, referencing water so clean that it could be used as a mirror. In the past, this water would eventually spill down into the Kawarau, feeding pure, clean wai māori into the lifeblood of the Mata-au.

Whakaahua 8: Waiwhakaata from Mill Creek



#### 3.7 Taoka

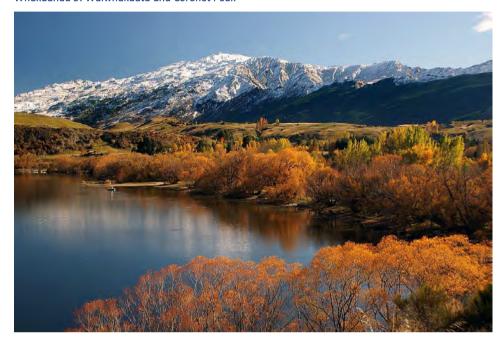
The term 'taoka' refers to cultural, physical, and metaphysical resources that are treasured by mana whenua, including practices, activities, and mātauraka associated with flora, fauna, and the natural world. In the context of the Ngāi Tahu settlement, taoka incudes: aspects of the natural environment like water or air; landscape features such as mountains, lakes, and rivers; locations and sites associated with the settlement and activity of tīpuna; and natural resources and species like pounamu, raupō, or tuna. Mahika kai is a significant taoka to Kāi Tahu and was a substantive component of both Te Kēreme and the settlement with the Crown.<sup>30</sup>

Indigenous species are valued as taoka by Kāi Tahu, as are the habitats in which taoka species survive and thrive. The ecosystems provided by wai māori, in lakes, rivers, wetlands, estuaries, and at the coast, offer lifegiving habitats for indigenous biodiversity. Whanaukataka is at the heart of this relationship, rather than an economic model of ownership. Thus, when the health of a waterway is degraded, the impacts are far-reaching, for the waterway, for the ecosystems, habitats, and species it supports, and for the people.

Waterways like Waiwhakaata are taoka for Kā Rūnaka. Their physical presence connects whānau today with their tīpuna in the past, but also with mokopuna, the future generations, placing an obligation that Kā Rūnaka will strive for the restoration and regeneration of these waterways. Imbued within the understanding of Waiwhakaata as a taoka is the lake as part of a natural system, as was seen through the eyes of ancestors in the days of the past.

<sup>30</sup> TRONT, 1997, Mahinga kai.

Whakaahua 9: Waiwhakaata and Coronet Peak



#### 4.0 E rite ana ki te karo o te moa: The Kāi Tahu history of loss

Te Tiriti o Waitangi was signed by representatives of Kāi Tahu whānui in late May and early June of 1840.<sup>31</sup> Subsequently, in 1844 and 1864, Kāi Tahu agreed a series of land sales with the Crown. Rather than acting in good faith, the Crown reneged on key elements of the agreements, resulting in widespread land alienation and economic deprivation for mana whenua.<sup>32</sup>

The 1848 Kemp's Deed was the largest of the Crown land purchases, comprising 13,551,400 acres for which £2,000 was paid. Although the deeds promised a tenth of the land would be retained as reserves for Kāi Tahu, less than 6,500 acres were allocated within the footprint of the deed.<sup>33</sup>

The meagre reserves that were afforded Kāi Tahu were clustered around the coast, with the pressures of colonisation meant that the relationship to te takutai moana was closely guarded, while the links to the inland areas diminished.

Barriers to following kā ara tawhito made visiting wāhi tīpuna and wāhi mahika kai as was done in the past more and more difficult. Over time, the ancestral lands were surveyed, on-sold, and settled. Wetlands were dammed; waterways were modified and drained. Changes in the landscape led to changes for the people, contributing to the displacement of whānau, loss of knowledge and identity, and the suffering of economic hardship.

The loss of connection to whenua that took place as a result of the Deeds, coupled with the visible deterioration and degradation of lakes, rivers, and waterways since that time, is a source of great mamae for mana whenua. This is particularly true given the obligations of mana whenua to fulfil their roles as kaitiaki whenua in their takiwā, mō tātou, ā, mō kā uri a muri ake nei.

When gold was struck in Otago in 1862, thousands flocked to Te Waipounamu to find their fortunes. In August of that year, alluvial gold was discovered by "Māori Jack" Tewa, a shearer who worked for William Rees, a runholder at present-day Queenstown. Jack Tewa is now recognised as "the original prospector of much of what became the Lakes District Goldfield, including the Shotover, Arrow, Glenorchy, and Skipper's Canyon fields."<sup>34</sup>

From the goldrush on, the impacts of layer upon layer of activity has influenced, altered, and damaged, the natural processes through which the lake managed itself in the past. Activities such as waterway modification, farming and growing, commercial and industrial activites, and housing development have contributed to increased sedimentation and phosphorous loading in the lake. These activities are summarised in Tūtohi 5 below.

Whakaahua 10: Waiwhakaata from Lake Hayes domain looking south



<sup>31</sup> Waitangi Tribunal, 1991, s4.2.

<sup>32</sup> Ibid.

<sup>33</sup> TRONT, 1997.

<sup>&</sup>lt;sup>34</sup> Carpenter, 2013, p. 112.

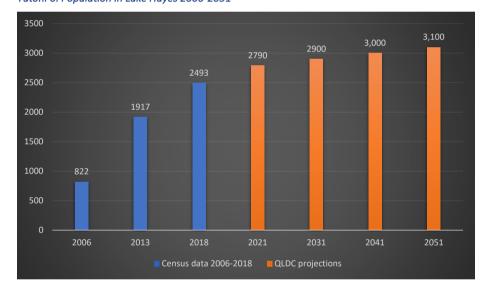
Tūtohi 5: A timeline of land-use activities in the Waiwhakaata catchment

Period	Catchment modification	Housing and construction	Farming and Growing activities	Commercial and Industrial
Pre-1880s			Land clearing	
1860- 1900	Brown trout released (1870) Perch released (1875-1880)	McIntyre Cottage (1860s) Ayreburn Farmstead (1864) Meadow Bank Farmstead (1864) Mill Farm (1865) Bridesdale Cottage (1865-1870) Steel's Cottage (1870s) Lake Hayes Farm (1873) Stone cottage/barn (1880-85)	Land clearing Exotic planting Sheep farming Cropping Orchards	Lake Hayes Hotel (1867) Wakatip Flour Mill (1868-1871) Arrow Flour Mill (1872) New Lake Hayes Hotel (1881-82)
1900- 1950		Threepwood Homestead (1909)	Sheep, cattle, dairy farming Arrow Irrigation Scheme (1926- 32) Bendemeer water race construction (1935-36)	Arrowtown Golf Club (1937) Coronet Peak Ski Field (1947)
1950- 1970	Wetland draining and artificial channelling (1961-62) First recorded pollution event (1961)		Introduction of superphosphates Aerial topdressing Topdressing plane crash in lake (1953) Pig farming, Mill Creek (1955)	Cheese factory – whey discharges (from 1955)
1970- 2000	Ongoing cutting and draining Loss of wetland buffering		Superphosphates Intensive pastoralisation	Cardrona Alpine resort (1980) Millbrook Country Club (1989) Millbrook Golf Course (1992) Millbrook Resort (1993)
2000- 2023	Lake Hayes Restoration and Monitoring Plan (2017) Lake Hayes South restoration (2018) Waiwhakaata rehabilitation J4N project (2021) ORC Restoring Lake Hayes project (2021)	Lake Hayes Estate (2012) HawkRidge Estate (2014)	Land clearing Orchards Exotic planting	The Hills Golf Course (2007) Millbrook Golf Course expansion (2009, 2018)
Future		Waterfall Park Hayes Creek Development Te Pūtahi/Ladies Mile		

This history of land use in the catchment has directly contributed to water quality issues associated with runoff of phosphorous, with 70% of nutrient loading to the lake attributed to overland flows. <sup>35</sup> Four primary influences have been identified as the main causes of nutrient loading through sedimentation.

- 1. Runoff of nutrients from farms due to fertiliser application and animal waste
- 2. Loss of vegetation on, and adjacent to, river banks
- 3. Drainage of wetlands
- 4. Erosion.<sup>36</sup>

Housing and recreation adds further pressure through irrigation, clearing of land, and stormwater runoff. Afforestation to enable housing development has created tracts of bare land, which, in some cases, have remained undeveloped for significant periods despite granting a consents to proceed. Both Mill and Hayes Creeks are now surrounded by housing estate. Consequently, the area around the lake has demonstrated considerable population growth, with further growth projected through to 2051 (see Tūtohi 6 below).



Tūtohi 6: Population in Lake Hayes 2006-2051

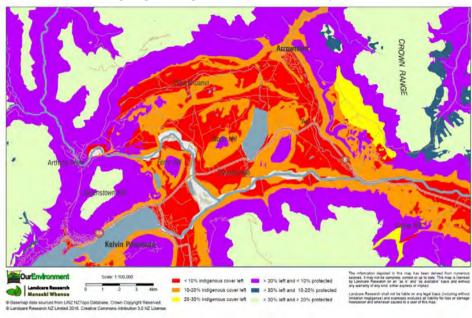
Golf courses located to the north of the lake may also have a bearing; land use practices associated with this particular recreational activity are known to impact water quality through entry into waterways of fertilisers, pesticides, and other contaminants via runoff or groundwater infiltration.<sup>37</sup>

Forestry and the spread of exotic plant species adds another layer of impact. Consequently, the majority of land bordering Waiwhakaata has less than 20% indigenous cover remaining (see Whakaahua 11 below).

<sup>&</sup>lt;sup>35</sup> Davis, 2018; ORC & QLDC, 1995.

<sup>&</sup>lt;sup>36</sup> Schallenger & Schallenger, 2017.

<sup>&</sup>lt;sup>37</sup> Guzmán & Fernández, 2014.



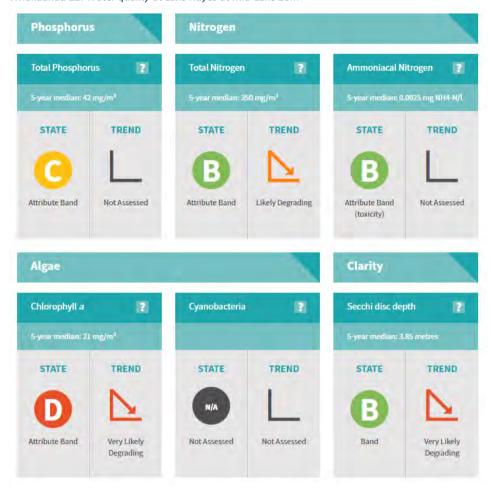
Whakaahua 11: Remaining indigenous vegetation cover in the Whakatipu Basin

The culmination of these influences is the recognised issues with water quality at the lake, particularly in terms of the level of total phosphorous and chlorophyll a, and poor water clarity (see Whakaahua 12 below for further details). These changes to the catchment have had significant impacts on mana whenua values for Waiwhakaata. Land usage and catchment modification has changed the nature of the lake, which has effectively stopped the natural processes of filling and flushing that enabled the lake to manage itself in the past.

Phosphorous laden sediment continues to flow in via Mill Creek, but now without the wetland complexes at its borders, which were once able to filter out sediments before they reached the lake. The result is that the mauri of Waiwhakaata has been significantly degraded. The impact of this degradation extends to the waterways that Waiwhakaata once fed, the Kawarau and the Mata-au.

The loss of wetlands and indigenous vegetation, and the decline in water quality in the lake, have contributed to the loss of opportunities for mahika kai activities. These were an integral component of mana whenua connection to the area of the inland lakes in the past. Without these opportunities, the associated practices, mātauraka and transition of knowledge has been affected, which in turn has significant impacts for the cultural identify of Kāi Tahu whānui.

Restoration activities related to Waiwhakaata need to go beyond scientific and engineering solutions to the problems in the lake. The restoration of mauri must be the focus of these activities in order to ensure that Te Mana o te Wai, that is, the health and wellbeing of the waterway and the indigenous biodiversity it supports, is upheld.



Whakaahua 12: Water quality at Lake Hayes at Mid-Lake 10m

## 5.0 He ara poutama: Relevant legislation and policy

## 5.1 Ngāi Tahu Claims Settlement Act 1998

The NTCSA 1998 was enacted to settle the historical Ngāi Tahu claims against the Crown and provides redress under Te Tiriti o Waitangi. The Crown apology in section 4 explicitly recognises the rakatirataka of Kāi Tahu within its takiwā. The Act provides specific provisions that provide for the exercise of rakatirataka and kaitiakitaka by mana whenua in relation to mahika kai, taoka species, and other resource management matters.

## 5.2 Resource Management Act 1991

In achieving the purpose of RMA 1991, particular regard is required to kaitiakitaka.<sup>38</sup> Kāi Tahu whānau exercise kaitiakitaka in this catchment. Tikaka indicates that whānau must strike a balance between the right to access and use natural resources, and the responsibility to care for te taiao, with a focus on providing a sustainable base for future generations; this is the basis of kaitiakitaka, as expressed in the whakataukī, 'Mō tātou, ā, mō kā uri a muri ake nei.'

## 5.2 National Policy Statement for Freshwater Management 2020

Te Mana o te Wai is a fundamental concept in the NPSFM 2020 and refers to. "...the fundamental importance of water and recognises that protecting the health of freshwater protects the health and well-being of the wider environment. It protects the mauri of the wai."<sup>39</sup>

The concept of Te Mana o te Wai represents a significant paradigm shift in freshwater management. The previous focus on the scale and significance of the effects of resource use is now redirected onto the mauri or life-force of water and the enquiry becomes, how do users of resources protect the water's health and well-being?

Mana whenua have undertaken a robust process to define Te Mana o te Wai in Otago, informed and framed by a vision for freshwater that aligns with the central elements of the creation traditions. This definition is informed by knowledge and mātauraka about te taiao and wai māori.

The primary objective of the NPSFM is to ensure that natural and physical resources are managed in a way that prioritises:

- first, the health and well-being of water bodies and freshwater ecosystems.
- second, the health needs of people (such as drinking water).
- third, the ability of people and communities to provide for their social, economic, and cultural well-being, now and in the future.<sup>40</sup>

## 5.3 Proposed Otago Regional Policy Statement 2021

Waiwhakaata forms part of the Mata-au catchment. The PORPS vision for the Mata-au FMU is that:

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<sup>&</sup>lt;sup>38</sup> RMA 1991, s.7(a).

<sup>&</sup>lt;sup>39</sup> NPSFM 2022, s.1.3.

<sup>&</sup>lt;sup>40</sup> Ibid.

- Management of wai māori recognises that the Mata-au is a single connected system ki uta ki tai, and that the source of the wai is pure, coming directly from Tāwhirimātea to the top of the mauka and into the awa.
- The ongoing relationship of Kāi Tahu with wāhi tīpuna is sustained.
- Water bodies support thriving mahika kai and Kāi Tahu whānui have access to mahika kai.
- Indigenous species migrate easily and as naturally as possible along and within the river system.
- In the Upper Lakes rohe, the high quality waters of the lakes and their tributaries are protected, recognising the significance of the purity of these waters to Kāi Tahu and to the wider community.<sup>41</sup>

The PORPS provides for Te Mana o te Wai and recognises that:

- water is the foundation and source of all life na te wai ko te hauora o ngā mea katoa.
- there is an integral kinship relationship between water and Kāi Tahu whānui, and this
  relationship endures through time, connecting past, present and future.
- each water body has a unique whakapapa and characteristics.
- water and land have a connectedness that supports and perpetuates life.
- Kāi Tahu exercise rakatirataka, manaakitaka and their kaitiakitaka duty of care and attention over wai and all the life it supports.<sup>42</sup>

## 5.4 QLDC Spatial Plan

The QLDC Spatial Plan is described as "a tool to support and direct change that benefits the wellbeing of the Queenstown Lakes community and New Zealand both now and into the future."<sup>43</sup> Collaboration with Kāi Tahu as has enabled the inclusion of a mana whenua values framework that has been used to identify the outcomes sought by mana whenua in the delivery of the Spatial Plan (see Tūtohi 7 and Whakaahua 13 below). The plan's operationalisation is directed by a governance board that includes direct representation from Kā Rūnaka.

Kāi Tahu values and outcomes in the QLDC Spatial Plan strongly echo key aspects of the values identified in section 4. Moreover, several of the spatial elements identified showing clear alignment with the mana whenua values and intentions identified in this report, for example,

- Avoidance of further urban development in the Wakatipu Basin beyond Te Pūtahi Ladies Mile.
- Exclusion of Waiwhakaata from housing intensification areas.
- Phasing out of wastewater and stormwater discharges to lakes and rivers.
- Enhancement and protection the Blue-Green Network.<sup>44</sup>

<sup>&</sup>lt;sup>41</sup> PORPS 2021. LF–VM–O2 – Clutha Mata-au FMU vision.

<sup>&</sup>lt;sup>42</sup> PORPS 2021, LF–WAI–O1 – Te Mana o te Wai.

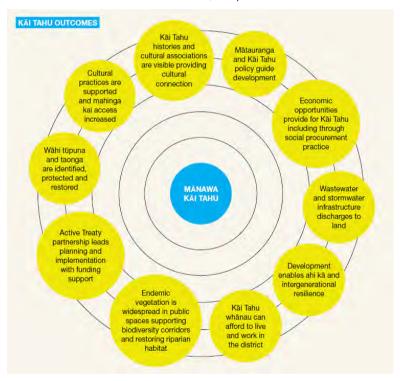
<sup>&</sup>lt;sup>43</sup> QLDC, 2021, p. 12.

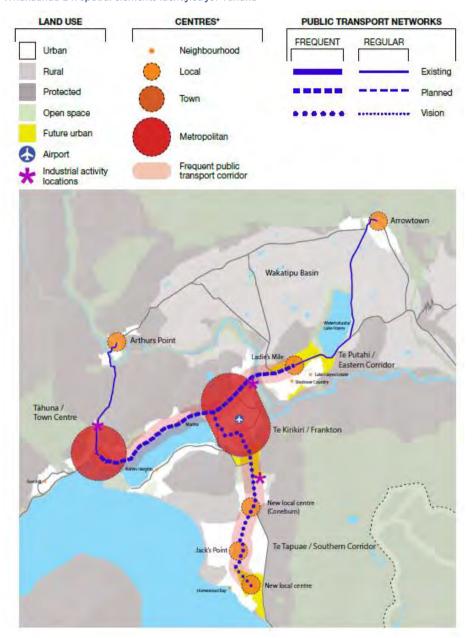
<sup>&</sup>lt;sup>44</sup> QLDC, 2021, pp. 48ff. See Whakaahua xx-xx below for maps relating to these spatial elements.

Tūtohi 7: Kāi Tahu values in the QLDC Spatial Plan

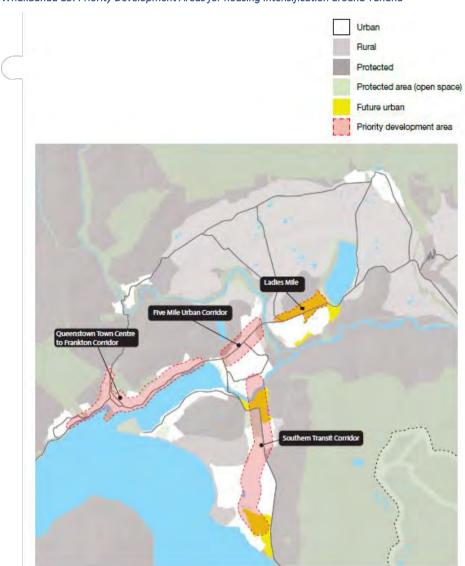
VALUE	DESCRIPTION	APPLICATION	
Whanaukataka	Family and community focused	Ensuring consideration of the social implications of decisions to enable community and whanau connections and growth.	
Manaakitaka	Hospitality	Demonstrating behaviour that acknowledges others, through the expression of aroha, hospitality, generosity and mutual respect.	
Rakatirataka	Leadership	Ensuring the treaty partnership is recognised to enable mana whenua leadership in decision making processes.	
Haere whakamua	Future focused	Adopting a forward looking orientation with future generations in mind.	
Tikaka	Appropriate action	Ensuring consideration of the appropriateness of decisions that will habearing on social, economic, environmental and cultural outcomes.	
Kaitiakitaka	Stewardship	Enabling the inherited responsibility of mana whenua to support and protect people, the environment, knowledge, culture, language and resources on behalf of future generations.	
Mauri	Life force	Recognising the life force in all lands, waters and the natural environmen that stems from time immemorial, requiring a high duty of care for kaitiak (and others) to maintain an intact and healthy mauri, ensuring that what is gifted from the Atua is not neglected.	

Whakaahua 13: Kāi Tahu outcomes in the QLDC Spatial Plan





Whakaahua 14: Spatial elements identified for Tāhuna



Whakaahua 15: Priority Development Areas for housing intensification around Tāhuna

SOCIAL INFRASTRUCTURE: NEW PROVISION OR MAJOR UPGRADE BLUE - GREEN NETWORK Enhanced / new green corridor School (primary or secondary) QLDC park Community facility / library Open Space Health facility QEII Trust covenant Major open space / public realm Significant Natural Area Active Recreation (large sport park, recreation centre or pool) Existing trail Proposed trail connection Indicative future need in the general location Wakatipu Basin Te Kirikiri / Frankton

Whakaahua 16: Blue-Green networks and social infrastructure around Tāhuna

## 6.0 He mahi kai hōaka: Statement of Expectation

Ka ora te wai, ka ora te whenua, ka ora ai te tākata. When the water is healthy and the land is healthy, then the people are healthy.

This whakataukī conveys the intrinsic holism that permeates te ao Māori. Mana whenua values for te taiao are strongly grounded in the principle ki uta ki tai, recognising that all aspects of our environment are interconnected, and we are connected to it. In the case of Waiwhakaata, the health of the lake reflects the health of the wider community. For mana whenua this means that the people will not be healed until the land and water are healed." <sup>45</sup> Consequently, Kā Rūnaka recognise the significant role that human activity plays in the outcomes we see in our environment, <sup>46</sup> as well as the significant role that we can play in environmental protection. Through our actions, we can restore the balance between what is taken from Waiwhakaata, and what is given back.

Rūnaka aspirations and intentions for Waiwhakaata reflect the values that were held by tīpuna in the past and that have been handed down as kawa, mātauraka, and tikaka. This confers an obligation upon mana whenua to actively seek the restoration of the mauri of the lake. To this end, Kā Rūnaka have identified the following seven expectations for this project.

## 6.1 The restoration of Waiwhakaata upholds the rakatirataka and mana of Kā Rūnaka.

The rakatirataka and kaitiaki responsibilities of Kāi Tahu in their takiwā are recognised under the Ngāi Tahu settlement with the Crown, with kaitiakitaka further enforced under the RMA 1991 and the NPSFM 2020. These mechanisms recognise the manawhenuataka of Kā Rūnaka, indicating their status as kaitiaki within their takiwā.

For the restoration of Waiwhakaata to uphold the rakatirataka and mana of mana whenua, the following expectations will need to be met:

- 6.1.1 The project is undertaken as a partnership between mana whenua, ORC, and QLDC.
- 6.1.2 The partnership is a living relationship that requires ongoing effort, commitment, and negotiation.
- 6.1.3 Mana whenua representation is an integral component of the project's governance, strategic oversight, and overall delivery, supported by appropriate resourcing.
- 6.1.4 Kā Rūnaka are central to decision-making about how to manage environmental events and algal blooms at Waiwhakaata.

## 6.2 The restoration of Waiwhakaata upholds the mana and mauri of the lake.

For the last 150 years, the needs of people and human activity has been prioritised over the health and wellbeing of Waiwhakaata. However, under the concept of Te Mana o te Wai, emphasis and priority is given to "the fundamental importance of water," recognising that "protecting the health of freshwater protects the health and wellbeing of the wider environment." This approach substantively aligns with Māori perspectives relating to freshwater management.

<sup>47</sup> NPSFM 2022 s.1.3(1).

<sup>&</sup>lt;sup>45</sup> J. Davis, 21 April 2023 (personal communication).

<sup>&</sup>lt;sup>46</sup> Shearer, 1986.

The restoration of the mauri of the lake requires the reestablishment of the catchment as a natural freshwater system and as part of an integrated catchment ki uta ki tai. To achieve this intention for Waiwhakaata, the following expectations will need to be met:

- 6.2.1 The lake is recognised as part of an integrated freshwater system, ki uta ki tai, encompassing the Mill Creek catchment, and extending to the Mata-au and to the sea.
- 6.2.2 Monitoring and assessment shows improved water quality and quantity in the lake, and the wider catchment.
- 6.2.3 Sediment and phosphorous contamination is reduced by at least 20%.
- 6.2.4 The natural form and function of tributaries are reinstated through re-establishment of wetland areas, and removal of barriers and structures on stream banks and beds.
- 6.2.5 Lowland areas, creeks, and indigenous habitats from activities that adversely affect mana whenua values, particularly those that contribute to sedimentation and nutrient loading within Waiwhakaata and the catchment.
- 6.2.6 The ecological services that wetlands can provide to support the lake's regeneration are recognised and valued as a primary means of addressing water quality issues in the catchment.

Whakaahua 17: Tuna being fed



## 6.3 The restoration of Waiwhakaata enables the regeneration of indigenous biodiversity and mahika kai values.

Abundant and thriving indigenous biodiversity is a key indicator of the mana and mauri of freshwater systems like Waiwhakaata. Indigenous species are taoka to Kāi Tahu, as recognised in the Ngāi Tahu Settlement Act 1998. Mahika kai practices are similarly recognised in the settlement. Mahika kai is a significant source of identity for mana whenua, reflecting the activities' cornerstone contribution to the intergenerational transmission of mātauraka Kāi Tahu.

In order for the restoration of Waiwhakaata to meet mana whenua expectations for mahika kai and indigenous biodiversity, the following expectations need to be met:

- 6.3.1 Remnant populations of indigenous species like tuna and koura are identified, monitored, and protected, and their habitats are restored and reinvigorated.
- 6.3.2 Instream and riparian habitats support thriving ecosystems, providing a suitable environment for re-establishment of absent species, either through translocation or natural repopulation.
- 6.3.3 Lake-edge wetlands are restored, including the removal of exotics species like willow and poplar, and suitable indigenous revegetation.
- 6.3.4 Indigenous species are abundantly present in and on the water across the lake, tributaries, wetlands, and springs.
- 6.3.5 Whānau engage in mahika kai practices in Waiwhakaata, and the surrounding catchment, based on the tikaka and kawa of mana whenua. There is good access to suitable sites, and the kai is safe for consumption.
- 6.3.6 The removal of vegetation within the catchment is undertaken to ensure best-practice management of erosion and sediment control.
- 6.3.7 Remnant biomes in the catchment are identified, protected, restored, and revitalised. Corridors and connections are established between remnant biomes in order to support ecological restoration and growth.

## 6.4 Mechanisms are established to reduce land-based effects on waterway health.

A significant driver of water quality and quantity issues is the land-based practices and activities in the catchment, such as farming, forestry, and residential and tourism development. For the mauri of Waiwhakaata to be restored, it is crucial that these practices are managed to reduce effects on water quality and quantity. The following expectations express how this outcome can be met:

- 6.4.1 Land management practices are undertaken in a way that promotes improvements in water quality.
- 6.4.2 Land use is increasingly diverse and intensive land practices are reducing.
- 6.4.3 Discharges are predominantly to land and are treated to a high standard.
- 6.4.4 Subdivisions and development activities are undertaken in such a way as to support and protect the mauri of the lake.
- 6.4.5 Contaminated land is being actively restored.

## Whakaahua 18: Tī kōuka in flower



## 6.5 Mātauraka, research, and education are central to the project's methodology.

For this project to truly succeed, education needs to be at its heart both for whānau, and for the community. Kā Rūnaka see education as a means of engaging the community and restating their long-standing connection with this place. Moreover, for mana whenua aspirations and intentions to be enacted, there must be opportunities for whānau to practice mahika kai and mātauraka in the catchment. For these outcomes to be achieved, the following expectations must be met:

- 6.5.1 Sites within the catchment that support mahika kai and biodiversity values are identified and resourced for mātauraka and educational purposes.
- 6.5.2 Wānaka, noho, and other activities that support mana whenua values for the catchment are being delivered with and by whānau.
- 6.5.3 Scientific assessment and monitoring activities relevant to the project prioritise and facilitate whānau involvement, collaboration, and leadership.
- 6.5.4 Whānau are leading and contributing to mātauraka-based activities in the catchment to assess and monitor the mauri of the lake and its biodiversity, and their findings are given due weighting alongside scientific methods.
- 6.5.5 Programmes, events, communications, and activities are being delivered to promote community engagement and education on mana whenua values, aspirations, and intentions for Waiwhakaata, and on actions that can be undertaken to support these values.

6.5.6 Suitable physical manifestations of mana whenua values, aspirations, and intentions for Waiwhakaata are initiated, for example, through naming and nomenclature, signage, or art and design.

## 6.6 The restoration of Waiwhakaata protects values associated with Māori archaeology.

It is crucial that any remaining archaeological evidence is protected in the course of any works in the area. Given the long history of association with the area, the following expectation applies:

6.6.1 An accidental discovery protocol is adopted for physical works associated with the project.

## 6.7 The restoration of Waiwhakaata provides opportunities for employment and broader social outcomes for Kāi Tahu whānui.

For the project to truly express mana whenua values, the benefits of the project will be equitably spread across the community, including whānau and Rūnaka. For this to be successful, the following expectations would need to be met:

- 6.7.1 The delivery of the project provides equitable opportunities for broader outcomes that benefit whānau, Rūnaka and Kāi Tahu whānui through contracting, procurement, employment, and capability-building opportunities.
- 6.7.2 The project advances the capacity and capability of Kāi Tahu whānau and Rūnaka, including through co-delivery, direct contracting and employment, and internships, secondments, and apprenticeships.

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## Appendix 1: Glossary of Māori terms

Āhua Nature, appearance

Ahikāroa The long-burning fires of occupation

Akiraho Olearia paniculata
Ara tawhito Ancestral trails

Atua Deity, early ancestor

Hapū Clan, clans
Hakeke Olearia ilicifolia

Heke Migration, movement

Kāika Villages

Kārearea Eastern falcon

Kāuru The edible part of the tī kouka or cabbage tree

Kaitiakitaka The exercise of guardianship by the mana whenua of an area in

accordance with tikaka Māori in relation to natural and physical

resources, and includes the ethic of stewardship

Kanakana Lamprey

Kautuku Australasian bittern

Kawau pū Black shag
Kimiākau Shotover River
Koekohe Hampden Beach

Kōaro Whitebait Kōkōreke Marsh crake

Kōrero Story

Kötare New Zealand kingfisher

Kōtuku White heron

Koreke New Zealand quail

Korimako Bellbird

Kuruwheki New Zealand shoveler Mātauraka Knowledge, wisdom

Mahika kai Practices, knowledge, and activities related to food gathering,

including food gathering resources and species

Makura Carex secta
Mamae Pain, distress

Mana Status, prestige, honour

41

Mana whenua Customary authority exercised by an iwi or hapū in an identified area,

and the people mandated to exercise it on their behalf

Manawhenuataka The tikaka and kawa associated with mana whenua status.

Manu kāhere Forest birds like tūī, kāka and kea.

Mata-au Clutha River

Matuku moana White-faced heron

Mauri Life force, life essence

Mikimiki Coprosma areolata

Mokopuna Grandchildren, descendants

Mōkihi Reed raft

Murihiku The area of Te Waipounamu south of the Waitaki River

Murihiku ki te Raki The area of Te Wai Pounamu now known as Otago

Murihiku ki te Toka The area of Te Wai Pounamu now known as Southland

Noa Free from tapu

Nohoaka Settlements, sites of occupation

Pā Fortified settlement

Pākihi Open grasslands, plains, flat ground

Pāpako New Zealand scaup

Pārera Grey duck Pāteke Grey teal

PūtaitaiAustralasian shovelerPūtakitakiParadise shelduckPāteketekeGreat crested grebe

Rāhui A temporary ritual prohibition
Rakatira Chief, person of high rank

Rakatirataka Chiefly authority

Raupō Bullrushes

Takiwā Territory, district

Taoka Treasure

Tapu Restriction, prohibition

Taramea Speargrass
Tawai Silver beech
Tawairauriki Mountain beech

 Te taiao The natural environment
Tikaka Correct procedure, custom

Tipuna Ancestor (singular)
Tipuna Ancestors (plural)

Toki Adze, adzes

Tuna Eel

Tupare Olearia colensoi
Wāhi mahika kai Food-gathering sites

Wāhi tīpuna Ancestral landscape of significance to iwi

Wai Water
Waihemo Shag River
Wai māori Freshwater

Waka Canoe

Whānau Family, families
Whakapapa Genealogy
Whakataukī Proverb

Whakatipu-waimāori Lake Whakatipu Whakatipu-wai-tai Lake McKerrow

Whanaukataka A sense of family connection

Whao Chisel

## Appendix 2: Acronyms and abbreviations

DOC Department of Conservation

KTKO Kāi Tahu ki Otago (now trading as Aukaha (1997) Ltd.)

LAWA Land Air Water Aotearoa LTP 2021-2031 ORC Long-term Plan 2021-2031

NPSFM 2022 National Policy Statement 2020 (2022 revision)

NRMP Natural Resource Management Plan
NZAA New Zealand Archaeological Association

ORC Otago Regional Council

PORPS 2021 Proposed Otago Regional Policy Statement 2021

QLDC Queenstown Lakes District Council RMA 1991 Resource Management Act 1991

TRONT Te Rūnanga o Ngāi Tahu

## Appendix 3: Tables and figures

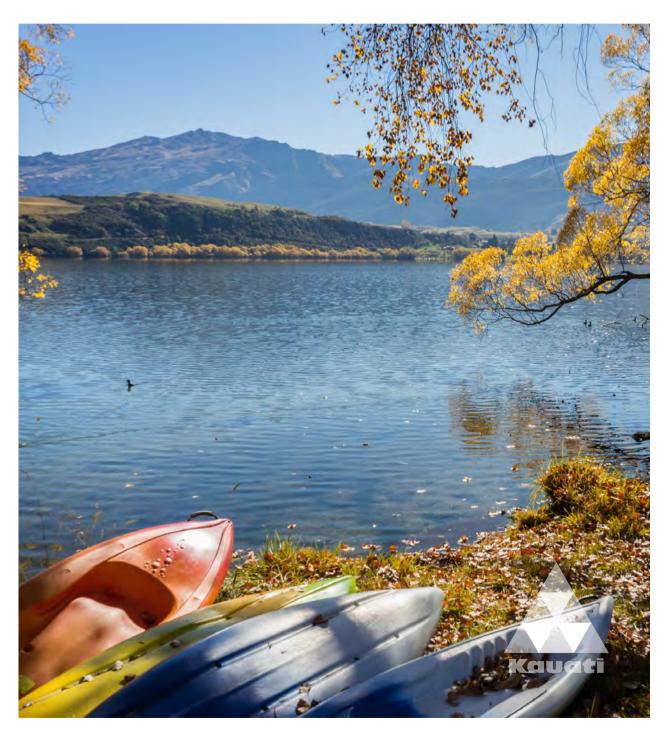
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# Ngāi Tahu ki Murihiku Environmental Statement of Expectation Waiwhakaata / Lake Hayes



Environmental Implementation Committee - 8 May 2024

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**Report date:** 20 June 2023

**Reviewed by:** Stevie Blair, Te Ao Marama Inc, and Jana Davis, representative on the Wai

Whakaata Lake Hayes Rehabilitation Project

**Approved by:** Te Ao Marama Inc.

Noted by: Aukaha





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This Environmental Statement of Expectation was written by Kauati for Te Ao Marama Inc on behalf of Ngāi Tahu ki Murihiku to be used by whānau and the Ngāi Tahu representatives on the Wai Whakaata Lake Hayes Rehabilitation Project, and is funded by the Otago Regional Council.

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## **MIHIMIHI**

Nāia te mihi ki ngā tangata mātau kua manaaki mai ki te kaupapa nei, Jana Davis, Gill Hopkins, Rewi Davis, Darren Rewi, Mike Rewi, Pere Rewi, Nikau Farrell, and Stevie Blair. Ko koutou te puna mātauranga, te mea whakahirahira o tēnei rīpota.

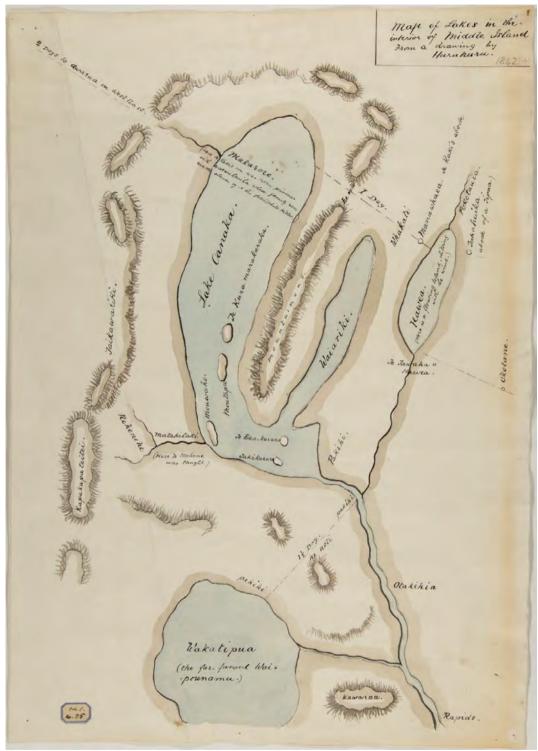
Ngā tomairangi o ngā tūpuna, hei whangaia ngā kākano nō apopo The efforts of today will give life to the seeds of tomorrow

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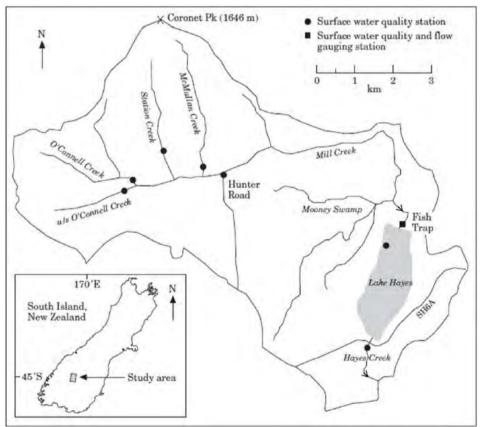
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Huruhuru Map of Whakatipu Waimāori, Wānaka and Hāwea, 1842. Hocken Library.



Waiwhakaata/Lake Hayes, Ka Huru Manu, 2023



Waiwhakaata / Lake Hayes area, taken from the Lake Hayes Restoration and Monitoring Plan 2017

## **ENVIRONMENTAL STATEMENT OF EXPECTATION**

The restoration of Waiwhakaata/Lake Hayes presents an opportunity for Ngāi Tahu Whānui to connect with their ancestral lands and waters and develop improved outcomes at local and regional levels. These connections have been frayed over the decades due to land alienation that has had a significant impact on Ngāi Tahu Whānui leading to detrimental social, cultural and economic effects. Ngāi Tahu ki Murihiku look to the restoration project to exercise their rangatiratanga as aligned with their expectations.

This Environmental Statement of Expectation outlines strategic objectives for Waiwhakaata through the mātauranga, kawa and tikanga of Ngāi Tahu ki Murihiku. This is a critical first step for Ngāi Tahu ki Murihiku in considering biocultural, environmental, and intergenerational outcomes for the lake and catchment. This approach aids Ngāi Tahu Whānui with:

- 1. Long-term visioning and goal setting.
- 2. Defining baselines, expectations and measures of success.
- 3. Identifying where the best points of influence are for any matters to be addressed or progressed.
- 4. Commonality in reasoning and outcomes sought.
- 5. Effectively using everyone's skills, time and resources.

Much of what is contained in this Statement comes from other sources including the Ngāi Tahu Deed of Settlement and Settlement Act 1998, and the Murihiku lwi Management Plan Te Tangi a Tauira (**Te Tangi**). Information was also collated through a site visit by Ngāi Tahu Whānui to Waiwhakaata who applied two Ngāi Tahu ki Murihiku designed and lead assessments tools, Āpiti Hono Tātai Hono and the Murihiku Cultural Waters Classification System.

The strength of an Environmental Statement of Expectation is that it draws together relevant information in one place for a clear and defined purpose. It is the starting point, a mauri stone to refer to. It is written with the expectation that new information will be generated over time that can be read in conjunction with the Environmental Statement of Expectation to determine the appropriate responses and methods for the ongoing management of Waiwhakaata and the Lake Hayes catchment.

This proactive approach encourages innovative actions based on Ngāi Tahu expectations and the opportunities put before Ngāi Tahu as decision-makers, kaitiaki and manawhenua as well as being 'locals'. This positioning is particularly important for the Ngāi Tahu representatives on the Wai Whakaata Lake Hayes Rehabilitation Project due to the complex issues facing Waiwhakaata and the catchment. The Environmental Statement of Expectation also moves Ngāi Tahu representatives away from having to react and spend limited resources on matters and problem definitions that may be fundamentally misaligned with their paradigms.

This Environmental Statement of Expectation does not stand alone from or supersede other manawhenua derived documents, reports, and advice. It is to be read alongside Te Tangi and other iwi management plans, Ngāi Tahu policies, value statements, and operational procedures with associated methods, tools and timeframes.

## HISTORICAL AND CONTEMPORARY ASSOCIATIONS WITH WAIWHAKAATA

The Ngāi Tahu relationships with Waiwhakaata and the broader landscapes, resources and associations remains culturally important. Waiwhakaata sits within ancestral lands that form part of the Ngāi Tahu identity, a timeless whakapapa relationship formed from tangible and intangible elements. The relationships are not solely defined by archaeological sites or Māori sites of significance. The cultural heritage of Ngāi Tahu is heavily etched on the place, and while remnants of a physical presence are at times light, this is reflective of Ngāi Tahu occupation being extensive rather than intensive.



Lake Hayes, circa 1885, New Zealand, by Burton Brothers. Purchased 1991. Te Papa (0.004714)

Waiwhakaata and the Queenstown Lakes District is in the Ngāi Tahu takiwā. Ngāi Tahu has centuries' long customary associations, rights and interests in the district and its resources. These associations, rights and interests are both historical and contemporary and include whakapapa, place names, mahinga kai, tribal economic development and landholdings. In the Whakatipu Basin, manawhenua is exercised by seven Papatipu Rūnanga³ on behalf of Ngāi Tahu whānui. This right is derived from mana ātua (gods), mana tūpuna (ancestors), mana whenua (land) and mana tangata (people).

Historically, Whakatipu Waimāori, Kawarau, Te Papapuni/Nevis area, Haehaenui/Arrow River have long formed part of the extensive network of kāik, mahinga kai and ara tawhito throughout this region connecting to the pounamu seams, inland lakes and out to the Otago and Southland coasts. The inland routes from the coast to the mountains tended to follow land features and utilise the waterways. Nohoanga along these routes were usually located around lakes or waterbodies. <sup>5</sup>

<sup>&</sup>lt;sup>1</sup>The takiwā of Ngāi Tahu is described in section 5 of the Te Rūnanga o Ngāi Tahu Act 1996.

<sup>&</sup>lt;sup>2</sup> Queenstown Lakes District Plan, Chapter 5

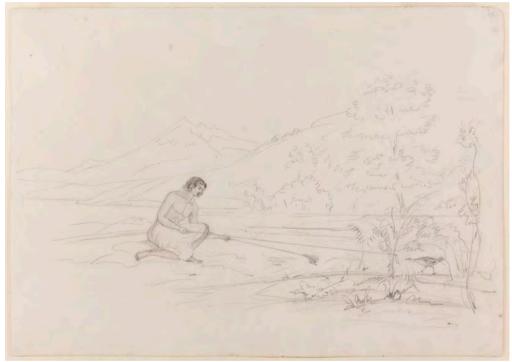
<sup>&</sup>lt;sup>3</sup> Awarua, Hokonui, Moeraki, Ōraka-Aparima, Ōtākou, Puketeraki, Waihōpai.

<sup>&</sup>lt;sup>4</sup> Barlow, C. (1991) Tikanga Whakaaro: Key concepts in Māori culture, pp. 61-2.

<sup>&</sup>lt;sup>5</sup> Ritchie, N. (1986) 'Archaeology and Prehistory in the Upper Wakatipu', *Journal of Pacific Archaeology*, p.245

Whakatipu Waimāori/Lake Wakatipu supported nohoanga that were the seasonal destinations of Otago and Southland whānau and hapū, and occasionally permanent kaik were established for generations. Waiwhakaata had no known permanent Ngāi Tahu settlement, although there would have been nohoanga. There are well-developed ara tawhito along the rivers and a rock shelter with distinctive Māori rock art along the banks of Haehaenui.<sup>6</sup>

As a society that worked within the limits of the physical environment, Ngāi Tahu cultural and social systems evolved according to those limits. People were heavily reliant on resources being found in specific areas along the route to either consume or harvest for future use. Around Waiwhakaata, targeted mahinga kai species were weka, koreke, tuna, aruhe, kāuru and kōura and they provided a large proportion of the protein attained from the area.



Heaphy, C. (n.d.) [Maori snaring bird]. Auckland War Memorial Museum - Tamaki Paenga Hira. PD-1952-2-2-12

Waters, stones, minerals, muds, clays, and plants were also harvested for use in situ or to be taken back to permanent settlements or traded. The waters from hukawai (melt waters) are culturally regarded as highest level of purity and were accorded traditional classifications by Ngāi Tahu that recognised this value.<sup>8</sup> Quarries and 'working floors' where adzes and other tools (chisels, cutters, drills) were created are common throughout Murihiku. Dr. Henry Skinner, former director of the Otago Museum, stated that 'Murihiku produced ground stone cutting implements in greater variety and in greater beauty than any other region in Polynesia, or perhaps in the whole world.'<sup>9</sup> This was in part cause of the 'greater variety of rocks from which such implements can be made...and [the implement maker] could experiment to an extent impossible elsewhere.'<sup>10</sup>

<sup>&</sup>lt;sup>6</sup> Kleinlangevelsloo, M. (2019) Cultural Values Statement: Queenstown Lakes District Council Wastewater Overflow Discharge, p.11 <sup>7</sup> Corry, S., Puentener, R. (1993) Tikanga Maori Cultural, Spiritual and Historical Values of the Waiau River, A Report for the lwi Task Group of the Waiau River Working Party, p.28.

<sup>&</sup>lt;sup>8</sup> Schedule 75: Statutory Acknowledgement for Whakatipu-wai-māori (Lake Wakatipu), NgāiTahu Claims Settlement Act 1998

<sup>&</sup>lt;sup>9</sup> Skinner, H. D. (1974) Comparatively Speaking: Studies in Pacific Material Culture 1921-1972, p. 101

<sup>&</sup>lt;sup>10</sup> Skinner (1974) p. 101

The historical record was somewhat interrupted for Ngãi Tahu with pastoralisation and mining in the latter half of the 1800s. This period resulted in land alienation for Māori and the area being transformed to tussock grasslands and dry scrub. Introduced domestic and pest plants and animals further changed the landscape. Whilst there was provision for it, Kemp's Purchase did not result in mahinga kai, nohoanga or kainga reserves in the Whakatipu Waimāori area.

The district is within the area that Tā Tipene O'Regan refers to as "The Hole in the Middle'. Essentially, the Hole was created by an argument about the inland boundary of the Kemp Purchase.<sup>13</sup> Ngāi Tahu continue to argue that the high country was never included in the land deeds and the boundaries in any sales finished at the foothills, not the Main Divide as argued by the Crown.

In spite of more than a century of alienation and deception by the Crown, Ngãi Tahu has maintained its presence in the district as citizens, visitors, workers, and private land and business owners. However, it was not until 1998 that redress elements from the Ngãi Tahu Treaty Settlement provided mechanisms for Ngãi Tahu Whānui to continue cultural practices and the return of lands. 14

The ongoing decline of Waiwhakaata is intergenerational and has altered the relationship Ngāi Tahu ki Murihiku has with its traditional waters and whenua. The practices, uses, and associations whānau have with the lake and its surrounds are not as their tūpuna had and the current relationship is largely driven by restoration efforts. Waiwhakaata is culturally degraded, and the mauri of the lake might take generations to be restored. However, as kaitiaki, Ngāi Tahu ki Murihiku are bound to do everything in their power to protect and restore its mauri.

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<sup>&</sup>lt;sup>11</sup> McIntyre, R. (2007) Historic heritage of high-country pastoralism: South Island up to 1948, p. 9

<sup>&</sup>lt;sup>12</sup> Evison, H. C. (2007) The Ngãi Tahu Deeds: A Window on New Zealand History, pp.83-85

<sup>&</sup>lt;sup>13</sup> Protecting Ngai Tahu History, Cultural Mapping Project, kahurumanu.co.nz, accessed April 2023.

<sup>&</sup>lt;sup>14</sup> Cain, A. (2020) Remarkables Conservation Area: Summary of Ngãi Tahu Values, Practices and Associations, p. 18.

## **NAMES OF THE LAKE**



Reflection on Lake Hayes, #179105642, by jiraphoto.

Lake Hayes has two known Ngāi Tahu names, both referring to the reflection in its waters of the wider environment and the personification of tūpuna in the landscape. One name is **Waiwhakaata** and the other is **Te Whaka-ata a Haki-te-kura** after the famous ancestress noted for her exploits and who lived at a kāik on the shores of Whakatipu Waimāori near Sunshine Bay.

## **OVERARCHING MATTERS**

## **VISION FOR WAIWHAKAATA**

It is the vision of Ngāi Tahu ki Murihiku that:

Waiwhakaata is in a state that reflects and upholds the mana of its name and consequently, its mauri is healthy and resilient, and permits living things to exist and thrive within their own realm and sphere.

All actions, mitigation, interventions, and best practices for Waiwhakaata are to proactively step towards achieving this vision. For over 50 years, it has been known that Waiwhakaata is under stress and continues to be in a highly degraded stated. <sup>15</sup> Action on the ground is urgently needed and requires work programmes to align with management strategies.

Education is a key tool in actioning change and must draw on Ngāi Tahu mātauranga as well as other sources. It is essential that Ngāi Tahu ki Murihiku be supported and unhindered to enact this change and work with other parties in accordance with Ngāi Tahu paradigms, mātauranga, tikanga and kawa.

## NGĀI TAHU KI MURIHIKU VALUES, ASSOCIATIONS, TIKANGA AND KAWA

The associations outlined by Ngāi Tahu in the 1995 Lake Hayes Management over 20 years ago are still principally relevant today.

Ngãi Tahu ki Murihiku, like other Māori, conceptualise the environment as an undivided entity and as part of a system of lakes, rivers, wetlands, soils, plants and animals, mountains and other terrestrial lands and the relationships between them. It is this holistic perspective that pervades mātauranga Māori – a knowledge based on relationships and connections over generations.

The environmental elements discussed in the following sections (wai, whenua, and mahinga kai) reflect a mix of core values, beliefs, principles and behaviours that are sustained through Ngāi Tahu associations, uses and practices. Collectively, they represent a management ethic similar to integrated management. Central to this management approach is the sustainable use of resources. Uses and practices were, and remain, intertwined and dependent on a healthy functioning environment.

These concepts shape the understandings of Ngāi Tahu ki Murihiku and guide them in the appropriate articulation and application of values for each situation. Kawa and tikanga with mātauranga also determine the local approach to nationally derived policies and environmental approaches.

## KI UTA KI TAI

Ki uta ki tai is a Ngāi Tahu environmental philosophy recognising that everything is connected and must be managed as such. Ki uta ki tai reflects that mana whenua belong to the environment and are only borrowing the resources from our generations that are yet to come. Ki uta ki tai is the basis of Ngāi Tahu Iwi Management Plans and is recognised in regional and district planning documents.

The Environmental Statement of Expectation is based on ki uta ki tai and any management tools, methods, and measures should be applied accordingly.

Ki uta ki tai is an opportunity for all resource users to enhance their management practices and undertake a holistic approach for environmental outcomes.

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<sup>&</sup>lt;sup>15</sup> Otago Regional Council and Queenstown Lakes District Council (1995) Lake Hayes Management Strategy, p. 2

## TE MANA O TE WAI - HAUORA

The paramount nature of wai is the connecting element of the catchment that sustains the way Ngāi Tahu interact with the environment of Waiwhakaata. In line with the responsibilities of the Regional Council to manage water, the expression of Te Mana o Te Wai is an important context for Ngāi Tahu ki Murihiku.

Recognising Te Mana o te Wai requires identification of the qualities that come together to support hauora, or the health and well-being, of waterbodies, and their associated environment and communities. Hauora is understood to be a state of health, which can be thought of as meaning fit, well, vigorous and robust, describing a healthy resilience for waterbodies. <sup>16</sup>

When a waterbody is no longer in the state of hauora, then is it degraded. If a waterbody continues to degrade over time it may come to a place where remedial actions to a state of te hauora o te wai is no longer possible or irreversible. Between the states of hauora and "terminal" is a continuum – degradation is both a state (i.e., it is either degraded or it's not) and a process (i.e., a continuum of degradation). Cultural thresholds can be used to determine the state of degradation and/or the extent of degradation along a continuum.<sup>17</sup>

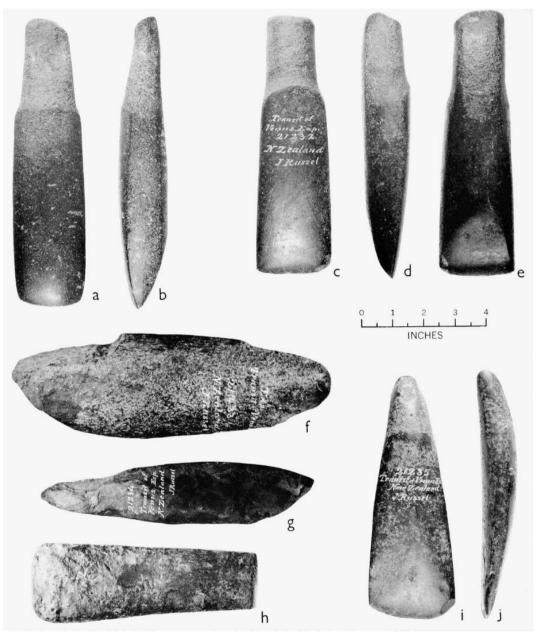
## UTU

Utu is sometimes referred to as the principle of reciprocity or as the principle of equivalence, and Metge (2001) regards its main purpose as maintaining relationships. In relation to a specific issue utu can be thought of as restoring balance and thereby maintaining whanaungatanga and there are many pathways and responses by which utu is put into practice. Ngāi Tahu ki Murihiku seek to explore the practice of utu in relation to environmental issues which may provide means of restoring balance in relationships and acknowledging the obligations on this generation to seek mutual benefits to achieve improved environmental outcomes. <sup>18</sup>

<sup>&</sup>lt;sup>16</sup> Bartlett, M. et al. (2020) Draft Murihiku Southland Freshwater Objectives, p.5

<sup>&</sup>lt;sup>™</sup> Ngā Rūnanga (2019) Memorandum of Counsel for Ngā Rūnanga regarding Cultural Indicators of Health, for Environment Court, ENV-2018-CHC-47

<sup>18</sup> Mead, H. (2016) Tikanga Māori: Living by Māori Values, p. 36.



Part of a cache of stone tools found by Israel Russell near Wakatipu, 1874/5, Smithsonian Institute Collection In 1874/5, Israel Russell found a cache of adzes in the vicinity of the United States of America's observatory in Queenstown, possibly at the Frankton Arm, towards the mouth of the Kawarau River. <sup>19</sup> The cache consisted of adzes made from locally sourced stone and one small chisel made from a stream pebble.  $^{20}$ 

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<sup>&</sup>lt;sup>18</sup> Keyes, I. W. (1967) 'New Zealand Artifacts from the United States "Transit of Venus Expedition" 1874-1875', Smithsonian Contributions to Anthropology, p. 22 <sup>20</sup> Keyes (1967) pp. 23-24

## **WAI WATER**

## **NGĀI TAHU CONTEXT**

Water is a taonga, or treasure of the people. It is the kaitiaki responsibility of tangata whenua to ensure that this taonga is available for future generations in as good as, if not better quality. Water has the spiritual qualities of mauri and wairua.

The continued well-being of these qualities is dependent on the physical health of the water. Water is the lifeblood of Papatūānuku and must be protected. We need to understand that we cannot live without water and that the effects on water quality have a cumulative effect on mahinga kai and other resources.

Ngāi Tahu ki Murihiku recognise that the welfare of the people and the success of their activities within the environment depends on water being maintained in the best possible condition. We believe that "if you have your water right, you will have everything else right".<sup>21</sup>

## **CURRENT SITUATION**

Water is the primary conduit for the constant reloading of contaminants into Waiwhakaata. Very little has improved in terms of reducing contaminant load and improving water quality since 1995 when improved catchment management was proposed as a priority action in the Lake Hayes Management Strategy.

Within the context of ki uta ki tai, consideration must also be given to the connection to other parts of the takiwā. The interconnected waterbodies of the catchment are heavily modified coming in and out of the lake. Waiwhakaata flows into the Kawarau River immediately below the confluence with the Kimiākau/Shotover River via an artificial outflow through constructed culverts under SH6 just before entering the Lake Hayes residential area. There is no provision for fish passage or movements up and down the river into and from the lake; it is managed as a drain or highly modified water course rather than functioning as a natural river. The Kawarau River connects these waters near Cromwell to Lake Dunstan and merges with the Mata-au, both water bodies having Statutory Acknowledgements from the Ngāi Tahu Claims Settlement Act 1998.

Additionally, the ground and surface waters are over allocated and there are proposals to further divert water from other waterbodies into tributaries of Waiwhakaata.

## **EXPECTATIONS**

Ngāi Tahu ki Murihiku expect transformational improvement to the management of water in its takiwā to recognise the paramount importance of water. Te Mana o Te Wai is the fundamental concept for freshwater management and provides a framework for the hauora of water, people and the environment to be protected. To achieve this, all actions are to focus on improving the quality of the water moving through and out of the Waiwhakaata catchment.

Priority actions that are currently supported are restoration and enhancement of the land and water environments and the significant improvements in unsustainable land use practices. Ngāi Tahu ki Murihiku expects for its goals and tohu to be included in freshwater visions and management tools, and for its people to be actively involved in all aspects of water management.

<sup>21</sup> Ngãi Tahu ki Murihiku (1998) The Cry of the People Te Tangi a Tauira, Natural Resource and Environmental Management Plan, p.147

#### WHAT DOES SUCCESS LOOK LIKE?

- Te Mana o te Wai the mauri and the health of Waiwhakaata is the paramount consideration in any
  environmental management decision, action, target, and activity.
- Waters uphold their cultural values and support cultural uses; for example, hukawai fed waters are
  of the highest quality, there are wai noho places for whānau to safely camp by the lake and harvest
  from it
- Existing and historical waterbodies, wetlands, and springs associated with Waiwhakaata and Haehaenui are identified, and their natural connections are proactively reinstated, maintained or improved to a state of hauora.
- Tributaries flowing into and out of Waiwhakaata are naturalised, connected, and allowed to
  meander along historic pathways with ecologically functioning and lively riparian margins; no longer
  characterised by straightened channels with unnatural banks nor regarded solely as drains and
  stormwaters outlets.
- At least 20% reduction in sediment and phosphorus contamination in Waiwhakaata is achieved through the restorative actions in the catchment including by achieving the connected elements below.
- In stream habitat is enhanced or restored through either direct action in stream or through natural recovery by the gradual reduced contaminant loading.
- Waiwhakaata and its tributaries, springs and wetlands and have improved water quality and quantity that is regularly reported on using manawhenua led monitoring and tools.
- Absent species can be translocated to Waiwhakaata and its tributaries because the instream
  habitat is flourishing or indigenous species are repopulating the catchment naturally as captured by
  Ngāi Tahu ki Murihiku monitoring programmes.
- Ngãi Tahu ki Murihiku is central to the decision making about how to manage in-lake algal blooms.
- Wetlands are valued as an important part of Waiwhakaata catchment and recognised for their ability to slow and manage contaminants flowing through the highly modified and channelised waterways, as well as for reducing the impacts of natural hazards and events.
- The restoration of lake edge wetlands is sustained with the removal of willows and rubbish as well
  as reductions in the impacts from urban and rural development and activities in the surrounding
- Wetlands and springs have indigenous species abundantly present both in and on the water.
- Any solution or action taken to maintain or improve water quality and quantity also benefits the groundwater aquifers, surface water, springs and wetlands.

#### WHENUA LAND

#### **NGĀI TAHU CONTEXT**

For tangata whenua, an important kaupapa for land use is "matching land use with land capability". This means taking a precautionary approach to land use, to ensure that what we do on land is consistent with what the lands can withstand, and not what we would like it to withstand through utilising external inputs.<sup>22</sup>

The abundance and quality of resources available to local whānau/hapū has throughout the past and continues today, to directly determine tribal welfare and future. History notes that those with resources flourished and those without perished, therefore management and maintenance of resources were of foremost concern.<sup>23</sup>

The land sustains and maintains all life and holds stories that enables Ngãi Tahu to connect with its heritage, identity, and cultural practices. As such, Ngãi Tahu ki Murihiku do not recognise any one location or landscape as being more or less significant than any other. All land is a taonga and should be treated accordingly. This means that Ngãi Tahu ki Murihiku do not ascribe to dissociative ideas around 'sites of significance to Māori' or 'cultural landscapes' within planning processes as it implies that, by contrast, unlisted sites or landscapes are not significant to mana whenua.

#### **CURRENT SITUATION**

Most land in the Waiwhakaata catchment has been modified, initially for primary production and mining, and more recently residential and tourism development that also contributes to the degradation of biodiversity, soil, and water. This condition has been exacerbated by increased residential development and physical and ecological modification of many of the contributing waterways. Other land uses including forestry, general earthworks, mining, and waste and hazard management practices create similar issues.

There is no Ngāi Tahu land ownership or entitlements in the Waiwhakaata catchment such as nohoanga, statutory acknowledgements, SILNA lands, tribal properties or Papatipu Rūnanga-owned land parcels as there are elsewhere in the district.

#### **EXPECTATIONS**

Ngāi Tahu ki Murihiku supports the coupling of land use zoning with land capability to reduce the negative effects on soils from compaction, pollution/contaminants, biodiversity loss, and erosion. It is also expected that improvements within the catchment will be made in land management practices to restore soil health, with these improvements also having flow on effects for water and biodiversity.

It also expects that any actions for Waiwhakaata and the catchment shall recognise and provide for Ngāi Tahu ki Murihiku understandings of landscape and whenua, as well as promoting and supporting ways that enable Ngāi Tahu Whānui to connect/reconnect with the whenua. Mana whenua designed and lead assessment methodologies, such as Āpiti Hono Tātai Hono that has been applied to inform this Environmental Statement of Expectation, should be used when and where deemed appropriate by Ngāi Tahu.

Reconnection with these lands by Ngāi Tahu Whānui and Papatipu Rūnanga can also happen through on the ground actions, decision making and improved environmental outcomes. These types of contributions assist with reconnection to place and ahi kā. Ngāi Tahu ki Murihiku expect to see many of the systemic barriers to accessing resources at place reduced and removed, so that this land can be utilised to support whānau expectations.

<sup>&</sup>lt;sup>22</sup> Ngāi Tahu ki Murihiku (1998), p.136

<sup>&</sup>lt;sup>23</sup> Ngāi Tahu ki Murihiku (1998), p.176

#### WHAT DOES SUCCESS LOOK LIKE?

- Ngāi Tahu Whānui standing anywhere along the lake shore feel proud and connected to their whakapapa, whenua, and heritage.
- Ngāi Tahu Whānui and manuhiri should feel the wairua of the place and be energised by the
  experience of visiting and interacting with Waiwhakaata.
- People should be enabled through the natural environment and mātauranga to view the landscape through a Ngāi Tahu cultural lens and understand its broader connections across the Te Waipounamu.
- Land management practices are enhanced by best practice and the adoption of ki uta ki tai.
- Land use is increasingly diverse with a reduction in intensive land practices.
- Point source discharges are predominantly to land with improved treatment technologies in ways which are acceptable to Ngāi Tahu ki Murihiku.
- Ngāi Tahu whānau have increased access and safe use of mahinga kai because of improved land use practices and access provisions.
- Subdivisions are well planned, encouraging a connection to place and acknowledging the vision Ngāi Tahu ki Murihiku has for Waiwhakaata.
- Land that has been degraded or heavily modified, such as contaminated land, is actively restored.
- Manawhenua monitoring shows land use activities are enhancing land, reducing pollution, and contributing to improved water quality and reduced use.
- Āpiti Hono Tātai Hono assessments and other manawhenua designed and led tools and frameworks are appropriately integrated into and inform planning processes, research, and scientific investigations.

#### **MAHINGA KAI**

#### **NGĀI TAHU CONTEXT**

Mahinga kai was, and is, central to the Ngāi Tahu ki Murihiku way of life. The collection and processing of mahinga kai is an important social and economic activity. Tangata whenua aspirations and expectations for mahinga kai are commonly expressed in any management tool relating to the environment, also noting its fundamental position in Ngāi Tahu cultural identity, social cohesion, and economy.

Mahinga kai is about mahi ngā kai - it is about places, ways of doing things, and resources that sustain the people. The loss of mahinga kai is attributed to habitat degradation, resource depletion, legislative barriers that impede access, changes in land tenure that affect the ability to access resources and the introduction of predators that have severely reduced the traditional foods of Ngāi Tahu.<sup>24</sup>

Mahinga kai is a pillar of Te Kerēme as the ninth tall tree - the historical Ngāi Tahu Treaty Claim. Mahinga kai practices rely on thriving and abundant biodiversity, safe and aesthetically pleasing places to practice, and the active transfer of knowledge between people. Biodiversity and aesthetics are dependent on the sustainable management of many other natural resources in the takiwā, especially waterbodies.

Mahinga kai is considered by Ngāi Tahu to be, in today's language, the principal 'environmental indicator' in natural systems. If mahinga kai is not present, is unsafe or unable to harvested, then that natural system is under stress and requires remedial action.

#### **CURRENT SITUATION**

Much of the Waiwhakaata catchment has been modified, leaving few areas of pre-European indigenous biodiversity remaining, much of which is in poor cultural health. Places in which to practice mahinga kai continue to be marginalised with access restricted due to development, encroachment, landscape modifications, and being unable to guarantee the safety of people harvesting, both through the act of harvesting in the water, semi or fully submerged, and the consumption of harvested species. The introduction and establishment of predatory and pest species have also severely reduced the abundance of species traditionally gathered using mahinga kai practices.

The oral and written histories where Ngāi Tahu talk about mahinga kai and its management are from a time of plenty, where preferential and optimal sites were selected. Ngāi Tahu ki Murihiku are now in a time of 'making do' with what traces are left and functioning to a nominal level that allows for aspects of mahinga kai. Many of the sites where whānau can go are not optimal or even aesthetically pleasing. Ngāi Tahu ki Murihiku are unwillingly disconnected from mahinga kai at Waiwhakaata and this has had detrimental intergenerational impacts on Ngāi Tahu identity and social cohesion, and the active transfer of mātauranga and kaitiakitanga at place.

#### **EXPECTATIONS**

Ngãi Tahu ki Murihiku expect to be able to practice mahinga kai in their takiwā at multiple locations on the shores and in the waters of Waiwhakaata and the surrounding area, deliberately selected for the quality of the resource and its ability to sustain itself. In undertaking these practices, whānau will have the opportunity to experience the landscape as their tūpuna did and rekindle the traditional practices of gathering food and other natural resources.

Ngāi Tahu ki Murihiku expect to see many of the systemic barriers to accessing resources reduced and removed so they can safely undertake cultural practices as aligned with whānau expectations.

<sup>24</sup> Ngāi Tahu ki Murihiku (1998), p.164

#### WHAT DOES SUCCESS LOOK LIKE?

- Mahinga kai is actively practiced around and within Waiwhakaata in accordance with Ngāi Tahu ki Murihiku tikanga and maramataka.
- Ngāi Tahu Whānui can select optimal and favoured sites to undertake mahinga kai and utilise resources in situ.
- Whānau are safe and supported in harvesting and consuming mahinga kai species.
- Mātauranga associated with mahinga kai is used to inform resource management decision making and research, and to be passed on to future Ngāi Tahu ki Murihiku generations through active practice.
- Taonga species are tohu of the hauora of the water, whenua, and people.
- Taonga species move unrestricted through the waterways and over/across the whenua with refuges and native habitat.
- Re-establishment of mahinga kai species and places that have been absent from the lake and its surrounds for generations.
- Native environments and species beyond remnant areas in urban and rural areas are restored and regenerating, especially around waterways and wetlands.
- Corridors are re-established for the restoration of natural and built pathways to re-connect biodiversity remnants and environmental processes.
- Biodiversity remnants are identified, protected, restored and revitalised.

#### METHODOLOGY FOR ENVIRONMENTAL STATEMENT OF EXPECTATION

#### NGĀI TAHU KI MURIHIKU SITE VISIT

On 8 December 2022, Ngāi Tahu ki Murihiku whānau supported by Te Ao Marama and Kauati undertook at site visit of Waiwhakaata and the surrounding catchment.

The site assessment started the evening prior with whakawhanaungatanga with the facilitators and whānau. The following day was made up of three site visits with additional informal interactions with the Waiwhakaata landscape travelling between assessment sites. The manaaki from the whānau was a highlight of the day providing a second opportunity for whakawhanaungatanga and an opportunity to look back to the previous site assessment location on the maunga encouraging further reflection.

The individual and rōpū insights, understandings and interpretation of the sites were recorded by each individual and the facilitators supporting the rōpū. This knowledge and mātauranga has been analysed from the collective written information and experiences on the day and represented in the Environmental Statement of Expectation.





Whānau undertaking the Āpiti Hono Tātai Hono assessment for the catchment from the high viewpoint of Coronet Peak.

Kauati 2022

Looking to the south, the rōpū settled down onto the side of the maunga on a minor ridge providing a sweeping wide view of the catchment from top to bottom (right to left) with Waiwhakaata just out of site behind the Dalethorpe elevation. The predominant positioning of the rōpū centred on the southern end of Whakatipu Waimāori in the direction of Kingston allowing a viewshaft to Whakatipu Waimāori and the majority of tūpuna maunga across the skyline in front of them.

At this point the rōpū were invited to be present in the landscape allowing them to connect with the environment in order to assist with their assessment of the upper catchment. A number of open-ended questions were put to the rōpū encouraging them to offer their personal interpretation of what they were seeing, and more importantly experiencing as mana whenua. The commentary was recorded through note taking at the time by facilitator members of the rōpū.

Site 2: Murihiku Cultural Water Classification System – Wai Tuna Theme – Lake Hayes Reserve, Mill Creek Confluence

Stevie Blair and Nikau Farrell putting in a hīnaki at Mill Creek for the Wai Tuna cultural use assessment of the Murihiku Cultural Water Classification System. Kauati 2022

For this evaluation the ropu were situated by the lower reach of Mill Creek (150m) down to where the creek enters Waiwhakaata. The activity undertaken here was a Wai Tuna themed form which everyone filled in based on their observations with some application of broader knowledge of the area and site specific detail. The site sits within the Lake Hayes Recreation Reserve.

The evening prior two hīnaki (fyke nets) had been set to provide any further aquatic data about any species caught. Both nets were removed from the creek and their contents documented and analysed.

At the conclusion of the visit an 'outlier test' was conducted to identify if there had been any unusual data entries made. Most of the data from the forms was very similar across the  $r\bar{o}p\bar{u}$ .

The unexpected find of a large female long-fin tuna was an exhilarating moment for Ngāi Tahu ki Murihiku whānau and the local school group who happened to be nearby.



1.25 metre long female long-fin tuna caught and released as part of the Wai Tuna cultural use assessment. Kauati 2022

#### Site 3: Āpiti Hono Tātai Hono - Lower Catchment - Lake Hayes Walkway and Wetland

This third and final site was located at the south western corner at the outflow end of Waiwhakaata. The second  $\bar{A}$ piti Hono Tatai Hono assessment was carried out using the formatted documents to record experiences and interpretations of the site and surrounding environment.

Time was taken to initially move about the immediate surrounds and orientate to the area. The outflow of the lake was situated to the east but was not visible. There was good visibility to the surrounding maunga to the east, south and north but the lake was obscured by a riparian boundary predominantly of raupō, willows and pūkio/carex secta.

Similar to how the first site visit was run, the  $r\bar{o}p\bar{u}$  was encouraged to offer verbal and any written observations, their experiences and feelings about the site. Facilitators recorded what was said by the  $r\bar{o}p\bar{u}$ .



Āpiti Hono Tātai Hono assessment was undertaken at the Threepwood side of Waiwhakaata. Kauati 2022

#### Debrief

Concluding the day, the  $r\bar{o}p\bar{u}$  was invited to debrief about the events of the day and any reflections about the way it ran or other comments.

Generally, there was a sense of positive achievement and a process much more grounded in tikanga and mātauranga than had been expected (rather than a western science based approach). There was support for the sites that were chosen and the different approaches at sites noting Āpiti Hono Tātai Hono and the Murihiku Cultural Water Use Classification were formats that provided accessible culturally based models that supported engagement as Ngāi Tahu.



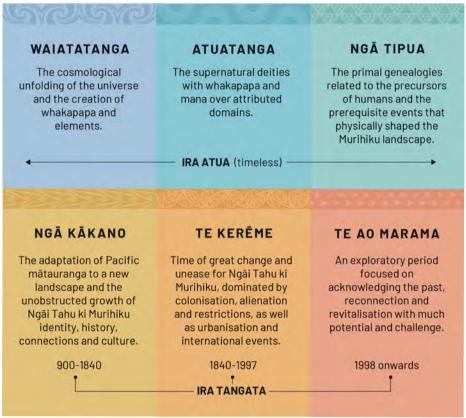
Waiwhakaata from the right bank looking towards the outlet and Kawarau. Kauati 2022.

#### **ASSESSMENT TOOLS**

All the mana whenua designed and led tools used in developing the Statement of Environmental Expectation work together as they are based on the same philosophies and principles, and their application and implementation are guided by the kawa, tikanga and mātauranga of Ngāi Tahu ki Murihiku. Their foundations are aligned with the inherent meanings, social norms and epistemological traditions of Ngāi Tahu culture.

Āpiti Hono Tātai Hono and the Murihiku Cultural Water Classification System look at different parts of landscape but are organised in the same way; consciously and subconsciously ordered by whakapapa and Ira Atua Ira Tangata. The tools expect to inform ki uta ki tai, they expect to draw on the collective knowledge of tangata tiaki/kaitiaki.

#### Āpiti Hono Tātai Hono: Ngā Whenua o Ngāi Tahu ki Murihiku



The six layers of Āpiti Hono Tātai Hono cultural landscape assessment methodology, 2021

In 2021, Ngāi Tahu ki Murihiku released its landscape methodology it named Āpiti Hono Tātai Hono in recognition of the act of ordering whakapapa. The methodology was designed by Ngāi Tahu ki Murihiku to enable a comprehensive understanding of landscape as known to them. The methodology is founded on the interwoven relationships between Ira Atua and Ira Tangata and the continuum of time and whakapapa. It acknowledges change, interdependencies, ki uta ki tai, duality (e.g., intangible/tangible, tuakana/teina, masculine/feminine) and the philosophies and paradigms of Ngāi Tahu ki Murihiku. <sup>25</sup>

<sup>&</sup>lt;sup>25</sup> Cain, A., Manihera, D. (2021) Āpiti Hono Tātai Hono: Ngā Whenua o Ngāi Tahu ki Murihiku, p. 7

The methodology does not assess significance; it considers what is held within a landscape and what is appropriate at place. A landscape holds and exerts many things in different ways, including whakapapa, mana, kawa, tikanga, mātauranga, identify, connections, practices, history, and future aspirations.

Āpiti Hono Tātai Hono blends Te Ao Ngāi Tahu philosophical concepts and mātauranga with aspects of heritage and landscape practice. It characterises the landscape into six layers based on Ira Atua Ira Tangata, with Ira Atua taking primacy as the tuakana.

**Ira Atua** recognises the metaphysical elements of culture and landscape and is not confined by time. Ira Atua has always existed and always will. The Ira Atua layers:

- **purpose** acknowledges the metaphysical and related connections and reverence they have in the kawa, tikanga and culture of Ngāi Tahu ki Murihiku.
- recognise and manage whakapapa, mauri, mana, tikanga, kawa fundamental philosophical components of culture and identity; what is right and wrong, and the interconnections between the elements, landscape and people.

**Ira Tangata** recognises the associations and connections humans have within the landscape over a defined period of time. The period focuses on 900cE to the modern day and into the future. The methodology acknowledges that some connections and events cross these periods; therefore, the dates are a guide rather than fixed starts and ends. The Ira Tangata layers:

- purpose identifies tangible and intangible cultural heritage and mātauranga, the evidential record
  of human occupation, personification of landscape and place names, and future aspirations.
- recognises and manages safeguarding whakapapa and connections between whenua and people, the human record, history, and continuing evolution of Ngāi Tahu ki Murihiku cultural heritage and mātauranga.

#### Murihiku Cultural Waters Classification System

For Ngāi Tahu the continuation of cultural uses and practices associated with the freshwaters in their takiwā/ tribal area, is crucially important for the sustenance of cultural identity, social cohesion, health and wellbeing. The concept of mahinga kai encompasses many entities and related aspects, including the resources harvested (such as fish, plants and stone), connections to place, intergenerational knowledge transmission, cultural tradition, and access. Use and associations are a key element that binds Ngāi Tahu to the landscape, and numerous attributes require landscape scale biocultural processes and connections to be protected and enabled.

Although mahinga kai is a central element in the Ngāi Tahu Treaty Settlement legislation, the protection and enhancement of mahinga kai is impeded by the numerous pieces of legislation and government agencies involved, that are not unified in this purpose, and in some cases act against this purpose.

This challenging situation requires mechanisms to empower decision-making and outcomes for Māori and protection of cultural use. To this end, Ngāi Tahu ki Murihiku, developed the Murihiku Cultural Water Classification System (MCWCS). The development of the MCWCS was part of six-year MBIE funded research programme Ngā Kete o te Wānanga: Mātauranga: Science and Freshwater Management (C01X1318).

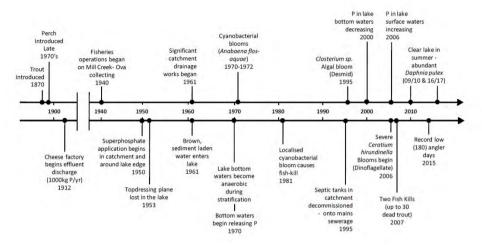
The Ngā Kete o te Wānanga: Mātauranga programme sought to align with Ngāi Tahu ki Murihiku freshwater research and management priorities, the current freshwater management context, the skillsets of Murihiku expert knowledge holders and scientists, and the outcomes expected by MBIE.

The MCWCS is a mixed methods approach to strengthens cross-cultural understandings about Murihiku cultural values and uses, and their water-related dependencies- as defined by Murihiku whānau – in a robust, respectful and meaningful way. The approach was built on the foundations of Ngāi Tahu ki Murihiku

tikanga and mātauranga and includes including understandings of place, time, and connections within the landscape, and different knowledge streams blended from various disciplines (including mātauranga Māori, social science, science and cultural heritage) around different cultural value/use theme that are of importance to Murihiku whānau. The initial cultural uses developed are:

- Wai Pounamu (Waters for the movement, collection and working of pounamu)
- Wai Nohoanga (seasonal camping areas across the landscape) and
- Wai Tuna (waters that sustain the intergenerational harvest of tuna/eels).

#### LITERATURE REVIEW



 $Waiwhakkata\ historical\ timeline\ of\ major\ events,\ taken\ from\ Lake\ Hayes\ Restoration\ and\ Monitoring\ Plan,\ 2017$ 

Much of what is contained in this document comes from sources mana whenua have published themselves or have been actively involved in writing and approving, including:

- Ngāi Tahu Claims Settlement Act 1998 and Deed of Settlement
- Ngāi Tahu 2025
- Te Tangi a Tauira Ngāi Tahu ki Murihiku Natural Resource and Environmental Iwi Management Plan
- Cultural Use in Murihiku (Draft)
- Lake Hayes Management Strategy 1995
- Lakes Hayes Restoration and Monitoring Plan 2017
- Statement of evidence of Jana Davis on behalf of Otago Regional Council and Kāi Tahu ki Otago and Ngāi Tahu ki Murihiku. Plan Change 8: Urban provisions, November 2022.

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# Otago lagarosiphon Site-led programmes

Information provided to ORC for their paper to update Council against Plan Objective 7.5.7, for Council meeting on 8 May 2024

Prepared for ORC on 10 April 2024.

#### Plan Objective 7.5.7

# Objective, principal measures and rules

#### Plan Objective 6.5.7

Over the duration of the Plan actively manage lagarosiphon to:

- reduce the extent of lagarosiphon in Lake Wanaka and the Kawarau River (Map 4 in Appendix 3) through progressive containment over the next 10 years;
- implement sustained control of lagarosiphon in Lake Dunstan (Map 4 in Appendix 3);
- prevent the establishment of lagarosiphon in Lake Wakatipu (Map 4 in Appendix 3);
- prevent the establishment of lagarosiphon in lakes, rivers and tributaries where it is not already present

to avoid, mitigate or prevent effects on the environment, and amenity and recreational

#### Principal measures to be used

Land Information New Zealand will take a lead role in controlling and eradicating lagarosiphon in Otago's lakes and rivers that it administers. Otago Regional Council will work collaboratively with Land Information New Zealand and other partners in the preparation, administration and delivery of 10-year Management Plans for the control of lagarosiphon and in other initiatives to deliver the outcomes in the objectives.

Occupiers will be responsible for eradicating lagarosiphon within private ponds and aquaniums.

The requirement to act, service delivery, advocacy, education, and collaboration described in section 5.3 of the Plan, will be used primarily to achieve Plan Objective 6.5.7.

How the Otago Regional Council intends to support the delivery of these objectives with Land Information New Zealand is described more fully in Section 3 of the Biosecurity Strategy.

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# Exclusion Frogressive containment Sustained control Not managed Lake Wānaka Clutha/Mata-Au River Lake Whakatipu Kawarau River

# 1 Update on progress made against objectives

Map 1: LINZ management aims for lagarosiphon.

#### 1.1 Lake Wanaka

Overall progressive containment is being achieved. The strategy of Eradication in the northern two-thirds of the lake (see map 1 above for eradication zone) is being achieved. Progressive containment in the southwest is being achieved - the control programme is on track to clear the remaining weed beds in the western part of the lake, which stretches over 13 km of shoreline. Ongoing maintenance is vital to ensure the controlled area is kept free of lagarosiphon reinvasion. Maintaining this stretch of shoreline would allow the containment line to be moved further south to include the Paddock Bay and Parkins Bay areas in the



Eradication zone (see: <a href="https://www.odt.co.nz/regions/wanaka/winning-weed-battle">https://www.odt.co.nz/regions/wanaka/winning-weed-battle</a>).

# 1.2 Lake Wakatipu

Preventing the establishment of lagarosiphon is being achieved. Surveillance and early hand-weeding is critical to removing lagarosiphon plants being found within the lake. Plants have consistently been found in the Frankton Arm and Kingston which have been removed immediately. The Frankton Marina (an extreme highrisk site) has now been incorporated into the LINZ management programme (see: <a href="https://www.linz.govt.nz/news/2023-10/prevention-measures-introduced-lagarosiphon-lakeweed-frankton-marina">https://www.linz.govt.nz/news/2023-10/prevention-measures-introduced-lagarosiphon-lakeweed-frankton-marina</a>).

#### 1.3 Kawarau River

The overall aim for the upper Kawarau River flowing out of the Lake Wakatipu is progressive containment in a downstream direction and this is being achieved. The upper Kawarau River has been divided into zones for management where the areas upstream are being managed for eradication to reduce the risk of weed transport back into Lake Whakatipu. The presence of lagarosiphon infestations in the upper Kawarau River between Kawarau bridge and the Shotover River poses the greatest invasion risk to Lake Wakatipu.

#### 1.4 Lake Dunstan

Sustained control is being achieved at High-Risk Areas (boat ramps, access areas) and High-Amenity Areas (recreational areas) that are agreed upon by the Lake Dunstan Weed Management Group.

# 2 Funding and surveillance in the Otago Lakes

The total budget for the Otago Lakes for FY2023/24 is \$1,767,028.00, with \$1,145,500.00 for Lake Wanaka, \$448,900.00 for Lake Wakatipu and Kawarau River, and \$172,628.00 for Lake Dunstan. Funding for FY2023/24 was higher than usual due to additional one-off funding from the LINZ appropriation.

For FY2023/24, LINZ received \$195,000 in partner contributions from QLDC, Contact Energy, and ORC. With ORC providing \$50,000 for control works in Lake Dunstan.

The greatest risk to achieving the objectives of the RPMP is inadequate funding to implement the required surveillance and control work. Current funding levels are stretched to manage lagarosiphon across lakes where it currently occurs, including LINZ funded work in the Waitaki Catchment in Canterbury. Relaxing the frequency of control and surveillance in even one area could threaten the current programme of work and compromise previous investments.

Initially, ORC funded all of the monitoring for lagarosiphon in the region, but not the control works, as stated in the 1996 Pest Plant Management Strategy for the Otago Region.

#### 2.1 Lake Wanaka surveillance

The 2005 Lagarosiphon Management Plan for Lake Wānaka, stated ORC was responsible for monitoring the whole of Lake Wānaka on a two-year cycle to detect new outbreaks of lagarosiphon. Later, the need for synchronisation and communication between the ORC surveillance team and LINZ contractors undertaking lagarosiphon removal was recognised as vital. Subsequently, ORC contributed funding for LINZ to undertake all surveillance in Lake Wānaka for efficiency. That funding was withdrawn in FY2020/21 when ORC funding into the LINZ programme was refocused on sustained control at Lake Dunstan.

LINZ currently undertake all lagarosiphon surveillance at Lake Wānaka, with no funding from ORC. Lagarosiphon surveillance is undertaken within the Eradication Zone of Lake Wānaka and focuses on risk, with the interval for surveillance being six months for high-risk sites (which also includes control), 12 months for moderate-risk sites and 18 months for low-risk sites. The interval changes in response to changed risk based on the history of detections. LINZ contractors cover all the sites at the prescribed intervals using divers.

The cost of surveillance at the moderate-risk and low-risk sites is roughly **\$20,000** annually. Surveillance and control at high-risk sites cost an average of **\$125,400** per year. It is proposed that ORC fund the total cost of the surveillance work into the LINZ control programme.

Note that the Northern Eradication Zone will only be maintained with ongoing funding to implement the surveillance work. Lagarosiphon fragments are transported by wind, currents and/or boats into the Eradication Zone. Regular



surveillance is needed to detect these initial incursions before they begin new infestations, which are harder and more expensive to control. Without surveillance and active control, the entire lake shoreline could be expected to become 'saturated' with weed (all available habitats colonised) within 5-10 years.

### 2.2 Lake Wakatipu surveillance

Since 2015/16, LINZ has carried out shoreline surveillance of lagarosiphon in Lake Whakatipu, without funding contribution from ORC. This was in response to increases in plants being found in Frankton Arm. There was concern that jetboats could transport plants to more remote areas of Lake Wakatipu, which, without surveillance, would go unnoticed until they became large remote weed beds.

The cost of shoreline surveillance with divers is 12 days for a dive team at a cost of around **\$92,000-\$94,000**. Surveillance in Lake Wakatipu has been carried out since 2015/16. For 2022/23 and 2023/24, we have reduced the full shoreline surveillance to targeted surveillance only, which costs approximately **\$50,000**. It is proposed that ORC fund the total cost of the surveillance work into the LINZ control programme. Without surveillance and incursion removal at Lake Whakatipu, surface reaching weed beds would establish successfully in areas with suitable habitat such as the Frankton Arm and Queenstown Bay.

# 3 Control works 2023/24 – completed and upcoming

The aquatic weed (*Lagarosiphon major*) control programme is nearing completion for this season (2023/24).

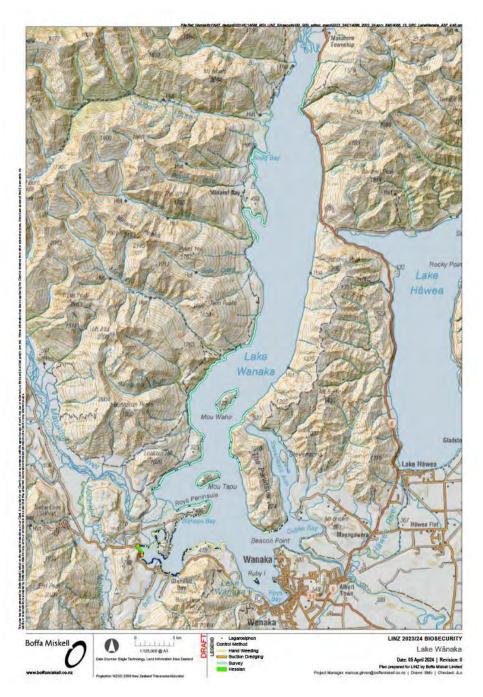
See attached spreadsheet of completed work and work to be completed. Some key information has been summarised below.

#### 3.1 Lake Wanaka

 Surveillance has been undertaken in the Eradication Zone (northern two thirds of lake) and further surveillance is scheduled for this season. Sites are checked according to risk and plants are hand-removed when found.

- Diver control work (hand-weeding, hessian) has been undertaken in the Western Target Control Zone, with significant progress made in clearing lagarosiphon weed beds (Map 2).
- Further diver control work is scheduled for this season. Boat-based spraying scheduled for this season.



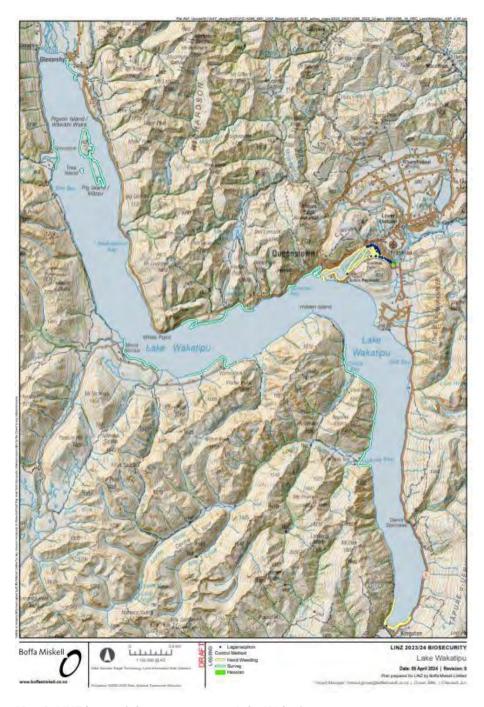


Map 2. LINZ lagarosiphon management Lake Wanaka

# 3.2 Lake Wakatipu

- Partial shoreline survey at key hygiene areas. No plants found outside of Frankton and Kingston (Map 3).
- Frankton Arm and Kingston surveyed 2-3 times. Fragments continually found and removed by hand at Kingston.
- The Frankton Marina (a high-risk site) is now included as part of the LINZ control programme.
- Further diver control is scheduled for Frankton Arm and Kingston, and the remainder of the full lake survey.

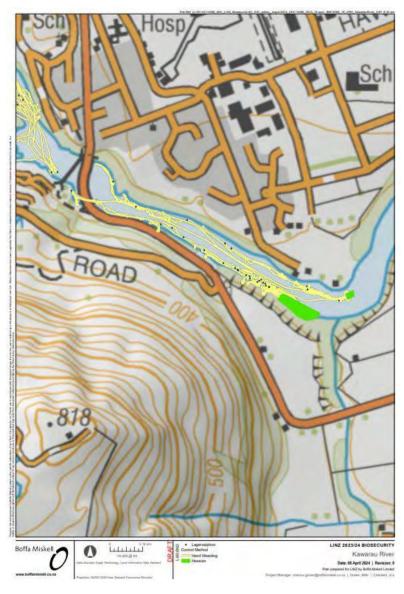




Map 3. LINZ lagarosiphon management Lake Wakatipu

# 3.3 Kawarau River

- Diver control (hand weeding and hessian) undertaken, and further work scheduled for this season (Map 4).
- Boat-based spraying scheduled for this season.

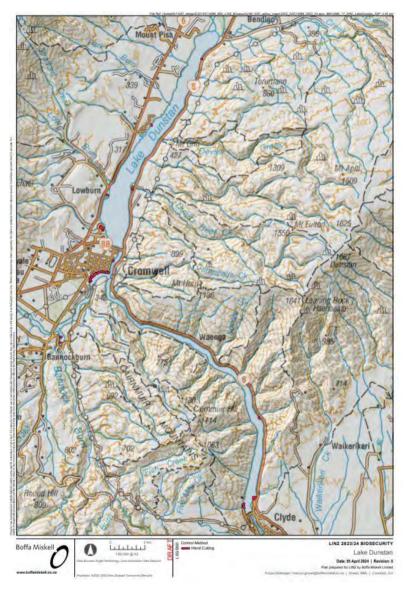


Map 4. LINZ lagarosiphon management Kawarau River



## 3.4 Lake Dunstan

- Bi-annual hand-cutting has been completed at High Risk Areas (boat ramps) and High Amenity Areas (recreational areas) (Map 5).
- Boat and aerial herbicide treatment scheduled for the end of season.



Map 5. LINZ lagarosiphon management Lake Dunstan

# 4 Outcomes, and any other relevant information

NIWA is engaged to provide scientific inspections and audits of control works at key waterbody sites and subsequent reporting and advice, including progress against the ten-year lake management plans. NIWA will update stakeholders at the upcoming annual committee meetings scheduled for early May. Copies of these reports can be shared.

We will be meeting with NIWA next week to discuss any of their findings ahead of the stakeholder meeting.

# 5 Agency consultation underway for the Lake Wānaka Lagarosiphon Management Plan: 2024-2034

LINZ has engaged NIWA on behalf of the Lake Wānaka Aquatic Weed Management Committee to update the ten-year lagarosiphon management plan. The lagarosiphon management plan needs updating to reflect changing control methodologies, control work progress and changes in influencing factors, for example, to align with the updated regional pest management plan. The lagarosiphon management plan is a non-statutory document developed in collaboration with the Lake Wānaka Aquatic Weed Management Committee and includes those with statutory responsibility but also the communities that will be impacted by weed in their lakes. The lagarosiphon management plan provides clear direction and outcomes for a ten-year timeframe.

Consultation is currently underway and committee members are due to provide feedback on the draft plan by 21 May.

Updates to the Ten-Year Lake Weed Management Plans for Lake Dunstan and Lake Wakatipu (including the Kawarau River) are scheduled to begin next financial year (FY2024/25).

# 6 The Annual Otago Aquatic Weed Management Committee Meetings

The Committees for Lake Wanaka, Lake Wakatipu (including the Kawarau River) and Lake Dunstan are scheduled to meet in person on 6, 7, and 8 May. These annual meetings are part of the annual planning process to enable the aquatic



weed management programme to be adaptive, respond to progress made, and realign subsequent priorities, including funding opportunities and any issues that may arise. The committees will review the control works for 2023/24 and plan for 2024/25, including discuss progress toward agreed goals, objectives, and milestones of each of the ten-year lake weed management plans.

Contractor	SiteUnique	Property Name	Site Name
Wai Dive	95026 2	Kawarau River	Upper Kawarau River
Wai Dive	95026 2	Kawarau River	Upper Kawarau River
Wai Dive	95001 2	Lake Dunstan	Bendigo Boat Ramp and Approaches
Wai Dive	95001 19	Lake Dunstan	Northburn Ski Lane
Wai Dive	95001 1	Lake Dunstan	Bannockburn Inlet
Wai Dive	95001 7	Lake Dunstan	Pisa Moorings
Wai Dive	95001 26	Lake Dunstan	Dairy Creek
Wai Dive	95001 17	Lake Dunstan	Weatherall Creek and Burton Creek
Wai Dive	95001_4	Lake Dunstan	Champagne Gully Ramp and Ski Lane
Wai Dive	95001_27	Lake Dunstan	Lowburn Boat Harbour
Wai Dive	95001_12	Lake Dunstan	McNulty's Inlet
Wai Dive	95001_26	Lake Dunstan	Dairy Creek
Wai Dive	95001_17	Lake Dunstan	Weatherall Creek and Burton Creek
Wai Dive	95001_9	Lake Dunstan	Cromwell Swimming Beach
Wai Dive	95001_4	Lake Dunstan	Champagne Gully Ramp and Ski Lane
Wai Dive	95001_7	Lake Dunstan	Pisa Moorings
Wai Dive	95001_2	Lake Dunstan	Bendigo Boat Ramp and Approaches
Wai Dive	95001_19	Lake Dunstan	Northburn Ski Lane
Wai Dive	95001_1	Lake Dunstan	Bannockburn Inlet
Wai Dive	95001_27	Lake Dunstan	Lowburn Boat Harbour
Wai Dive	95001_12	Lake Dunstan	McNulty's Inlet
Wai Dive	95001_6	Lake Dunstan	Old Cromwell Town & Boat Ramps
Wai Dive	95001_6	Lake Dunstan	Old Cromwell Town & Boat Ramps
Wai Dive	95028_4	Lake Wakatipu	Frankton Marina
Wai Dive	95028_1	Lake Wakatipu	Frankton Arm
Wai Dive	95028_4	Lake Wakatipu	Frankton Marina
Wai Dive	95028_3	Lake Wakatipu	Kingston
Wai Dive	95028_1	Lake Wakatipu	Frankton Arm
Wai Dive	95028_2	Lake Wakatipu	All of lake Foreshore
Aquateq	95027_9	Lake Wanaka	Parkins Bay
Aquateq	95027_5	Lake Wanaka	Glendhu Shoreline
Aquateq	95027_11	Lake Wanaka	Paddock Bay
Aquateq	95027_19	Lake Wanaka	Minaret Burn
Aquateq	95027_18	Lake Wanaka	Rumbling Burn
Aquateq	95027_17	Lake Wanaka	Colquhouns Coast
Aquateq	95027_6	Lake Wanaka	Glendhu Bay
Aquateq	95027_12	Lake Wanaka	Sandspit
Aquateq	95027_1	Lake Wanaka	Roys Bay Boat Ramp and Jetty
Aquateq	95027_8	Lake Wanaka	Fern Burn
Aquateq	95027_10	Lake Wanaka	Glendhu Bluff Bay
Aquateq	95027_10	Lake Wanaka	Glendhu Bluff Bay
Aquateq	95027_48	Lake Wanaka	Eely Point
Aquateq	95027_43	Lake Wanaka	Quartz Creek
Aquateq	95027_14	Lake Wanaka	Roys Peninsula
Aquateq	95027_34	Lake Wanaka	The Peninsula North End
Aquateq	95027_42	Lake Wanaka	Stevensons Island
Aquateq	95027_13	Lake Wanaka	Bishops Bay
Aquateq	95027_36	Lake Wanaka	Mou Tapu Island
Aquateq	95027_33	Lake Wanaka	Mou Waho Island

Aquateq	95027_48	Lake Wanaka	Eely Point
Aquateq	95027_10	Lake Wanaka	Glendhu Bluff Bay
Aquateq	95027_22	Lake Wanaka	Snag Bay
Aquateq	95027_26	Lake Wanaka	Wharf Creek
Aquateq	95027_27	Lake Wanaka	Windy Point
Aquateq	95027_20	Lake Wanaka	Minaret Bay
Aquateq	95027_7	Lake Wanaka	Glendhu Bay Boat Ramp
Aquateq	95027_37	Lake Wanaka	The Peninsula West Coast
Aquateq	95027_35	Lake Wanaka	Fishermans Cove
Aquateq	95027_3	Lake Wanaka	Ruby Island
Aquateq	95027_16	Lake Wanaka	West Wanaka Bay
Aquateq	95027_38	Lake Wanaka	The Peninsula South
Aquateq	95027_10	Lake Wanaka	Glendhu Bluff Bay

Hessian	Activity	Total Hours Worked	End date for this CWRS:
Hand Cutting   30.00   11 Oct 2023   Hand Cutting   30.00   15 Oct 2023   Hand Cutting   30.00   15 Oct 2023   Hand Cutting   30.00   15 Oct 2023   Hand Cutting   30.00   17 Oct 2023   Hand Cutting   30.00   17 Oct 2023   Hand Cutting   30.00   17 Oct 2023   Hand Cutting   15.00   18 Oct 2023   Hand Cutting   15.00   18 Oct 2023   Hand Cutting   30.00   19 Feb 2024   Hand Cutting   30.00   20 Feb 2024   Hand Cutting   30.00   20 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   22 Feb 2024   Hand Wetting   30.00   23 Feb 2024   Hand Wetting   30.00   24 Oct 2023   Hand Weeding   30.00   20 Oct 2023   Hand Weeding   480.00   10 Oct 2023   Hand Weeding   480.00   10 Oct 2023   Hand Weeding   175.00   18 Dec 2023   Hand Weeding   100.00   16 Nov 2023   Hand Weeding   175.00   18 Dec 2023   Hand Weeding   175.00   175 Dec 2023   Hand Weeding   175.00   175 Dec 2023   Hand Weeding   175.0			
Hand Cutting   30.00   11 Oct 2023   Hand Cutting   30.00   15 Oct 2023   Hand Cutting   30.00   15 Oct 2023   Hand Cutting   30.00   15 Oct 2023   Hand Cutting   30.00   17 Oct 2023   Hand Cutting   30.00   17 Oct 2023   Hand Cutting   30.00   17 Oct 2023   Hand Cutting   15.00   18 Oct 2023   Hand Cutting   15.00   18 Oct 2023   Hand Cutting   30.00   19 Feb 2024   Hand Cutting   30.00   20 Feb 2024   Hand Cutting   30.00   20 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   22 Feb 2024   Hand Wetting   30.00   23 Feb 2024   Hand Wetting   30.00   24 Oct 2023   Hand Weeding   30.00   20 Oct 2023   Hand Weeding   480.00   10 Oct 2023   Hand Weeding   480.00   10 Oct 2023   Hand Weeding   175.00   18 Dec 2023   Hand Weeding   100.00   16 Nov 2023   Hand Weeding   175.00   18 Dec 2023   Hand Weeding   175.00   175 Dec 2023   Hand Weeding   175.00   175 Dec 2023   Hand Weeding   175.0	Hand Weeding	290.00	14 Nov 2023
Hand Cutting   30.00   11 Oct 2023   Hand Cutting   30.00   15 Oct 2023   Hand Cutting   30.00   15 Oct 2023   Hand Cutting   30.00   17 Oct 2023   Hand Cutting   15.00   18 Oct 2023   Hand Cutting   30.00   18 Oct 2023   Hand Cutting   30.00   18 Oct 2023   Hand Cutting   30.00   19 Feb 2024   Hand Cutting   30.00   19 Feb 2024   Hand Cutting   30.00   19 Feb 2024   Hand Cutting   30.00   20 Feb 2024   Hand Cutting   30.00   20 Feb 2024   Hand Cutting   30.00   20 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   21 Feb 2024   Hand Cutting   30.00   22 Feb 2024   Hand Cutting   30.00   25 Feb 2024   Hand Weeding   30.00   20 Oct 2023   Hand Weeding   480.00   10 Oct 2023   Hand Weeding   480.00   10 Oct 2023   Hand Weeding   480.00   10 Oct 2023   Hand Weeding   30.00   15 Dec 2023   Hand Weeding   100.00   16 Nov 2023   Hand Weeding   110.00   16 Nov 2023   Hand Weeding   110.00   16 Oct 2023   Hand Weeding   110.00   16 Oct 2023   Hand Weeding   110.00   10 Oct 2023   Hand Weeding   110.00   12 Oct 2023   Hand Weeding   100.00   12 Oct 2023   Hand Weeding   100.00   12 Oct 2023   Hand Weeding   100.00   10 Oct 2023   Hand Weeding   100.00		30.00	11 Oct 2023
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Hand Cutting	Hand Cutting	30.00	15 Oct 2023
Hand Cutting	Hand Cutting	30.00	15 Oct 2023
Hand Cutting	Hand Cutting	30.00	17 Oct 2023
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Hand Weeding       30.00       02 Oct 2023         Hand Weeding       480.00       10 Oct 2023         Hand Weeding       100.00       15 Dec 2023         Hand Weeding       175.00       18 Dec 2023         Hand Weeding       360.00       31 Oct 2023         Hand Weeding       110.00       06 Oct 2023         Hand Weeding       95.00       08 Oct 2023         Hand Weeding       276.00       08 Oct 2023         Survey       70.00       08 Sep 2023         Survey       70.00       08 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       49.00       10 Sep 2023         Hand Weeding       77.00       11 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hand Weeding       105.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Hand Weeding       35.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       35.00       14 Sep 2023         Hand Weeding       35.00       15 Sep 2023         Hand Weeding	Hand Cutting	330.00	24 Oct 2023
Hand Weeding       480.00       10 Oct 2023         Hand Weeding       30.00       15 Dec 2023         Hand Weeding       100.00       16 Nov 2023         Hand Weeding       175.00       18 Dec 2023         Hand Weeding       360.00       31 Oct 2023         Hand Weeding       95.00       08 Oct 2023         Hand Weeding       276.00       08 Oct 2023         Survey       70.00       08 Sep 2023         Survey       70.00       09 Sep 2023         Survey       70.00       09 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       49.00       10 Sep 2023         Hand Weeding       77.00       11 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Hand Weeding       35.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       60.00       17 Sep 2023         Hand Weeding       140.00       20 Aug 2023	Hand Cutting	120.00	25 Feb 2024
Hand Weeding       30.00       15 Dec 2023         Hand Weeding       100.00       16 Nov 2023         Hand Weeding       360.00       31 Oct 2023         Hand Weeding       110.00       06 Oct 2023         Hand Weeding       95.00       08 Oct 2023         Hand Weeding       276.00       08 Oct 2023         Survey       70.00       08 Sep 2023         Survey       35.00       08 Sep 2023         Survey       70.00       09 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       49.00       10 Sep 2023         Hand Weeding       77.00       11 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Hand Weeding       35.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       60.00       17 Sep 2023         Hand Weeding       140.00       20 Aug 2023         Survey       35.00       21 Aug 2023		30.00	02 Oct 2023
Hand Weeding       100.00       16 Nov 2023         Hand Weeding       175.00       18 Dec 2023         Hand Weeding       360.00       31 Oct 2023         Hand Weeding       110.00       06 Oct 2023         Hand Weeding       95.00       08 Oct 2023         Hand Weeding       276.00       08 Oct 2023         Survey       70.00       08 Sep 2023         Survey       70.00       09 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       49.00       10 Sep 2023         Hand Weeding       77.00       11 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hessian       24.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Survey       30.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       60.00       17 Sep 2023         Hand Weeding       140.00       20 Aug 2023         Survey       35.00       21 Aug 2023	Hand Weeding	480.00	10 Oct 2023
Hand Weeding       175.00       18 Dec 2023         Hand Weeding       360.00       31 Oct 2023         Hand Weeding       110.00       06 Oct 2023         Hand Weeding       95.00       08 Oct 2023         Hand Weeding       276.00       08 Oct 2023         Survey       70.00       08 Sep 2023         Survey       70.00       09 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       49.00       10 Sep 2023         Hand Weeding       77.00       11 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hessian       24.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Survey       30.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       60.00       17 Sep 2023         Hand Weeding       140.00       20 Aug 2023         Survey       35.00       21 Aug 2023	Hand Weeding	30.00	15 Dec 2023
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Hand Weeding       110.00       06 Oct 2023         Hand Weeding       95.00       08 Oct 2023         Hand Weeding       276.00       08 Oct 2023         Survey       70.00       08 Sep 2023         Survey       70.00       09 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       49.00       10 Sep 2023         Hand Weeding       77.00       11 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hessian       24.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Survey       30.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       60.00       17 Sep 2023         Hand Weeding       140.00       20 Aug 2023         Survey       35.00       21 Aug 2023	Hand Weeding	175.00	18 Dec 2023
Hand Weeding       95.00       08 Oct 2023         Hand Weeding       276.00       08 Oct 2023         Survey       70.00       08 Sep 2023         Survey       70.00       09 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       49.00       10 Sep 2023         Hand Weeding       77.00       11 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hessian       24.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Survey       30.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       60.00       17 Sep 2023         Hand Weeding       140.00       20 Aug 2023         Survey       35.00       21 Aug 2023	Hand Weeding	360.00	31 Oct 2023
Hand Weeding       276.00       08 Oct 2023         Survey       70.00       08 Sep 2023         Survey       35.00       08 Sep 2023         Survey       70.00       09 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       77.00       11 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hessian       24.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Hand Weeding       35.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       60.00       17 Sep 2023         Hand Weeding       140.00       20 Aug 2023         Survey       35.00       21 Aug 2023	Hand Weeding	110.00	06 Oct 2023
Survey       70.00       08 Sep 2023         Survey       35.00       08 Sep 2023         Survey       70.00       09 Sep 2023         Hand Weeding       100.00       10 Oct 2023         Hand Weeding       49.00       10 Sep 2023         Hand Weeding       105.00       12 Oct 2023         Hand Weeding       140.00       12 Oct 2023         Hand Weeding       146.00       13 Oct 2023         Hand Weeding       35.00       14 Sep 2023         Hand Weeding       35.00       15 Sep 2023         Survey       30.00       15 Sep 2023         Hand Weeding       60.00       17 Sep 2023         Hand Weeding       140.00       20 Aug 2023         Survey       35.00       21 Aug 2023	Hand Weeding	95.00	08 Oct 2023
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Hand Weeding	30.00	21 Feb 2024
Hessian	1127.00	22 Sep 2023
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Survey	17.50	23 Aug 2023
Survey	30.00	24 Aug 2023
Hand Weeding	14.00	27 Sep 2023
Survey	42.00	27 Sep 2023
Survey	17.50	28 Aug 2023
Hand Weeding	35.00	28 Aug 2023
Survey	17.50	28 Aug 2023
Hand Weeding	49.00	28 Sep 2023
Suction Dredging	872.00	30 Sep 2023

Were lagarosiphon plants found at this site?
ŭ i i
Yes
Yes
No
Yes
Yes
Yes
Yes Yes
Yes Yes
Yes
Yes
Yes
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Yes
162

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Yes	
No	
No	
No	
No	
Yes	
	Totals:

?
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16
88
5
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3
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10
0
170

How many catch bags were removed?	Were any unrooted fragments found at this site?
46	Yes
0	No
	Yes
	No
	No
	Yes
0	No
	Yes
	Yes
	Yes
0	Yes
	No
	Yes
	Yes
	Yes
	Yes
54	Yes
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27	Yes
8	Yes
10	Yes
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0	Yes Yes
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8	Yes
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6	No
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4	Yes
382	

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29125
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Site ID	Contractor	Property Name	Site Name	Activity
95026 2	Aguateg	Kawarau River	Upper Kawarau River	Boat Herbicide
95026 2	Wai Dive	Kawarau River	Upper Kawarau River	Hand Weeding
	Wai Dive	Kawarau River	Upper Kawarau River	Hessian
	Aguateg	Lake Dunstan	Bendigo Boat Ramp and Approach	
	Aquateq	Lake Dunstan	Pisa Moorings	Boat Herbicide
	Aquateq	Lake Dunstan	Lowburn Boat Harbour	Boat Herbicide
95001_19		Lake Dunstan	Northburn Ski Lane	Boat Herbicide
95001_19	Aquateq	Lake Dunstan	Cromwell Swimming Beach	Boat Herbicide
95001_9	<u> </u>	Lake Dunstan	Lowburn Inlet	Boat Herbicide
95028 1	Wai Dive	Lake Wakatipu	Frankton Arm	Hand Weeding
95028_1	Wai Dive	Lake Wakatipu	Frankton Marina	Hand Weeding
95028_4	Wai Dive			
95028_3	Wai Dive	Lake Wakatipu Lake Wakatipu	Kingston	Hand Weeding
			Kingston	Hand Weeding
95027_43		Lake Wanaka	Quartz Creek	Boat Herbicide
	Aquateq	Lake Wanaka	Roys Bay Boat Ramp and Jetty	Boat Herbicide
95027_48		Lake Wanaka	Eely Point	Boat Herbicide
95027_13		Lake Wanaka	Bishops Bay	Hand Weeding
	Aquateq	Lake Wanaka	Glendhu Bay	Hand Weeding
95027_7	Aquateq	Lake Wanaka	Glendhu Bay Boat Ramp	Hand Weeding
95027_10		Lake Wanaka	Glendhu Bluff Bay	Hand Weeding
	Aquateq	Lake Wanaka	Glendhu Shoreline	Hand Weeding
	Aquateq	Lake Wanaka	Paddock Bay	Hand Weeding
95027_43		Lake Wanaka	Quartz Creek	Hand Weeding
95027_1	Aquateq	Lake Wanaka	Roys Bay Boat Ramp and Jetty	Hand Weeding
95027_3	Aquateq	Lake Wanaka	Ruby Island	Hand Weeding
95027_38		Lake Wanaka	The Peninsula South	Hand Weeding
	Aquateq	Lake Wanaka	Fern Burn	Hessian
95027_10		Lake Wanaka	Glendhu Bluff Bay	Hessian
95027_11		Lake Wanaka	Paddock Bay	Hessian
	Aquateq	Lake Wanaka	Parkins Bay	Hessian
95027_17		Lake Wanaka	Colquhouns Coast	Survey
	Aquateq	Lake Wanaka	Fishermans Cove	Survey
95027_20		Lake Wanaka	Minaret Bay	Survey
95027_19		Lake Wanaka	Minaret Burn	Survey
95027_36		Lake Wanaka	Mou Tapu Island	Survey
	Aquateq	Lake Wanaka	Mou Waho Island	Survey
95027_14	Aquateq	Lake Wanaka	Roys Peninsula	Survey
	Aquateq	Lake Wanaka	Rumbling Burn	Survey
95027_22	Aquateq	Lake Wanaka	Snag Bay	Survey
95027_34		Lake Wanaka	The Peninsula North End	Survey
95027_37	Aquateq	Lake Wanaka	The Peninsula West Coast	Survey
95027_16		Lake Wanaka	West Wanaka Bay	Survey
95027_26	Aquateq	Lake Wanaka	Wharf Creek	Survey
95027_27	Aquateq	Lake Wanaka	Windy Point	Survey

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Environmental Implementation Committee - 8 May 2024		

Environmental Implementation Committee 8 May 2024 - MATTERS FOR CONSIDERATION



## Check, Clean, Dry 2023/2024 Report

#### Prepared by Check, Clean Dry Advocates February 2024

#### Background

The Check, Clean, Dry programme (CCD) is a Ministry for Primary Industries initiative aimed at preventing the spread of aquatic pests, such as didymo and lagarosiphon. The Otago Regional Council (ORC) operated this programme throughout the Central Otago region, encompassing all water bodies and rivers frequented by water users and members of the public. This programme operated from December 2023 – February 2024, the program's primary objective was to conduct public outreach on freshwater pest species, emphasising the importance of preventing their spread.

The programme's methodology involved three key steps:

- Check, and remove any plant matter from water equipment and leave it at the site or put it in the rubbish.
- Clean, use a 10% detergent or 2% bleach and water mix to clean equipment that is wet or moist. Spray or soak any wet clothing or footwear for 10 minutes to remove algae.
- Dry, dry any equipment that has been immersed to ensure that no pest species can survive on any remaining damp surfaces or material. Leave to dry for at least another 48 hours before the equipment is used again.

## Aim/Objectives

The aim of the Check, Clean, Dry programme was to have educational and receptive conversations with water users regarding invasive freshwater pests, such as didymo and lagarosiphon. Encouraging water users through active engagement to follow the CCD method and its key messaging, as pests can spread easily between waterways on people's equipment and vessels. Following the simple CCD steps can help to minimise the risk of pests spreading between waterways.

An additional aim of the programme is to make people aware of the freshwater gold clam (*Corbicula fluminea*) which is a new pest to New Zealand and is currently only known to be in the North Island. Including informing people on the dangers of the gold clam, and how to identify and report the clam as part of a campaign to keep freshwater gold clams out of Otago.

Furthermore, the advocates aimed to have a presence at key water events throughout Central Otago over the Summer period to interact with freshwater users, raise awareness of aquatic pests, and educate people on the Check, Clean, Dry method.



#### Measures

Throughout the contract period, the advocates had a number of measures to which they adhered to as guidelines for the work. The advocates were to ensure that all collateral material being distributed to members of the public was up-to-date and factually correct. This was maintained by checking stock resources and disposing of any old material that was outdated.

During interactions, the advocates ensured to allow for communication, feedback and comments on all freshwater messaging, information, and collateral. This is a key aspect of the role, as it is important to receive feedback/constructive criticism to improve and adopt changes where they are needed.

Collaboration with the Community Coordinator for Biosecurity was of immense help in communicating with sports groups/clubs and event organisers, allowing the advocates to provide on-going support, through operating cleaning stations, assisting volunteers and talking to members of the public and competitors. It was imperative that CCD brochures were carried at all times during events, as they were useful for providing a visual representation of the pest species when having 1-to-1 interactions.

#### Groups/individuals

The primary engagement groups that ORC interacted with over the course of the CCD programme, consisted of boaters, jet skiers, swimmers, fishermen, kayakers/paddleboarders, and members of the public. Additionally, communication with event managers, organisers, and volunteers facilitated the organisation of CCD initiatives at various events throughout Central Otago.

## Results

Data was logged on a variety of variables, including the number of interactions (classed into water user type), the percentage of daily interaction totals that were locals/tourists, and the number of differing attitudes to CCD (this was logged on a receptivity scale where 1 was 'not receptive' through to 5 which was 'very receptive.' This information was gathered and formulated into an Excel spreadsheet for a consistent and concise viewing format.

Over the course of our contract, a total of 642 water user interactions were recorded. This is the accumulative total of all water user groups that we interacted with. Note that the 'boaters' group was always logged as 1 per group of boaters, when primarily a group of boaters would include 2-5 people.

Key takeaways from our collected data were that out of the 642 total interactions, a total of 68 people were not 'very receptive' (1-4) for the number of differing attitudes scale, and 574 were



'very receptive' (5). Additionally, the majority of people spoken to were of local origin, with 70% being the lowest local percentage day.

(For a full breakdown of our results and all associated data, please see the attached spreadsheet and daily notes for specific information.)

#### **Events**

As per the Excel spreadsheet, the following events occurred over our contract period. Clyde Open Water Swim - 31<sup>st</sup> December, Tri-Wanaka - 5<sup>th</sup> Jan (weekly), Revenant Ultra Adventure Run - 18<sup>th</sup> January, Jet Sprints Wanaka - 20<sup>th</sup> January, Old 4 New Life Jacket Swap - 21<sup>st</sup> /24<sup>th</sup> January, The Ruby - 27<sup>th</sup> January, Spirited Women Adventure Race – 10<sup>th</sup> February, and the Challenge Wanaka Triathlon – 15<sup>th</sup>, 16<sup>th</sup>, 17<sup>th</sup> February. From these events, the Clyde Open Water Swim was the only event not attended.

#### **Discussion/Suggestions**

The CCD programme was highly successful. This is attributed to the majority of water users interacted with having a 'very receptive' rating (5) for their attitudes towards the CCD programme, and the information and collateral that the advocates provided. Across all water user types, the collected data in useful for determining the dominant user type at different locations throughout Central Otago. This data enable ORC and MPI to maintain records and target specific user types in the future.

The change from previous years where survey questions were asked as opposed to a general conversation was great. Although we were not familiar with the prior years survey questions, we found that being able to have an informative conversation on a personal level was insightful and we believe this aspect boosted the level of overall receptivity.

In terms of Collateral material, we found that the brochures were very informative, well made, and useful for providing detailed information to people. Specifically, the instructions for cleaning outboards, jet skis, trailers, and hulls were easy for people to follow and gave simple and clear instructions.

The small spray bottles were great to give out to very enthusiastic water users and provided a great conversation topic in regard to the detergent solution and the application of the solution. It was also great to see that some users already had their own cleaning solution and carried this with them throughout their boating activities.

The keychain floaters were not useful. We found that nobody we offered the floaters to wanted them on their keychain. This can be attributed to their size as they can not easily be stored



inside of pockets and as such, water users were not receptive to them, and they did not have any use for us during our work.

Bumper stickers in theory are a great idea to spread the CCD message to a large number of people. However, we found that their uptake was extremely minimal, and people did not want to have a CCD bumper sticker on their personal vehicles. This was a shame as the new design with the cartoon lagarosiphon and Didymo were well made and clear with their intended message. As such, the bumper stickers did not have a practical application for us.

Events were a great opportunity for the advocates to speak to a large diverse demographic of people. They found that being proactive at events and actively engaging with members of the public to spread CCD information was beneficial. As such, a recommendation that we have is for ORC to organise event gear for future year's ambassadors. Items such as a CCD gazebo, a foldable table, and chairs would provide a large clear message, a welcoming environment, and would help to further CCD outreach. This gear could be taken to events such as the Jet Sprints which is a national event and has considerable potential for public engagement.

An area of work that the advocates could have improved on, is through taking more photos during our general CCD advocacy and at events. This would enable more media to be produced and for members of the public to see an online presence for CCD information.

### **Conclusion:**

In summary, the CCD programme for the 2023/2024 Summer period in Central Otago was very successful. Both the advocates thoroughly enjoyed being able to work around freshwater environments. It was very rewarding to be able to have personal and informative conversations with such a diverse range of people from all walks of life. Working with a variety of people on a daily basis greatly improved our communication skills, confidence, and general levels of compassion and understanding for people and their own individual situations.

Thank you,

The Check, Clean, Dry Advocates 2023-2024

#### 9.5. Wallaby Programme Update and Recommendations

**Prepared for:** Environmental Implementation Committee

Report No. OPS2260

**Activity:** Governance Report

Author: Libby Caldwell, Manager Environmental Implementation and Gavin Udy,

Project Delivery Specialist, National Programmes

**Endorsed by:** Gavin Palmer, General Manager Operations

**Date:** 8 May 2024

#### **PURPOSE**

[1] To update the Environmental Implementation Committee on the Otago Wallaby Eradication Programme and provide recommendations to ensure the programme is achieving the best outcomes possible with the goal of Wallaby eradication in Otago.

#### **EXECUTIVE SUMMARY**

- [2] Bennett's Wallaby are listed as an Unwanted Organism under the Biosecurity Act 1993 and are identified as an eradication pest in the Otago Regional Pest Management Plan 2019-2029. These animals have the potential to significantly impact on our environment, primary industry and economy and become a burden for future generations should feral populations establish in Otago.
- [3] In 2016, ORC initiated the Otago Wallaby Programme aimed at preventing wallabies from establishing in Otago. This was in response to a sharp increase in Bennett's Wallaby sightings in Otago along the northern regional boundary.
- [4] In 2020, Biosecurity New Zealand (Ministry for Primary Industries MPI) initiated the Tipu Mātoro National Wallaby Eradication Programme ("Tipu Mātoro Programme"). \$27 million in funding over 4 years was allocated to the Tipu Mātoro Programme nationally, with on-going baseline funding of \$6.9 million from the 2024/25 financial year onwards. Since July 2020, ORC has received \$3,393,392 in funding from the Tipu Mātoro Programme.
- [5] MPI and ORC are parties to a funding agreement in relation to the Tipu Mātoro Programme and work in partnership to progress the Otago Wallaby Programme and eliminate wallaby from Otago. The Agreement records the terms on which MPI will distribute funding to ORC for wallaby operations during 2020-2024, and the terms on which ORC will apply the funding and ensure that wallaby surveillance and control activities are carried out.
- [6] Since July 2020 a total of 1,061,295 hectares of wallaby surveillance and control work has been completed in Otago using ground and aerial surveillance and control techniques. A total of 41 wallabies have been destroyed.
- [7] An extensive and intensive surveillance monitoring programme continues to target known wallaby hotpots, previously affected areas and potential pathways for migration/dispersal within the Otago region. Public sighting reports also contribute to

- understanding the distribution of wallaby across the region, with all credible sightings followed-up and inspected.
- [8] There continues to be a heavy focus on increasing public awareness of wallabies in Otago across multiple communication channels, aimed at educating the public about the wallaby problem in Otago and impacts, informing the public about the Tipu Mātoro Programme and eradication efforts in Otago, and encouraging people to report sightings through reportwallabies.nz
- [9] The current extent of wallaby distribution and number of breeding populations in Otago is difficult to quantify due to the limited understanding of the effectiveness of current intervention tools and methods to objectively measure progress. The number of breeding populations is however thought to be extremely low based on recent surveillance results.
- [10] To maintain the gains and continue to progressively eliminate Bennett's wallaby from Otago, funding of \$1.4 million is needed annually. The current funding proposed for 2024/25 financial year is \$850,000.

#### **RECOMMENDATION**

That the Environmental Implementation Committee:

1) Notes this report.

#### **BACKGROUND**

- [11] Bennett's Wallaby are listed as an Unwanted Organism under the Biosecurity Act 1993 and are identified as a pest animal in the Otago Regional Pest Management Plan 2019-2029 (RPMP). These animals have the potential to significantly impact on our environment, primary industry and economy and become a burden for future generations should feral populations establish in Otago. They are adaptable with regards to habitat and can thrive in environments from forest through to open tussock country.
- [12] In 2016, ORC initiated a Wallaby Programme in response to a sharp increase in Bennett's Wallaby sightings through Otago and evidence of breeding populations emerging along the northern regional boundary, from Hawea to Oamaru, and near Dunedin. Efforts to locate and control breeding populations and prevent wallabies from establishing in Otago is ongoing.
- In 2020, Biosecurity New Zealand (Ministry for Primary Industries MPI) initiated the Tipu Mātoro National Wallaby Eradication Programme ("Tipu Mātoro Programme"), working in partnership with affected regional councils to reduce the spread of wallabies and eliminate them from New Zealand. \$27 million over 4 years was allocated to the Tipu Mātoro Programme through Jobs for Nature, with the bulk of this funding earmarked for control operations to both find and eradicate satellite populations outside of traditional containment zones, while reducing populations within these zones to reduce dispersal of wallaby into new areas.

- [14] The short-term goal of the Tipu Mātoro Programme is that by 2025 all Bennett's Wallaby are contained within the South Island Containment Area<sup>1</sup>. This involves:
  - i. eliminating all outlier populations;
  - ii. reducing wallaby numbers within buffer areas inside containment;
  - iii. developing innovation in wallaby detection and control methods.
- Once containment is achieved, the aim is to continue to reduce Bennett's wallaby numbers inside the containment area and shrink the size of the containment area over time (Figure 1).
- [16] MPI and ORC are parties to a funding agreement in relation to the Tipu Mātoro Programme and work in partnership to progress the Otago Wallaby Programme and eliminate wallaby from Otago. The Agreement records the terms on which MPI will distribute funding to ORC for wallaby operations during 2020-2024, and the terms on which ORC will apply the funding and ensure that wallaby surveillance and control activities are carried out. Since July 2020, ORC has received \$3,393,392 in funding from the Tipu Mātoro Programme.
- [17] Under the RPMP, Plan Objective 6.2.3 aims to reduce all infestations of Bennett's wallaby to zero levels within the Otago region to prevent adverse effects on the environment and economic well-being, over the duration of the RPMP.

#### **DISCUSSION**

- [18] Since July 2020 a total of 1,061,295 hectares of wallaby surveillance and control work has been completed (see Table 1 and Figures 1 and 2 below). Surveillance methods have included ground-based searching using hunters, dogs, and thermally equipped UAV (drones), and aerial methods using thermal cameras. Control methods have included shooting and poisoning techniques.
- [19] A total of 41 wallaby have been killed through control operations, from roadkill or by being culled by the public (e.g. farmers). Surveillance monitoring continues to target known wallaby hotpots, previously affected areas and potential pathways for migration/dispersal along the northern regional boundary. The current extent of wallaby distribution and number of breeding populations in Otago is difficult to quantify due to the limited understanding of the effectiveness of current intervention tools and ability to objectively measure progress. The number of breeding populations is however thought to be extremely low based on recent surveillance results.

Table 1. Total hectares of wallaby surveillance and control, and wallaby killed.

Year	No. wallaby killed	Area (hectares)
2020/21	6	72,904
2021/22	9	514,246
2022/23	15	383,537
2023/24*	11	90,608
<b>Grand Total</b>	41	1,061,295

<sup>\*</sup>As of 31 March 2024

 $^{\rm 1}$  The South Island Containment Area is presently 942,000ha in size.

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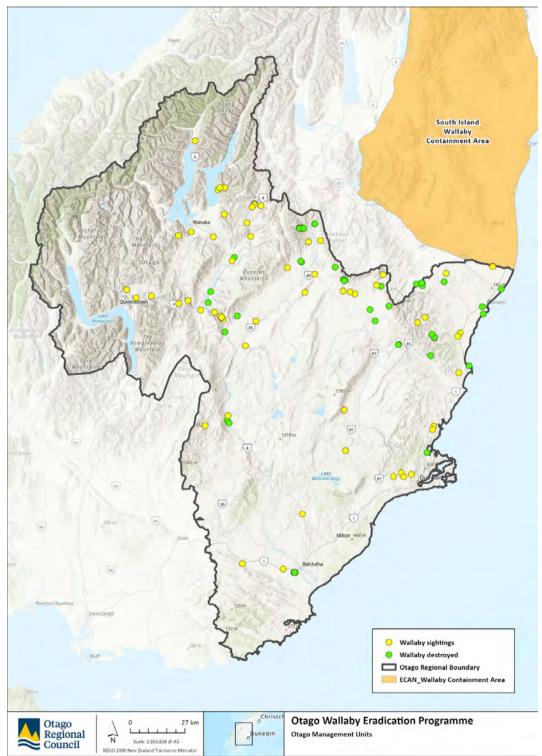


Figure 1: Wallaby sightings and wallaby destroyed from 1 July 2020 to 31 March 2024

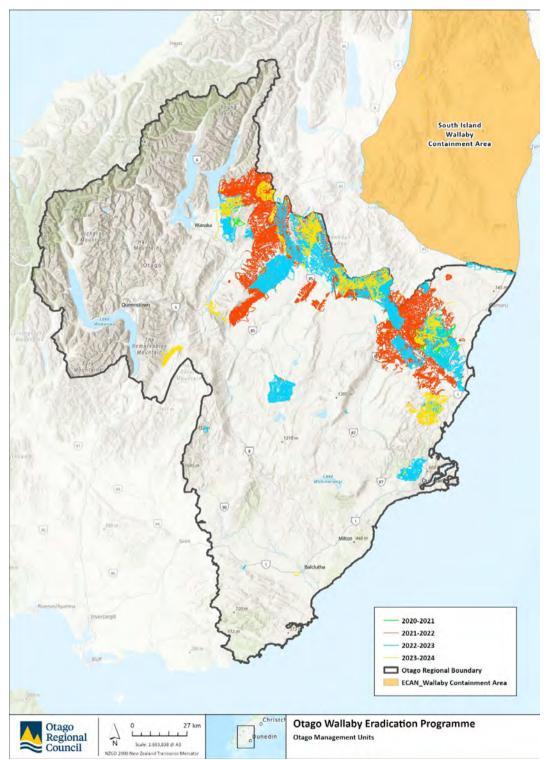


Figure 2: Wallaby surveillance tracks from 1 July 2020 to 31 March 2024

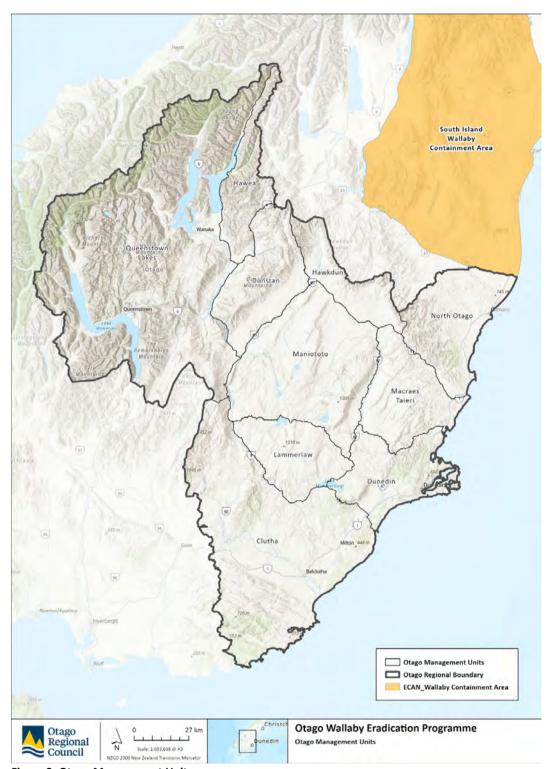


Figure 3: Otago Management Units

- [20] A total of 146 public sighting reports have been received since July 2020, with 105 (72%) of these sightings deemed "credible"<sup>2</sup> (i.e. confirmed through a wallaby or wallaby sign being found, or the informant providing reliable intelligence) (Table 2). Sightings are typically inspected within 1-3 working days of receiving the report and use ground hunters with dogs and/or thermally equipped helicopters or UAV (drones) to search the area. Some sightings have taken longer to inspect due to uncertainty around the precise location, or challenges with logistics and access. Although the sightings inspected are considered genuine, it is very difficult to find evidence of wallaby in most cases. This indicates that public sightings are picking up transient individuals that are passing through an area and leaving little or no trace, unlike breeding populations that can leave abundant evidence (i.e. prints, scat, tunnels in scrub and tussock) in one place.
- [21] Recent studies using translocated Bennett's wallabies with satellite GPS collars showed most mean daily movements are less than 2.5 km, but daily movements up to 9 km were observed in all wallabies studied. These results indicate that credible reported sightings should be investigated and extend out to about 3km if searching for a live wallaby.
- [22] Reporting sightings or sign of wallabies (dead or alive) has been a key part of ORC's communications and engagement strategy this financial year, with reports helping to identify areas where wallabies are present and enable immediate follow-up control to stop them spreading.

Table 2. Public sighting reports received

Year	Unconfirmed sightings	Credible sightings
2020/21		8
2021/22	13	24
2022/23	13	35
2023/24*	15	38
TOTAL	41	105

<sup>\*</sup>As of 31 March 2024

- [23] The difficulty in locating and killing wallables that are reported may eventually pose a key risk to the goal of eradication.
- [24] A total of 33,429 contractor hours have been worked while undertaking wallaby surveillance and control operations since July 2020 (Table 3). At present we have 5 contractors with up to 27 contract staff in the field, depending on the location and type of work being undertaken.
- [25] Total operational expenditure for surveillance and control work since July 2020 is \$3.66M.

Table 3. Operational expenditure and hours worked.

Year	Hours worked	Expenditure (\$)
2020/21	2,534	191,096
2021/22	13,974	1,631,910

<sup>&</sup>lt;sup>2</sup> Credible sighting = confirmed as wallaby roadkill, public cull, wallaby sign found or reliable intelligence

Environmental Implementation Committee - 8 May 2024

Year	Hours worked	Expenditure (\$)
2022/23	13,776	1,503,348
2023/24*	3,145	337,000
TOTAL	33,429	3,663,354

<sup>\*</sup>As of 31 March 2024

- [26] Due to the difficult nature of finding low numbers of wallaby in largely mountainous and remote terrain, there has been a heavy focus on increasing public awareness of wallabies in Otago using multiple channels e.g. social media, print media, radio, television, webpages, newsletters, public events and signage. As wallaby are not common, repetition is seen as the key to ensuring the public know what to do if they ever come across a wallaby or sign of wallabies.
- [27] Our key objectives delivered on during the 2023/24 financial year have been:
  - i. to continue to increase the number of reported wallaby sightings for Otago,
  - ii. to ensure the community understands why wallaby are a pest,
  - iii. to ensure the community is informed about the work ORC does in wallaby management.
- [28] Targeted communications regarding the wallaby programme will continue during the 2024/25 financial year, to increase public awareness of wallabies in Otago, and nationally.
- [29] The development of national good practice guidance and tools for wallaby surveillance and/or control is ongoing. The Tipu Mātoro Programme and Otago Wallaby Programme collaborate closely on many research projects as funding and opportunities allows (Table 4, Table 5 and Table 6).

Table 4: Tipu Mātoro Programme research in progress.

Research project	Description of services / Programme value
Image recognition software for detecting wallabies using trail cameras.	To develop software that uses Artificial Intelligence to automate the identification of wallabies from non-wallabies from trail camera images with a high level of accuracy – to remove the need to manually process 1000s of images which in turn speeds up processing times and increases response times to initiate operational activities.
Dispersal ecology of Bennett's	To assess the spatial and dispersal ecology of Bennett's wallaby using a number of methods, and whether the use of spatial and dispersal ecological factors can optimise surveillance and management strategies.
Determine the rate that Bennett's wallaby reinfest a control area	To assess whether Bennett's wallaby populations recover after a control operation and, if recovery occurs, determine the likely factors contributing to their recovery i.e. to quantify how significant the problem of reinvasion is.
Wallaby Environmental DNA (eDNA)	To determine whether eDNA (via water and air sampling) is a suitable surveillance and monitoring tool to accurately detect wallabies at a landscape scale, and if successful,

Research project	Description of services / Programme value	
	whether it can determine proof of absence.	
Spy wallaby research	To assess if the 'spy' wallaby technique has utility in the detection and control of Bennett's wallabies in areas of low density.	

Table 5: Tipu Mātoro Programme research upcoming (funding confirmed, contract pending).

Research project	Description of services / Programme value		
Elimination Case Studies	To assess the feasibility of local elimination to inform the feasibility of the wider eradication goals.		
Genotyping by sequencing (GBS) forensic marker development.	To develop amplified Single Nucleotide Polymorphism (SNP) markers to enable the identification of individuals from trace samples like scat, hair, and saliva.		
Detection Probability	To measure the detection probabilities and estimate the derived surveillance sensitivities and efficacy of selected mobile surveillance methods for detecting Bennett's wallabies, including:  Daytime aerial thermal camera Nighttime aerial thermal camera UAV aerial thermal camera Indicator Dogs Walk-through surveillance		
Wallaby local elimination case studies	Establish two pilot case studies (one each for dama and Bennett's) to act as precedents to inform the feasibility of the wider national eradication goals.		
Improved ground based VTA delivery	Explore effectiveness of different formulations and delivery mechanisms of existing vertebrate toxin agents (e.g. Feratox strikers; Cyanara). Only a small number of pesticides are registered for wallabies, however, there are unresolved questions and concerns about their effectiveness, which depends in part on the method of delivery (e.g., Feratox strikers). This study aims to improve several ground based VTA delivery methods for both Bennett's and dama and possibly parma wallabies.		
Estimation of density for Bennett's	Estimate density of Bennett's and dama wallabies. To assess whether the benefits achieved in controlling wallabies are greater than the costs spent on managing wallabies, the relationship between density and impact needs to be known to accurately evaluate future costs/benefits analyses. Knowing the relationship between density and impact also help informs future modelling around dispersal pressure, geographical range expansion, and production impacts. This research will provide robust quantitative data about the level of damage wallabies cause at high densities.		
Outcomes of wallaby	Measure production and economic impacts of Bennett		

Research project	Description of services / Programme value
control for farm productivity	wallabies and the benefits that has on farm productivity.
Improving DNA marker capabilities	Development of DNA markers for dama, parma and Bennett's to identify individual wallabies from scat DNA. The ability to match individual DNA in wallaby faeces (easy to find) to DNA in tissues of wallabies subsequently killed (which are 'difficult' to kill) is a key research gap to support proof-of-absence analyses.

Table 6: Tipu Mātoro Programme research completed.

Research project	Description of services / Programme value	
Eradication Decision Support System Model (DSS)	To develop a decision support tool that will help decision makers and operational staff to make informed decisions about tactics, logistics, and expenditure for achieving local wallaby eradication (or elimination), and surveillance effort to validate eradication.	
Understanding non- compliance behaviour of the illegal capture and release of wallabies	To understand the behaviour of risk individuals and groups that drive non-compliance behaviour in the illegal capture and/or release of wallabies and mitigation strategies to increase the level of compliance.	
Strontium isotope baseline	To establish and complete the baseline strontium isotope map or isoscape covering the remaining areas of interest in North Canterbury; Mackenzie Country; Queenstown Lakes and parts of Southern Canterbury and Otago.	
Bennett's translocation	Understanding of Bennett's wallaby behaviour to understand future detection probability	
Evaluation of bait delivery system designs for control of Bennett's wallabies	Understanding of which bait delivery systems are most effective for Bennett's wallaby control.	
Determining the efficacy of Feratox and Cyanara as a broadleaf application for control of Bennett's	Understanding the efficacy of these poison options for wallaby control.	
Determining the LD99 for Bennetts wallabies	To understand sowing rates for operational efficacy when using 1080.	

[30] Detecting and controlling Bennett's wallaby in areas of very low density is one of the major challenges within the Tipu Mātoro Programme. This is particularly relevant to Otago and parts of South Canterbury, which have a very low density of wallaby and are the closest to achieving eradication. The tools involved with reducing wallabies from high to low-density are reasonably well-developed, but the research to date into detecting and controlling wallabies at very low-density has been minimal.

- [31] ORC and the Tipu Mātoro programme have co-funded research for the release of 10 satellite GPS tracked 'spy' wallabies into areas with known low wallaby density in South Canterbury as part of a 12-month research project looking at whether wallabies will seek out others. The spy wallabies are being monitored monthly by a hunting team to see if they lead the hunters to other wallabies, which are then destroyed, leaving the spy wallaby to continue to seek out more wallabies until no more individuals can be found. This research is expected to conclude in mid-2025.
- [32] Monitoring of the spy wallabies since their release in December 2023 has resulted in 35 wallabies being found and destroyed (Table 7). If successful, this technique has the potential to significantly increase detection rates and kill rates in areas with very low wallaby density, compared to current approaches, and accelerate the eradication of Bennett's wallaby.

Table 7 Wallaby destroyed during monthly monitoring of spy wallaby.

Month	Males	Females	Unknown	TOTAL
January 2024	2		15	15
February 2024	3	6		9
March 2024	4	5		9
TOTAL	9	11	15	33

- [33] A small number of wallaby sightings continue to be reported outside of the 4 main wallaby regions (Waikato, Bay of Plenty, Canterbury and Otago). While Councils outside the Tipu Mātoro Programme contribute staff time (e.g. to call sighting reporters, search for carcasses on roads and put-up surveillance cameras), they don't have the budget available for paying for contractors (e.g. dog surveillance) or contracts in place to respond.
- [34] It is proposed that a small contingency fund from the Tipu Mātoro Programme budget is allocated regionally to support regions outside the programme. The funds to pay for this follow up reactive surveillance would be incorporated into the existing funding agreements with Bay of Plenty Regional Council to cover all North Island sightings, Otago to cover sightings in Southland, and Canterbury for the rest of the South Island.
- [35] The current funding agreement between MPI and ORC is set to expire in June 2024. MPI is currently exploring options to renew (or vary) the funding agreement for the 2024/25 financial year onwards, and a draft agreement is expected to be provided to ORC in the next 4-6 weeks for staff to review and provide feedback.
- In June 2024, the Jobs for Nature funding allocated over 4 years to the Tipu Mātoro Programme will end, and ongoing national baseline funding of \$6.9M will continue until at least 30 June 2026. Approximately \$5.2 million will be available for operations nationally each year. The level of national funding from 1 July 2026 onwards is currently unclear. MPI is still working through a 7.5% target savings reduction to its overall spend, of which the impact to the Tipu Mātoro Programme won't be known until May 2024. The outcome of this will be reported to Council so considerations can be made for future investment.

The Tipu Mātoro Programme have provided an indicative budget of \$700,000 to ORC for operations for the 2024/25 financial year, with ORC providing an additional \$150,000 included in the Draft 2024/34 Long Term Plan (Table 8).

Table 8: Otago Wallaby Eradication Programme operational funding.

Year	Council (\$)	MPI (\$)
2020/21	150,000	309,342
2021/22	100,000	1,559,000
2022/23	100,000	1,448,050
2023/24	77,000	700,000
2024/25*	150,000 <sup>^</sup>	700,000
TOTAL	427,000	4,716,392

<sup>\*</sup> MPI and ORC funding allocation to be confirmed

- [38] A work package for the 2024/25 financial year with the following objectives is currently being prepared for sign-off by the Tipu Mātoro Programme Governance Group.
  - i. to eliminate wallaby from 4 known sites (Flagstaff, Boundary Creek, Mt Difficulty and Waikouaiti North Branch).
  - ii. to re-monitor all poison operations completed in 2023/24 to measure success.
  - iii. to respond to all 'credible' public sightings within 1-3 working days.
  - iv. to provide operational support for research projects.
- Based on the current understanding of the investment required to maintain the gains and continue to progressively eliminate wallaby from Otago, increasing funding to \$1.4M in 2024/25 and outyears would enable the Otago Programme to:
  - i. to eliminate wallaby from extremely difficult areas.
  - ii. to survey key areas suspected of harbouring undetected populations of wallaby, but have been unable to be surveyed (due to funding levels)
  - iii. expand the geographical area and the time spent searching when responding to 'reliable' public sightings.
  - iv. obtain a clearer picture of wallaby distribution in Otago.
  - v. progress towards 'proof of freedom' surveys.
- [40] Continued investment and intervention in the South Waitaki management unit (in Canterbury), and the Hawkdun, North Otago, Macraes Taieri and Dunedin management units (in Otago) is critical to finding and preventing small, localised residual populations from establishing and breeding.
- [41] It is recommended that an Otago Wallaby Eradication Strategy is developed over the 2024/25 financial year to ensure that specific goals are detailed and progress on these is measured to support achieving eradication of wallaby from Otago by 2029. This can be covered by existing biosecurity budgets provided in the draft LTP 2024-2034.
- [42] Staff recommend that a national cost benefit analysis is advocated for by Council to understand better the value of this work and how much funding is required to achieve the eradication goal. This will support understanding how much funding will be required in Otago to achieve eradication of Bennetts Wallaby.

<sup>^</sup> excludes \$100k for co-funding of 'spy' wallaby research project

## **CONSIDERATIONS**

#### **Strategic Framework and Policy Considerations**

[43] There are no strategic frameworks or policy considerations relevant to this report.

#### **Financial Considerations**

- [44] In the draft Long-Term Plan 2024-2034 \$250,000 is allocated annually by ORC to work on the Wallaby eradication programme.
- [45] The Tipu Mātoro Programme have provided an indicative budget of \$700,000 to ORC for the 2024/25 financial year. The Tipu Mātoro Programme Governance Group is expected to sign-off on regional allocations in June 2024 (Table 8).

#### **Significance and Engagement Considerations**

[46] Not applicable

#### **Legislative and Risk Considerations**

[47] Not applicable

#### **Climate Change Considerations**

[48] Not appliable

#### **Communications Considerations**

[49] Communications regarding the Wallaby programme have been undertaken and will continue with increasing public awareness of wallabies in Otago being a key mechanism to achieving eradication of wallabies in Otago.

#### **ATTACHMENTS**

Nil

#### 9.6. RPMP Operational Plan 2024/25

**Prepared for:** Environmental Implementation Committee

Report No. OPS2405

Activity: Governance Report

Author: Libby Caldwell, Manager Environmental Implementation

Murray Boardman, Performance and Delivery Specialist

**Endorsed by:** Gavin Palmer, General Manager Operations

**Date:** 8 May 2024

#### **PURPOSE**

[1] To seek approval of the 2024-2025 Biosecurity Operational Plan.

#### **EXECUTIVE SUMMARY**

- [2] The Otago Regional Pest Management Plan 2019-2029 (RPMP) was adopted in November 2019. The RPMP details the plants and animals that are declared pests in the Otago region, explains why they are pests, and outlines how each pest will be managed over the ten-year period of 2019-2029.
- Under Section 100B of the Biosecurity Act 1993, an Operational Plan is required to detail the nature and scope of activities the Council intends to undertake in the annual implementation of the RPMP. For reasons of operational efficiency, the Operational Plan aligns with Council's financial year (1 July to 30 June). The Operational Plan details the range of activities that will be undertaken by Council on the implementation of pest control across the five management programmes. The proposed Biosecurity Operational Plan aligns with the commitment to pest management as laid out in the RPMP.
- [4] The 2024-2025 Biosecurity Operational Plan (henceforth, the Operational Plan) continues the progress made under the previous three Operational Plans (2021-22, 2022-23 and 2023-24), focusing on the following operational areas:
  - a. Continue property inspections, on both private and public land, to ascertain compliance against pest management rules.
  - b. Maintain the focus on the five regional pest priorities (Exclusion pests, Rabbits, Wallabies, Wilding conifers and Lagarosiphon).
  - c. Capitalise on business improvement outcomes to enhance the effective delivery of the Operational Plan.
- The Operational Plan supports the implementation of the national programmes addressing wallabies and wilding conifers, the objectives of Integrated Catchment Management (ICM) and engaging with community groups (e.g., site-led programmes, community rabbit programmes and wilding conifer control groups).
- [6] The proposed 2024-2025 Biosecurity Operational Plan is attached. A comparison document is also included to highlight the differences between the proposed Plan and the current Biosecurity Operational Plan 2024-2025.

#### **RECOMMENDATION**

That the Environmental Implementation Committee:

- 1) **Notes** this report.
- 2) Recommends to Council to approve the Otago Regional Council's 2024-2025 Biosecurity Operational Plan to enact the Otago Regional Pest Management Plan 2019-2029 and authorises the Chief Executive to correct minor errors to the 2024-2025 Biosecurity Operational Plan in consultation with the Co-Chairs of the Environmental Implementation Committee.
- 3) **Notes** that a copy of the Otago Regional Council's Regional Pest Management Plan 2024-2025 Biosecurity Operational Plan will be provided to the Minister for Biosecurity.
- 4) **Notes** that staff will report back to Council any response from the Minister for Biosecurity.

#### **BACKGROUND**

#### Regional Pest Management Plan

- [7] In November 2019, after public consultation, the Otago Regional Council adopted the Otago Regional Pest Management Plan 2019-2029 (RPMP).
- [8] The RPMP details the regulatory and non-regulatory mechanisms the Council will utilise for effective biosecurity leadership in Otago over the next 10 years. It contains pest control programmes, objectives and rules to manage pests that cause harm to the wellbeing of Otago's people, economy and environment.
- [9] The RPMP follows the National Policy Direction for Pest Management 2015 by classifying biosecurity implementation through one of five management programmes:
  - Exclusion
  - Eradication
  - Progressive Containment
  - Sustained Control
  - Site-led
- [10] The proposed 2024-2027 Long Term Plan seeks to consolidate the recent expansion of Council's statutory biosecurity function. Biosecurity staffing and funding support our obligations under the Biosecurity Act 1993 and to assist others to comply with the RPMP rules and wider biodiversity goals.

## Regional Pest Management Plan – Operational Plan

- To deliver on the objectives of the RPMP, the Biosecurity Act (Section 100B), requires an Operational Plan be prepared. The Operational Plan outlines the activities the Council intends to undertake to achieve the objectives the RPMP.
- [12] The Operational Plan must be consistent with the current RPMP. Consequently, the Operational Plan cannot introduce any new objectives, rules, or regulatory tools. Due to this, there is no statutory requirement to consult the community on the preparation of the Operational Plan.
- [13] The Operational Plan is required to be accessible to the public (e.g. on ORC website) and reviewed annually. The Operational Plan can either be formally rolled over or revised to account for progress made and changes in implementation focus and lessons learnt.

- [14] As required by the Biosecurity Act, the Council is required to evaluate progress of the Operational Plan against the deliverables and key performance indicators within five months from the end of the financial year.
- [15] Under section 100B of the Biosecurity Act, the ORC is required to inform the Minister for Biosecurity on Operational Plan and its performance.

#### **DISCUSSION**

#### 2024-2025 Biosecurity Operational Plan

- [16] The Operational Plan details how the RPMP will be implemented through specific deliverables (actions) and their related performance measures and targets. For reasons of operational simplicity and efficiency, the Operational Plan aligns with Council's financial year (1 July to 30 June).
- The Operational Plan continues the multi-year programme to manage biosecurity in Otago, building on the progress made under the previous three Operational Plans (2021-22, 2022-23 and 2023-24), focusing on the following operational areas:
  - a. Continue property inspections, on both private and public land, to ascertain compliance against pest management rules.
  - b. Maintain the focus on the five regional pest priorities (Exclusion pests, Rabbits, Wallabies, Wilding conifers and Lagarosiphon).
  - c. Capitalise on business improvement outcomes to enhance the effective delivery of the Operational Plan.
- [18] Feedback is regularly received from staff and lessons learnt have been incorporated into the 2024-2025 Biosecurity Operational Plan. Staff in the Environmental Implementation team are also involved in sector groups where learnings from other Councils are also incorporated where possible to ensure consistency in approaches to biosecurity. Changes have been made to improve efficiency and effectiveness and to ensure deliverables keep pace with progress, focusing on:
  - Ensuring deliverables are practical and consistent to achieve the stated RPMP objectives.
  - b. Revising/rewording certain KPIs to ensure they are relevant to measuring the achievement of deliverables (e.g. classifying the reliability of pest sightings).
  - c. Some deliverables have been, or will be, completed hence are not applicable in the proposed Operational Plan (e.g. revision of rabbit proneness model).
  - d. Due to work progression, some deliverables need to be adapted. For example, the initial engagement phase with community rabbit programmes is now completed. Compliance inspections targets have been increased as these programmes move forward. Engagement with existing community rabbit programmes will continue over the 2024/25 financial year and an exit strategy will be prepared for each of these.
  - e. Some deliverables have been retired and replaced with more appropriate activities. For example, density monitoring of plant pests has been replaced by development of monitoring plans for specific pests. This is seen as being a more effective approach to manage pests.
  - f. Overall, targets remain consistent with the current Biosecurity Operational Plan. The main target change relates to inspections and monitoring visits around Wilding conifers. This has decreased from 100 to 50. This change is proposed due to the complex nature of rules related to wilding conifers, the need to identify

strategic areas to inspect/monitor, acknowledges that these inspections are complex and took more time than was anticipated when the target was included in the current plan and to ensure adequate time is given to engage with landowners.

[19] The proposed 2024-2025 Biosecurity Operational Plan is included as Attachment 1. A comparison document is also included (Attachment 2) to highlight the differences between the proposed Plan and the current Biosecurity Operational Plan 2023-2024.

#### **CONSIDERATIONS**

#### **Strategic Framework and Policy Considerations**

[20] The Operational Plan does not set policies or objectives. These have already been set in the RPMP that has been adopted by Council. The Operational Plan must be consistent with the RPMP in that it cannot introduce any new objectives, rules, or regulatory tools. The Minister is not required to approve the Plan but may disallow all or part of it if they believe that it is inconsistent, even in part, with the RPMP.

#### **Financial Considerations**

[21] The 2024-2025 Biosecurity Operational Plan is based on the Draft 2024-2034 Long Term Plan programme and budget. If there are significant changes to the LTP then, depending on the nature of the changes the proposed Operational Plan will need to be revised and brought back to Council for approval.

#### **Significance and Engagement**

[22] As the Operational Plan is consistent with the current RPMP, there is no statutory requirement to consult with the community on the details of the Operational Plan.

#### **Legislative and Risk Considerations**

[23] The Otago Regional Council's Regional Pest Management Plan 2024-2025 Biosecurity Operational Plan has been prepared in accordance with the Biosecurity Act 1993. The 2024-2025 Biosecurity Operational Plan is a legislative requirement of the Act.

#### **Climate Change Considerations**

[24] Climate change is widely regarded as one of the greatest challenges facing ecological systems in the coming century. Climate change poses risks to biosecurity through factors such as the establishment of new pests, change in the ecological range of current pests and shifts in introduction pathways.

#### **Communications Considerations**

[25] Council will disseminate biosecurity priorities, strategies and actions via the usual communications channels and will undertake more active community education and advocacy on the RPMP. Once approved by Council, the 2024-2025 Biosecurity Operational Plan will be available on the website for public access.

#### **NEXT STEPS**

[26] The next step is to provide a copy of the Operational Plan to the Minister for Biosecurity. As noted above, the Minister is not required to approve the Plan but may disallow all or part of the plan if they believe that it is inconsistent with the RPMP. Delivery of this Operational Plan will commence on 1st July 2024.

## **ATTACHMENTS**

- 1. Biosecurity Operational Plan 2024 2025 [9.6.1 22 pages]
- 2. Comparison between Biosecurity Operation Plan 23 24 24 25 [9.6.2 28 pages]



# Biosecurity Operational Plan 2024-2025



Implementing the Otago Regional Pest Management Plan 2019-2029

Otago Regional Council Biosecurity Operational Plan 2024-2025

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Environmental Implementation Committee 8 May 2024 - MATTERS FOR CONSIDERATION

## **Executive Summary**

Under the Biosecurity Act (1993), the Otago Regional Council (ORC) is the regional management agency responsible for biosecurity and pest control. To achieve this regulatory function, the ORC has developed the *Otago Regional Pest Management Plan 2019-2029* (RPMP) which sets objectives and rules for land occupiers to control pests to set levels. This Biosecurity Operational Plan annualises the objectives of the RPMP for the 2024-2025 financial year.

The ORC engages with occupiers and landowners who are ultimately responsible for pest management. To achieve practicable biosecurity outcomes, the ORC undertakes inspections (to ensure compliance with rules), monitoring (to determine the effectiveness of control) and surveillance (identifying new issues and trends). The ORC undertakes advocacy and education around pest threats, pathways of pest spread and the provision of advice. Furthermore, the ORC delivers national programmes for the management of nationally significant pests (wallabies and wilding conifers).

This work is supported by close engagement with allied organisations involved in implementing and funding biosecurity across the region, including the Ministry for Primary Industries (MPI), Land Information New Zealand (LINZ), the Department of Conservation (DoC), Kāi Tahu, other councils and community groups.

Under the RPMP, pest management is classified into five programmes.

- Exclusion pest programme: to prevent the establishment of six high threat pest plants in the region.
- 2. Eradication pest programme: to proactively eradicate spiny broom, Bennett's wallaby and rooks from the region.
- Progressive containment pest programme: to contain or reduce the geographic distribution of 11 pest plants (or groups of plants) across the region.
- **4. Sustained control pest programme:** to enforce ongoing control of rabbits and five widespread pest plants to reduce their impact.
- Site-led pest programmes: listed pests are managed as deemed appropriate for the values of the stated location.

This Operational Plan is the final iteration under the current Long-Term Plan and is a continuation of the same approaches. Where necessary, changes have been made from the previous 2022-23 Operational Plan based on lessons learnt to improve efficiency and effectiveness.

As part of the continuation, this Operational Plan retains the priority pests from the previous Operational Plans, covering one programme and four pests:

- · Exclusion pest programme
- Feral rabbits
- Bennett's wallaby
- Wilding conifers
- Lagarosiphon

The exclusion programme and four pests are of concern to local communities and have heightened adverse effects (current or future) on environmental, economic and social grounds.

Otago Regional Council Biosecurity Operational Plan 2024-2025

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## **Version Control**

Version #	Date	Event/Changes made	
1	8 May 2024	Submitted to Environmental Implementation Committee for consideration.	

## **Cover Photo**

Duffers Saddle, Nevis Valley (Photo Credit: Gary Smith)

## 1. Introduction

## 1.1 Background

Under the Biosecurity Act 1993, the Otago Regional Council (ORC) developed the *Otago Regional Pest Management Plan 2019-2029* ('the RPMP'). The RPMP is a statutory document that lists specific pests which have the greatest adverse effect on the environment and economy within Otago. In order to control, or eliminate, such adverse effects, the RPMP establishes rules that are legally enforceable. This provides a framework for the effective management of declared pests in the Otago region over the next decade. The RPMP sits alongside the non-statutory ORC Biosecurity Strategy which focuses on wider biosecurity issues including the collaboration with stakeholders to manage pests.

The key purpose of the RPMP is to outline how the identified pests will be managed to reduce or remove their threat to the environmental (e.g. ecosystem or species), economic (e.g. farming/forestry) and cultural/social (e.g. Māori and human health) values of the region. The RPMP allows the council to use relevant advice, service delivery, regulatory enforcement and funding provisions as provided by the Biosecurity Act.

The RPMP identifies 30 plants (or groups of plants) and 11 animals (or groups of animals) as pests. Except for specified pests, where the ORC may coordinate or undertake direct control, the responsibility for pest control rests with occupiers and landowners.

The responsibility of the ORC focuses on advocacy and education, supported by inspections, monitoring and surveillance. As the designated Management Agency under the Biosecurity Act, the ORC enforces the RPMP rules to ensure occupiers and landowners are aware of and meet their obligations for pest management on their properties by adhering to RPMP rules. In addition, the ORC delivers national programmes for the management of nationally significant pests (wallabies and wilding conifers). This is further supported through various community groups that are actively involved in pest management (e.g. wilding conifer trusts, Predator Free Dunedin, community rabbit programmes).

## 1.2 Operational plan purpose, duration and linkages

Under the Biosecurity Act, the ORC is required to prepare an annual Operational Plan that implements the RPMP. The Operational Plan is a publicly available document and is reported on each year to Council.

This document (the Biosecurity Operational Plan 2024-2025) outlines the nature, scope and priority activities that ORC intends to undertake for pest management across the Otago region for the financial year 1<sup>st</sup> July 2024 through to 30<sup>th</sup> June 2025.

The Operational Plan presents what will be delivered during the 2024-2025 financial year in terms of focus areas and the associated actions to implement the RPMP. For context, it is important the Operational Plan is read in conjunction with the RPMP. The ORC Biosecurity and Biodiversity Strategies and wider catchment management planning also provides additional context to the Operational Plan.

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# 2. Summary of Regional Pest Management Plan

## 2.1 Pest management programmes

The RPMP is implemented through five pest management programmes<sup>1</sup>, as summarised below.

- 1. **Exclusion:** This programme is to ensure specific pests that are present in New Zealand do not become established in Otago. Under Section 100V of the Biosecurity Act, there is provision to implement emergency controls for the incursion of any new pests that are not listed in the RPMP.
- 2. **Eradication:** This programme focuses on eradicating identified pests from the areas where they occur in the region. Eradication involves reducing the infestation of the pest to zero density.
- 3. Progressive Containment: This programme aims to contain and reduce the geographic spread of the listed pests to specific areas. Containment arises where the pest is at high densities in specific parts of the Otago region, but in low densities or limited range in other parts. While eradication is not feasible, it is realistic to contain the pest from spreading to other 'clear' parts of the region.
- 4. Sustained Control: This programme centres on the continuing control of the listed pests to reduce their impacts and spread to other properties. The emphasise is to manage the densities of the pests so they do not reach a level where they cause significant environmental impact. Sustained control is a strategy for pests with a wide geographical spread that they cannot feasibly be contained.
- 5. **Site-led:** This programme aims to exclude or if present eradicate, reduce or control, identified pests from specified locations.

## 2.2 Methods of Action – how pest management will be enacted

The ORC achieves pest management outcomes through the following methods and provision of resources.

- 1. Advocacy and education: ORC will provide education, advice and information to landowners and/or occupiers and the public about the impacts of pests and pathways (vectors) of pest spread and appropriate methods of control. The ORC will ensure land occupiers are informed of their responsibilities under the RPMP. This activity also includes contributing to research and costsharing with other agencies and developing/promoting 'good practice' around control methods aimed at pest management contractors and occupiers who are required to act.
- Inspection, monitoring and surveillance: Regular property inspections ensure that RPMP rules are being adhered to. The focus is to achieve voluntary compliance first before enforcement action is initiated. Monitoring is carried out to determine effectiveness of control and to understand trends of infestations. Surveillance activities focus on protecting the region from the incursion of new pests.
- 3. Collaboration: ORC works with landowner/occupier groups and central and local government agencies to develop consistent approaches for the effective management of pests. This includes Land Information New Zealand (LINZ), Department of Conservation (DoC), Ministry of Primary Industries (MPI), neighbouring regional councils and community groups like Predator Free Dunedin, and wilding conifer trusts.

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<sup>&</sup>lt;sup>1</sup> As prescribed by the National Policy Direction for Pest Management 2015.

- 4. **Requirement to Act** (*regulation*): RPMP rules are the 'backbone' of the pest management. These rules require identified pests to be controlled to specified standards or levels. Failure to comply with RPMP rules can lead to enforcement action by ORC.
- 5. Service delivery: This is achieved through the delivery of national programmes (wildings and wallabies) and the provision of direct control where special expertise is required that is beyond the capability of the land occupier to arrange. Service delivery includes providing appropriate control tools (e.g. traps, spraying, shooting) and the approved release of biological control agents.

## 2.3 Regional Priority Pests

Continuing from the previous years, the Operational Plan has a focus on one pest programme and four priority pests. These pests are selected due to their high community interest, environmental impact, economic impact, supporting national programmes and the need to invest in long-term sustained action. Table 1 provides further details of the specific pests.

Table 1: Focus area pests

Pest	Programme	Reason to Prioritise
Exclusion Pests	Exclusion	Exclusion of pests not established in Otago is a critical responsibility of the RPMP. To ensure new pests are excluded there is a need to develop and implement a proactive surveillance approach. This will identify pathways of potential spread (e.g. product movement).
Feral rabbits	Sustained Control	Feral rabbits generate significant ecosystem damage to the environment and production systems within Otago. Feral rabbits terraform a landscape. The Ministry of Primary Industries estimate production-related losses exceed \$50 million per year, on top of control expenses of \$25 million. Other losses include destruction of habitat for indigenous flora and fauna, changes to landscape value and impacts on social activities.
Bennett's wallaby	Eradication	Wallabies are an ever-present threat due to their high numbers in neighbouring South Canterbury. As wallabies present a significant threat to the ecosystem and a production risk to the economy, it is imperative that they are prevented from establishing a foothold in Otago.
Wilding conifers	Progressive containment	Wilding conifers interfere with ecosystems where they can shade out native species. This has consequential effects on the wider environment, especially water availability. From a social perspective, they interrupt Otago's iconic landscape and present a fire risk to farmlands and communities. If not controlled, they will significantly change the landscape, hydrological cycle and conservation values, especially high country, tussock grasslands and alpine catchments.
Lagarosiphon	Site-led programme	Lagarosiphon is an aquatic plant pest that threatens the aquatic environment. It is fast growing, displacing and shading out aquatic native plants. Thick areas of lagarosiphon disturb water flows and

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cause localised deoxygenation of water changing the aquatic ecosystem for animals. Lagarosiphon blocks water bodies, resulting in negative visual effects, reduces recreational activities and chokes water supply intakes. If lagarosiphon is left uncontrolled, large beds can form and wash ashore, leaving an unpleasant heap to decay.

# 2.4 Operational Plan Reporting

As the lead management agency, ORC is responsible for reporting on activities and progress during the year. The ORC is required by Section 100B of the Biosecurity Act 1993 to "prepare a report on the operational plan and its implementation not later than 5 months after the end of each financial year". This report is provided to the Minster of Biosecurity and is made available to the public through reporting to Council and on ORC's website.



Blueskin Bay (Photo Credit: M. Boardman)

# 3. Implementation of the Operational Plan

# 3.1 Exclusion pest programme

## **Regional Focus Programme**

The exclusion pest programme is to prevent the establishment of a specified pest that is present in New Zealand but not yet in the Otago region which could have potential adverse effects on economic well-being and environmental values. While the RPMP lists six exclusion pests, under Section 100V of the Biosecurity Act, there is provision to implement emergency controls for any incursion of a new pest that are not listed in the RPMP.

#### Objective

Over the duration of RPMP, preclude establishment of African feather grass, Chilean needle grass, egeria, false tamarisk, hornwort and moth plant within the Otago region to prevent adverse effects on economic well-being and environmental values.

Deliverable	KPI	Target
Engage with neighbouring regional councils on pest threats not currently present in Otago.		6
If the presence of an exclusion pest (or other unwanted pests) is confirmed, response actions completed as per the incursion response plan.	% of response actions completed within the required timeframes as set out in the incursion pest response plan for each confirmed sighting (assessed by checklist).	100%

# 3.2 Eradication pest programmes

The eradication programme focuses on three pest species in the region. They belong in this programme as their infestation levels are considered low enough for eradication to be feasible in the long-term (over the 10-year duration of the RPMP). The pests include one marsupial (Bennett's wallaby), a bird (rook) and a plant (spiny broom). Implementation of management programmes for each pest is described separately in the following subsections due to the different approaches taken.

## 3.2.1 Bennett's wallaby

### **Regional Focus Programme**

# Objective

Reduce all infestations of Bennett's wallaby to zero levels within the Otago region to prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
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Classify all reported sightings of wallabies and determine appropriate control action when confirmed.	All sightings are classified to determine credibility <sup>2</sup> within three working days of receiving a report.	100%
	If presence is confirmed, a decision on appropriate control action is decided within a further two working days.	100%
Collaborate with and participate in the national wallaby programme.	% of Operational Advisory Group meetings attended.	100%
	Fulfil requirements of MPI funding agreement.	100%
Engage with Environment Canterbury on Wallaby control.	# of meetings or visits with Environment Canterbury on wallaby control.	4

## 3.2.2 Rooks

# Objective

Reduce all infestations of rooks to zero levels within the Otago region to prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
Undertake monitoring visits of known rookeries	# of known rookeries monitored	50
Classify all reported sightings of rooks and determine appropriate control action when confirmed.	All sightings are classified to determine credibility within three working days of receiving a report.	100%
	If presence is confirmed, a decision on appropriate control action is decided within a further two working days.	100%

# 3.2.3 Spiny broom

# Objective

Reduce all infestations of spiny broom to zero levels within the Otago region to prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
Undertake monitoring visits of spiny broom at known sites* and surveillance of surrounding areas.	# of monitoring and surveillance visits undertaken for spiny broom.	13
Determine appropriate control action when spiny broom is confirmed.	If presence is confirmed, a decision on appropriate control action is decided within five working days.	100%

<sup>&</sup>lt;sup>2</sup> There are three classifications: [1] Unreliable, [2] Reliable but unconfirmed and [3] Confirmed.

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# 3.3 Progressive containment pest programmes

The 11 pest plants (or groupings of plants) in this programme are reasonably well established in the region. While eradication is unlikely, it is an aim of the RPMP that pest densities can be progressively reduced.

## 3.3.1 Wilding conifers

## **Regional Focus Programme**

## Objective

Progressively contain and reduce the geographic extent of wilding conifers within the Otago Region to minimise adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
Undertake assessments <sup>3</sup> of wilding conifers as guided by the regional wilding conifer strategy.	# of properties assessed for wilding conifer compliance.	50
Collaborate with and participate in the national wilding conifer programme.	% of Operational Advisory Group meetings attended.	100%
	Fulfil requirements of MPI funding agreement.	100%
Implement regional wilding conifer strategy.	% of actions from the regional strategy commenced within specified due timeframes.	100%
Support regional partnerships through funding community control groups. <sup>4</sup>	Funding disbursed as per agreements.	100%

## 3.3.2 African love grass

## Objective

Progressively contain and reduce the geographic distribution or extent of African love grass at known sites within the Otago region to minimise or prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
Undertake monitoring visits of African Love Grass at known sites and surveillance of surrounding areas.	# of monitoring and surveillance visits undertaken for African Love Grass.	20

 $<sup>^{\</sup>rm 3}$  An assessment is either a formal inspection or a monitoring visit.

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<sup>\*</sup> See glossary for definition of location, known sites and surrounding areas

<sup>&</sup>lt;sup>4</sup> Currently partnerships are with Whakatipu Wilding Conifer Control Group, Central Otago Wilding Conifer Control Group and Upper Clutha Wilding Tree Group.

Determine appropriate control action	If presence is confirmed, a decision on	100%
when African love grass is confirmed.	appropriate control action is decided within	
	five working days.	

## 3.3.3 Nassella tussock

## Objective

Progressively contain and reduce the geographic distribution or extent of Nassella tussock at known locations within the Otago region to minimise or prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
,	# of inspections, monitoring and surveillance visits undertaken for Nassella tussock.	38

#### 3.3.4 Old Man's Beard

## Objective

Progressively contain and reduce the geographic distribution or extent of old man's beard within the Otago region to minimise or prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
Undertake inspections for Old Man's	% of Old Man's Beard inspections	50%
Beard to support biodiversity outcomes across Otago.	undertaken on properties with high biodiversity values. <sup>5</sup>	

## 3.3.5 Spartina and six containment pest plants

## **Objective**

Progressively contain and reduce the geographic distribution or extent of bomarea, boneseed, bur daisy, cape ivy, perennial nettle, spartina and white-edged nightshade within the Otago region to minimise or prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
Undertake inspections or monitoring visits of spartina at known sites and surveillance of surrounding areas.	# of inspections, monitoring and surveillance visits undertaken for spartina.	12

<sup>&</sup>lt;sup>5</sup> A property with high biodiversity values consists of:

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<sup>[1]</sup> Any property that contains (whether fully or partially) a Significant Natural Area (SNA), a QEII covenant or land demarcated as 30% high biodiversity area (Leathwick, 2020).

<sup>[2]</sup> Any property that has a common boundary with a property defined by [1]

Determine appropriate control action when spartina is confirmed.	If presence is confirmed, a decision to initiate appropriate control action occurs within five working days.	100%
1	% of non-compliant properties re-inspected within set timeframes <sup>6</sup> for bomarea, boneseed, bur daisy, cape ivy, perennial nettle, and white-edged nightshade.	100%

# 3.4 Sustained control pest programmes

This programme covers well-established legacy pests that are present across Otago and many regions of New Zealand. Although eradication isn't viable, opportunities exist to prevent spread from infested areas to clear areas and to reduce 'externality impacts' on adjoining occupiers' values where those adjoining occupiers are motivated to undertake control.

## 3.4.1 Feral rabbits

## **Regional Focus Programme**

## **Objective**

Implement sustained control of feral rabbits to ensure population levels do not exceed Level 3 on the Modified McLean Scale in order to minimise adverse effects on production and environmental values within the Otago region.

Deliverable	KPI	Target
Undertake rabbit inspections to determine compliance.	# of rabbit inspections undertaken in non-community programme areas.	250
	# of rabbit inspections undertaken in community programme areas.	80
	% of non-compliant rabbit inspections re- inspected within set timeframes for compliance.	100%
Analyse trends in rabbit densities.	# of rabbit night count routes completed.	30
	# of fly traps routes monitored.	10
	Report on analysis of historical serological data completed by 30 November 2024.	1
	# of peri-urban areas with fixed photo counts undertaken.	2
Engage with landowners in community rabbit programmes.	# of community rabbit programmes <sup>7</sup> where landowner engagement is undertaken.	5

<sup>&</sup>lt;sup>6</sup> See Appendix 1 for set timeframes.

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<sup>&</sup>lt;sup>7</sup> Active community rabbit programmes are located in Otago Peninsula, Moeraki, Lake Hayes, Gibbston and Queensberry.

Support com	munity initi	atives through	Funding	round	is	oversubscribed	with	Yes/No
Sustainable	Rabbit	Management	eligible a	pplicatio	ns.			
Funding.								

## 3.4.2 Gorse and broom

## Objective

Implement sustained control of broom and gorse to ensure land that is free of, or being cleared of, broom and gorse does not become infested (primarily in Central Otago and Queenstown Lakes districts) in order to prevent adverse effects on production values and economic well-being.

Deliverable	KPI	Target
. •	% of non-compliant properties re-inspected within set timeframes in gorse and broom free areas.	100%

## 3.4.3 Russell Lupin

## Objective

Implement sustained control of the extent of Russell lupin and wild Russell lupin within specified distances from waterways and property boundaries to preclude establishment of wild Russell lupin and to prevent adverse effects on environmental values.

Deliverable	KPI	Target
Implement regional strategy on Russell lupin including communications plan.	% of actions completed by due date as described in the Russell lupin strategy.	100%
Stakeholder engagement implemented in one high risk catchment.	Action plan developed and presented to stakeholders.	1

## 3.4.4 Nodding thistle and Ragwort

## Objective

Implement sustained control of nodding thistle and ragwort on rural zoned land within specified distances of property boundaries throughout the Otago region to prevent their spread in order to minimise adverse effects on production values and economic well-being.

Deliverable	KPI	Target
Respond to GNR complaints around	% of GNR complaints responded to within	100%
nodding thistle and ragwort.	one month.	

# 3.5 Site-led pest programmes

The RPMP site-led programme is about protecting the environmental values at several named sites from the ravages of multiple pests. As a result, the management programme focuses on specific

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threats to each site and provides for the control of many pests, often those that are not managed elsewhere in the region (e.g. possums, rats).

The RPMP establishes four site-led programmes. For the Operational Plan three of them, Otago Peninsula, West Harbour-Mount Cargill and Quarantine and Goat islands (all within Dunedin City) are grouped, as the same six pest plant species and 15 pest animal species are managed generically across all three places. The fourth site-led programme concerns the LINZ-led management of lagarosiphon (oxygen weed), where different controls are implemented in different lakes. New site-led programmes will be considered via the RPMP in the future.

3.5.1 Otago Peninsula, West Harbour - Mount Cargill and Quarantine and Goat Islands

# Objective

Otago Regional Council will take a lead role in supporting community groups and agencies in bringing about the desired levels of environmental protection to these sites [Otago Peninsula (9,000 ha), West Harbour-Mt Cargill (12,500 ha) and Quarantine and Goat Islands].8

Deliverable	KPI	Target
Confirm site-led plans for the three terrestrial programme areas.	Site-led plan reconfirmed by 30 September 2024.	1
Site-led programme plan implemented.	% of actions implemented by 30 June 2025.	100%

#### 3.5.2 Lagarosiphon

# **Regional Focus Programme**

# Objective

To support LINZ in controlling lagarosiphon in the region's rivers and lakes by:

- · Preventing its establishment in Lake Wakatipu and other regional water bodies
- Progressively reducing its spread in Lake Wanaka and the Kawarau River
- Undertaking sustained control in Lake Dunstan

Deliverable	KPI	Target
Joint planning with LINZ and other stakeholders.	# of meetings attended with LINZ and other stakeholders.	4
Support LINZ in the management and control of lagarosiphon.	Funding disbursed as per agreement.	100%
Undertake summer monitoring of water users at designated sites. <sup>9</sup>	# of interactions in the 'Check, clean, dry' programme.	650

<sup>&</sup>lt;sup>8</sup> Refer to RPMP Objectives 6.5.4, 6.5.5 & 6.5.6 respectively for Otago Peninsula, West Harbour-Mt Cargill and Quarantine and Goat Islands

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<sup>&</sup>lt;sup>9</sup> This KPI is dependent on funding being confirmed from MPI.

Undertake monitoring and inspections of freshwater pests.	# of bi-annual monitoring visits to priority water bodies <sup>10</sup> to determine the presence of lagarosiphon.	22
	# of sites monitored or inspected for freshwater pests.	40

# 3.6 Integrated programmes

While the RPMP has five defined programmes, aspects of these programmes are shared or interconnected, such as through associated analysis, common biodiversity outcomes and engagement with partners and stakeholders.

## 3.6.1 Shared Pest Programmes

The following are shared or interconnected deliverables related to achieving biosecurity outcomes, hence apply across the five RPMP programmes listed above.

Deliverable	KPI	Target
Undertake pest inspections or monitoring to progress biodiversity outcomes.	# of pest inspections or monitoring visits undertaken. <sup>11</sup>	1,500
Re-inspect non-compliant properties (or sites) <sup>12</sup> .	% of non-compliant properties (or sites) reinspected.	100%
Undertake monitoring visits to assess the efficacy of biocontrol agents	# of monitoring visits to sites where biocontrol agents are present	25
Prepare monitoring plans for selected pest species & biocontrol agents.	A set of monitoring plans completed by 31 October 2024.	1
Analyse pest trends based on inspection, monitoring and surveillance data.	Report on 'State of Pest Management in Otago' submitted to Council before 31 March 2025.	1
Selected pests <sup>13</sup> (whose presence has been confirmed) are appropriately controlled.	Control actions for the selected pests are completed by 30 June 2025.	100%

# 3.6.2 Pest Programme Engagement

The management of pests extends beyond just the ORC. Due to this, it is essential to engage with partners and stakeholders to promote and achieve biosecurity outcomes. These engagements

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Manorburn, Poolburn, Butchers, Conroys, Falls and Fraser Dams, Pinders Pond, Blue Lake, Moke Lake, Bullock Creek and Albert Town stormwater detention ponds. They are monitored, at a minimum, twice a year. These sites are not overseen by other agencies.

<sup>&</sup>lt;sup>11</sup> This target excludes rabbits which are listed above.

<sup>&</sup>lt;sup>12</sup> Generally, pest compliance is done or a property basis however for some pests, the location is a site that is not a property (e.g. lagarosiphon)

<sup>13</sup> The selected pests are the six exclusion pests, rooks, spiny broom, wallabies, African love grass and spartina.

explain the rules as they pertain to these agencies, advocate for their increased action and for the agencies to have consistent biosecurity work programmes with the RPMP.

Deliverable	KPI	Target
Engage with crown agencies and territory authorities on pest management. <sup>14</sup>	# of communication engagements with listed agencies at least once annually.	10
Support and educate occupiers, landowners and community groups to undertake best practice pest control.	# of community events attended to support best practice pest management.	8
Develop an Otago Marine Biosecurity programme	Otago Marine Biosecurity Programme presented to Council by 30 June 2025	1
Collaborate with regional councils on freshwater and marine pests.	# of collaborations with other regional councils.	4
Collaborate with Kāi Tahu on biosecurity issues and support them to be involved in biosecurity initiatives.	# of collaborations with Kāi Tahu on biosecurity issues.	4
Undertake visits to pet shops and nurseries to advocate and inspect for biosecurity compliance.	# of pet shops or nurseries visited.	10

<sup>&</sup>lt;sup>14</sup> Namely MPI, DoC, LINZ, KiwiRail, Waka Kotahi, Territorial Authorities [WDC, DCC, CDC, CDC, QLDC]

# 4. RPMP Administration

# 4.1 Compliance and Enforcement Actions

As the RPMP is a rules-based approach to pest management, there is need to ensure actions are taken to ensure compliance. The specific approach to compliance and enforcement is covered in the ORC Biosecurity Compliance and Enforcement Policy. To achieve this, the following actions will be delivered.

Deliverables	KPI	Target
Provide occupiers and landowners with the declared pest status	% of occupier/landowner advised of inspection status within three weeks of the inspection.	75%
following an inspection.	% of occupier/landowner advised of inspection status within six weeks of the inspection.	100%
Continued non-compliance, as confirmed by enforcement criteria, is addressed through issuing a Notice of Direction	Any Notices of Direction are issued within 20 working days after re-inspection.	100%
Pest enquiries <sup>15</sup> are responded to in a timely manner as appropriate to the	% of exclusion pest enquiries responded to within 24 hours.	100%
risk of the pest.	% of eradication pest enquiries responded to within three working days.	100%
	% of all pest enquiries responded to within 10 working days.	100%

<sup>&</sup>lt;sup>15</sup> Enquiries are defined as either 'reports, sightings, notifications and complaints.

# 5. Glossary

For the purposes of this operational plan, the following definitions are provided. Further definitions can be found in the RPMP and the ORC Biosecurity Compliance and Enforcement Policy.

Assessment: An inspection or monitoring visit.

**Boundary:** refers to a line in a geographical space the delineates the surface extent between two (or more) adjoining land parcels.

Compliant: refers to when a rule in the RPMP is adhered to.

**Default Action:** means work undertaken by the management agency to carry out pest control when a 'Notice of Direction' or 'Compliance Order' has not been complied with by an occupier, under section 128 of the BSA. The management agency can then recover costs and expenses reasonably incurred under section 129 of the BSA.

**Known site:** refers to a location that has a historical or current record of the pest being present. For ease of monitoring, a known site can include a buffer radius of up to 50 metres.

**Inspection:** means a site visit (normally defined by a property) to determine compliance to RPMP rules undertaken by an authorised person as defined under the Biosecurity Act 1993.

Landowner: has the same meaning as occupier in the Biosecurity Act 1993.

**Land Parcel:** is a unique area of land, identified by the cadastral survey plan showing the legal boundaries, location, dimensions and area, along with the unique legal description (appellation).

**Location:** refers to a geographical point on the surface of the earth. This will typically be identified by the GPS co-ordinates of northing and easting. For New Zealand, most common projections are the New Zealand Traverse Mercator or World Geodetic 1984).

**Management agency:** has the same meaning as in the Biosecurity Act 1993, specifically "means the body specified as the management agency in a pest management plan or a pathway management plan". For the purposes of the RPMP and Operational Plan, Otago Regional Council is the management agency for pests to be controlled in the Otago region.

**Management Plan:** refers to a landowner/occupier agreement to manage selected pests as explained in the respective monitoring plan.

Modified McLean Scale: this scale assesses rabbit population levels (see RPMP, Appendix 2).

**Monitoring:** means work undertaken to determine the prevalence and/or trend of a pest. This will normally be in-person visit to a location but can use remote sensing tools. Monitoring differs from an inspection in that no subsequent enforcement is undertaken however monitoring can result in control actions being commenced.

**Monitoring Plan:** refers to a detailed description of how selected pests will be targeted to achieve the objectives of the RPMP.

**Notice of Direction (NOD):** means the actions required and notice issued pursuant to section 122 of the Biosecurity Act 1993. A NOD can require a person to take action to address pest plant or animal problems or to comply with a rule in an RPMP.

Occupier: see landowner.

**Non-compliance:** refers to any breach in a RPMP rule, upon a formal inspection. Non-compliance is liable for enforceable under the provisions of the BSA. For clarification, a breach of a RPMP rule does not have to be widespread across a property and may relate to a single location (or a defined

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area) within a property. Due to the potential of spread, the whole property is deemed non-compliant even if the infestation is localised.

**Operational plan:** means a plan prepared by the Management Agency under Section 100B of the Act

**Pest:** has the same meaning as in the Biosecurity Act 1993: "an organism specified as a pest in a pest management plan."

**Property:** For the purposes of this plan, a property is an extent of land that is either [1] under unique ownership (whether individual, joint, partnership or corporate) or [2] is managed as a single operational entity. A property can be made up of one or more adjoining land parcels (see land parcel).

**Surveillance:** means work undertaken to determine the status (presence and extent) of pest species. This can be in-person or, increasingly, use remote sensing tools.

**Surveillance Plan:** describes the approaches used to determine the presence, or extent, of pest species. A surveillance plan may cover a number of pest species.

**Surrounding area:** means a wider area surrounding a known sites. This is variable depending on context of the pest but, at a minimum, includes all adjoining properties to the property with the pest infestation. A property is considered adjoining even if it is separated by a road, paper road, waterway or easement. A designated surrounding area does not prevent pest assessments from being carried out in non-surrounding areas.

**Water body:** means fresh water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area.

**Wilding conifer:** wilding conifers are any introduced conifer tree, including (but not limited to) any of the species listed in Table 3 of the RPMP.

**Zero level/zero density:** where the pest is not detectable in an area, however the pest may continue to appear afterwards due to plant seed sources or animal migration from an unmanaged area.

# **Appendix**

# Appendix 1: Timeframes associated with Biosecurity Inspections

Compliance Type	Plants	Rabbits
Work Request	Three months; except six weeks for Old Man's Beard between Oct-Feb.	May-Dec: six months; Jan-Apr: three months
Notice of Direction	Three months; except six weeks for Old Man's Beard between Oct-Feb.	One year

## Notes:

- 1. Where suitable, poisoning for rabbits is best in winter, hence the one-year timeframe for Notices of Direction ensures there is at least one winter to undertake control before re-inspection.
- 2. Timeframes are based on the date the letter was sent, not when the inspection was undertaken.
- 3. Re-inspections occur within a three-week period after the timeframe expires.



# Biosecurity Operational Plan 2023-2024-2025





Implementing the Otago Regional Pest Management Plan 2019-2029

# **Executive Summary**

Under the Biosecurity Act (1993), the Otago Regional Council (ORC) is the regional management agency responsible for biosecurity and pest control. To achieve this regulatory function, the ORC has developed the *Otago Regional Pest Management Plan 2019-2029* (RPMP) which sets objectives and rules for land occupiers to control pests to set levels. This Biosecurity Operational Plan annualises the objectives of the RPMP for the 2023–2024-2025 financial year.

The ORC engages with occupiers and landowners who are ultimately responsible for pest management. To achieve practicable biosecurity outcomes, the ORC undertakes inspections (to ensure compliance with rules), monitoring (to determine the effectiveness of control) and surveillance (identifying new issues and trends). The ORC undertakes advocacy and education around pest threats, pathways of pest spread and the provision of advice. Furthermore, the ORC delivers national programmes for the management of nationally significant pests (wallabies and wilding conifers).

This work is supported by close engagement with allied organisations involved in implementing and funding biosecurity across the region, including the Ministry for Primary Industries (MPI), Land Information New Zealand (LINZ), the Department of Conservation (DoC), Kāi Tahu, other councils and community groups.

Under the RPMP, pest management is classified into five programmes.

- 1. Exclusion pest programme: to prevent the establishment of six high threat pest plants in the region.
- Eradication pest programme: to proactively eradicate spiny broom, Bennett's wallaby and rooks from the region.
- **3. Progressive containment pest programme:** to contain or reduce the geographic distribution of 11 pest plants (or groups of plants) across the region.
- **4. Sustained control pest programme:** to enforce ongoing control of rabbits and five widespread pest plants to reduce their impact.
- Site-led pest programmes: listed pests are managed as deemed appropriate for the values of the stated location.

This Operational Plan is the final iteration under the current Long-Term Plan and is a continuation of the same approaches. Where necessary, changes have been made from the previous 2022-23 Operational Plan based on lessons learnt to improve efficiency and effectiveness.

As part of the continuation, this Operational Plan retains the priority pests from the previous Operational Plans, covering one programme and four pests:

- · Exclusion pest programme
- Feral rabbits
- Bennett's wallaby
- Wilding conifers
- Lagarosiphon

The exclusion programme and four pests are of concern to local communities and have heightened adverse effects (current or future) on environmental, economic and social grounds.

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# **Version Control**

Version #	Date	Event/Changes made
1	8 May 2024 <del>2</del> February 2023	Submitted to Environmental Implementation Committee for consideration.approval
	22 February 2023	Approved by the Otago Regional Council

## **Cover Photo**

<u>Duffers Saddle, Nevis ValleyLake Wanaka, from Glen Dene Ridge Track</u> (Photo Credit: <u>Gary SmithRichard Lord</u>)

# 1. 1. Introduction

# 1.1 Background

Under the Biosecurity Act 1993, the Otago Regional Council (ORC) developed the <u>Otago Regional Pest Management Plan 2019-2029</u> ('the RPMP'). The RPMP is a statutory document that lists specific pests which have the greatest adverse effect on the environment and economy within Otago. In order to control, or eliminate, such adverse effects, the RPMP establishes rules that are legally enforceable. This provides a framework for the effective management of declared pests in the Otago region over the next decade. The RPMP sits alongside the non-statutory ORC Biosecurity Strategy which focuses on the wider biosecurity issues including the collaboration with stakeholders to manage pests.

The key purpose of the RPMP is to outline how the identified pests will be managed to reduce or remove their threat to the environmental (e.g. ecosystem or species), economic (e.g. farming/forestry) and cultural/social (e.g. Māori and human health) values of the region. The RPMP allows the council to use relevant advice, service delivery, regulatory enforcement and funding provisions as provided by the Biosecurity Act.

The RPMP identifies 30 plants (or groups of plants) and 11 animals (or groups of animals) as pests. Except for specified pests, where the ORC may coordinate or undertake direct control, the responsibility for pest control rests with occupiers and landowners.

The responsibility of the ORC focuses on advocacy and education, supported by inspections, monitoring and surveillance. As the designated Management Agency under the Biosecurity Act, the ORC enforces the RPMP rules to ensure occupiers and landowners are aware of and meet their obligations for pest management on their properties by adhering to RPMP rules. In addition, the ORC delivers national programmes for the management of nationally significant pests (wallabies and wilding conifers). This is further supported through various community groups that are actively involved in pest management (e.g. wilding conifer trusts, Predator Free Dunedin, community rabbit programmes).

# 1.2 Operational plan purpose, duration and linkages

Under the Biosecurity Act, the ORC is required to prepare an annual Operational Plan that implements the RPMP. The Operational Plan is a publicly available document and is reported on each year to Council.

This document (the 2023-2024-Biosecurity Operational Plan 2024-2025) outlines the nature, scope and priority activities that ORC intends to undertake for pest management across the Otago region for the financial year 1st July 20242023 through to 30th June 20252024.

The Operational Plan presents what will be delivered during the 2023–2024-2025 financial year in terms of focus areas and the associated actions to implement the RPMP. For context, it is important the Operational Plan is read in conjunction with the RPMP. The ORC Biosecurity and Biodiversity Strategies and wider catchment management planning also provides additional context to the Operational Plan.

# 2. 2. Summary of Regional Pest Management Plan

# 2.1 Pest management programmes

The RPMP is implemented through five pest management programmes<sup>1</sup>, as summarised below.—The pests listed under each programme are given in Table 1.

- Exclusion: This programmeThe objective is to ensure specific pests that are present in New
  Zealand do not become established in Otago. Under Section 100V of the Biosecurity Act, there is
  provision to implement emergency controls for theany incursion of anya new pestspest that are
  not listed in the RPMP.
- 2. **Eradication:** This programme focuses on eradicating The objective is to eradicate identified pests from the areas where they occur in the region. Eradication involves reducing the infestation of the pest to zero density.
- 3. **Progressive Containment:** This programme aimsThe objective is to contain and reduce the geographic spread of the listed pests to specific areas. Containment arises where the pest is at high densities in specific parts of the Otago region, but in low densities or limited range in other parts. While eradication is not feasible, it is realistic to contain the pest from spreading to other 'clear' parts of the region.
- 4. Sustained Control: This programme centres on the continuingThe objective is for ongoing control of the listed pests to reduce their impacts and spread to other properties. The emphasisefocus is to manage the densities of the pests soto ensure they do not reach a level where they cause significant environmental impact. Sustained control is a strategy for pests with a wide geographical spread that they cannot feasibly be containederadicated.
- Site-led: <u>This programme aims The objective is</u> to exclude, or <u>— if present eradicate</u>, <u>reduce or control</u>, <u>from identified pests from specified locations or to contain, reduce or control within those places</u>.

# 2.2 Methods of Action - how pest management will be enactedcarried out

The ORC achieves pest management outcomes through the following methods and provision of resources. Table 1 outlines which pest and programmes are related to each method.

1. Advocacy and education: ORC will provide education, advice and information to landowners and/or occupiers and the public about the impacts of pests and pathways (vectors) of pest spread and appropriate methods of control. The ORC will ensure land occupiers are informed of their responsibilities under the RPMP. This activity also includes contributing to research and cost-sharing with other agencies and developing/promoting 'good practice' around control methods aimed at pest management contractors and occupiers who are required to act.

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As prescribed by the National Policy Direction for Pest Management 2015.

- Inspection, monitoring and surveillance: Regular property inspections ensure that RPMP rules
  are being adhered to. The focus is to achieve voluntary compliance first before enforcement action
  is initiated. Monitoring is carried out to determine effectiveness of control and to understand
  trends of infestations. Surveillance activities focus on protecting the region from the incursion of
  new pests.
- 3. Collaboration: ORC works with landowner/occupier groups and central and local government agencies to develop consistent approaches for the effective management of pests. This includes Land Information New Zealand (LINZ), Department of Conservation (DoC), Ministry of Primary Industries (MPI), neighbouring regional councils and community groups like Predator Free Dunedin, and wilding conifer trusts.
- 4. Requirement to Act (regulation): RPMP rules are the 'backbone' of the pest management. These rules require identified pests to be controlled to specified standards or levels. Failure to comply with RPMP rules can lead to enforcement action by ORC.
- 5. Service delivery: This is achieved through the delivery of national programmes (wildings and wallabies) and the provision of direct control where special expertise is required that is beyond the capability of the land occupier to arrange. Service delivery includes providing appropriate control tools (e.g. traps, spraying, shooting) and the approved release of biological control agents.

# 2.3 Regional Priority Pests Focus Programmes

Continuing from the previous <u>years</u>, <u>the Operational Plan has Plans</u>, <u>there is</u> a focus on one pest programme and four <u>priority</u> pests. <u>TheseThe focus on these</u> pests <u>are selected</u> due to their high community interest, environmental impact, economic impact, supporting national programmes and the need to invest in long-term sustained action. Table 1 provides further details of the specific pests.

Table 1: Focus area pests

Pest	Programme	Reason to Prioritise
Exclusion Pests	Exclusion	Exclusion of pests not established in Otago is a critical responsibility of the RPMP. To ensure new pests are excluded there is a need to develop and implement a proactive surveillance approach. This will identify pathways of potential spread (e.g. product movement).
Feral rabbits	Sustained Control	Feral rabbits generate significant ecosystem damage to the environment and production systems within Otago. Feral rabbits terraform a landscape. The Ministry of Primary Industries estimate production-related losses exceed \$50 million per year, on top of control expenses of \$25 million. Other losses include destruction of habitat for indigenous flora and fauna, changes to landscape value and impacts on social activities.
Bennett's wallaby	Eradication	Wallabies are an ever-present threat due to their high numbers in neighbouring South Canterbury. As wallabies present a significant threat to the ecosystem and a production risk to the economy, it is imperative that they are prevented from establishing a foothold in Otago.

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Wilding conifers	Progressive containment	Wilding conifers interfere with ecosystems where they can shade out native species. This has consequential effects on the wider environment, especially water availability. From a social perspective, they interrupt Otago's iconic landscape and present a fire risk to farmlands and communities. If not controlled, they will significantly change the landscape, hydrological cycle and conservation values, especially high country, tussock grasslands and alpine catchments.
Lagarosiphon	Site-led programme	Lagarosiphon is an aquatic plant pest that threatens the aquatic environment. It is fast growing, displacing and shading out aquatic native plants. Thick areas of lagarosiphon disturb water flows and cause localised deoxygenation of water changing the aquatic ecosystem for animals. Lagarosiphon blocks water bodies, resulting in negative visual effects, reduces recreational activities and chokes water supply intakes. If lagarosiphon is left uncontrolled, large beds can form and wash ashore, leaving an unpleasant heap to decay.

# 2.4 Operational Plan Reporting

As the lead management agency, ORC is responsible for reporting on activities and progress during the year. The ORC is required by Section 100B of the Biosecurity Act 1993 to "prepare a report on the operational plan and its implementation not later than 5 months after the end of each financial year". This report is provided to the Minster of Biosecurity and is made available to the public through reporting to Council and on ORC's website.



## **Blueskin Bay**

Otago Regional Council Biosecurity Operational Plan 2023–2024-2025



Hawkdun Range (Photo Credit: M. Boardman)

# 3. Implementation of the Operational Plan

# 3. Pest Management Activities to Enact the RPMP

# 3.1 Exclusion pest programme

## **Regional Focus Programme**

The exclusion pest programme is to prevent the establishment of a specified pest that is present in New Zealand but not yet in the Otago region which could have potential adverse effects on economic well-being and environmental values. While the RPMP lists six exclusion pests, under Section 100V of the Biosecurity Act, there is provision to implement emergency controls for any incursion of a new pest that are not listed in the RPMP.

#### Objective

Over the duration of <u>RPMPthe Plan</u>, preclude establishment of African feather grass, Chilean needle grass, egeria, false tamarisk, hornwort and moth plant within the Otago region to prevent adverse effects on economic well-being and environmental values.

Deliverable	KPI	Target
Engage with neighbouring regional councils on exclusion pest threats not currently present in Otago.	# of meetings with neighbouring regional councils on exclusion pest threats.	6
Develop surveillance plans for the six exclusion pest species as a component of the incursion pest response plan <sup>2</sup>	Exclusion pest management and surveillance plans covering the six identified exclusion pests finalised by 31 May 2024	6
If the presence of an exclusion pest (or other unwanted pests) is confirmed, response actions completed as per the incursion response plan.	% of <u>response</u> actions completed within the required timeframes as set out in the incursion pest response plan for each confirmed sighting (as-assessed by checklist).}	100%

# 3.2 Eradication pest programmes

The eradication programme focuses on three pest species in the region. They belong in this programme as their infestation levels are considered low enough for eradication to be feasible in the long-term (over the 10-year duration of the RPMP). The pests include one marsupial (Bennett's wallaby), a bird

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<sup>&</sup>lt;sup>2</sup>-This was referred to as the "exclusion pest response plan" in the 2022-23 Biosecurity Operational Plan. The name change reflects the purpose of the response plan which is to cover any unwanted pests, not just the listed exclusion pests, if their presence has been confirmed.

(rook) and a plant (spiny broom). Implementation of management programmes for each pest is described separately in the following subsections due to the different approaches taken.

## 3.2.1 Bennett's wallaby

# **Regional Focus Programme**

#### Objective

Reduce all infestations of Bennett's wallaby to zero levels within the Otago region to prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
ClassifyPrompt response to all reported sightings of wallabies and determine appropriate control action when	All%—of sightings are classified to determine credibility <sup>3</sup> inspected within three3 working days of receiving athe sighting report.	10090%
confirmed.	If presence is confirmed, a decision on appropriate control action is decided% of sightings inspected within a further two10 working days. of receiving the sighting report	100%
Collaborate with and participate in the national wallaby programme.	% of Operational Advisory Group meetings attended.	100%
	Fulfil requirements of MPI funding agreement_	100%
	# of wallaby R+D trials supported	2
Engage with Environment Canterbury on Wallaby control.	# of meetings or visits with Environment Canterbury on wallaby control.	<u>4</u> 6

## 3.2.2 Rooks

## Objective

Reduce all infestations of rooks to zero levels within the Otago region to prevent adverse effects on economic well-being and the environment.<sup>4</sup>

Deliverable	КРІ	Target
Undertake monitoring visits of Inspect	#% of known rookeries monitoredrookery	<u>50</u> 100%
all known rookeries rookery locations	locations inspected	

<sup>&</sup>lt;sup>3</sup> There are three classifications: [1] Unreliable, [2] Reliable but unconfirmed and [3] Confirmed.

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<sup>&</sup>lt;sup>4</sup>-Historically rookeries have been known to exist in South Otago, Strath Taiari and the Maniototo.

Classify all reported sightings of rooks	All sightings are classified to determine	<u>100%</u>
and determine appropriate control	credibility within three working days of	
action when confirmed.	receiving a report.	
	If presence is confirmed, a decision on	100%
	appropriate controlControl action is	
	decided commenced within a further two3	
	working days-of confirmed rook sighting.	

# 3.2.3 Spiny broom

## Objective

Reduce all infestations of spiny broom to zero levels within the Otago region to prevent adverse effects on economic well-being and the environment.<sup>5</sup>

Deliverable	KPI	Target
Undertake monitoring visits ofinspections for spiny broom at known sites*locations and surveillance ofat surrounding areas.	#% of monitoringknown locations (13) inspected and surveillance visits undertakensurrounding areas† surveyed for spiny broom.	<del>100%</del> <u>13</u>
Determine appropriatelf there is a confirmed sighting of spiny broom, undertake necessary control action when spiny broom is confirmed.	If presence is confirmed, a decision on appropriate control Control action is decided commenced within five working days of confirmed sighting of spiny broom	100%

<sup>\*\*</sup> See glossary for definition of location, known sites location and surrounding areas-

# 3.3 Progressive containment pest programmes

The 11 pest plants (or groupings of plants) in this programme are reasonably well established in the region. While eradication is unlikely, it is an aim of the RPMP that pest densities can be progressively reduced.

## 3.3.1 Wilding conifers

# **Regional Focus Programme**

## Objective

Progressively contain and reduce the geographic extent of wilding conifers within the Otago Region to minimise adverse effects on economic well-being and the environment.

<sup>5</sup> Previous Spiny Broom infestations have been identified in the Waihola, Chain Hills and Brighton areas.

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Deliverable	KPI	Target
Undertake <u>assessments</u> of <u>inspections</u> of wilding conifers <u>asat locations</u> guided by the regional wilding conifer strategy.	# of properties <u>assessed</u> inspected for wilding conifer compliance.	<u>50100</u>
Collaborate with and participate in the national wilding conifer programme.	% of Operational Advisory Group meetings attended.	100%
	Fulfil requirements of MPI funding agreement.	100%
Implement regional wilding conifer strategy.	% of actions from the regional strategy commenced within specified due timeframes.	100%
Support regional partnerships through funding community control groups. <sup>7</sup>	Funding disbursed as per agreements.agreement	100%

Note: Any compliance actions are covered under 3.6 Integrated Programmes and 4.1 Compliance and Enforcement Actions.

## 3.3.2 African love grass

## Objective

Progressively contain and reduce the geographic distribution or extent of African love grass at known <a href="mailto:siteslecations">siteslecations</a>® within the Otago region to minimise or prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
Undertake monitoring visits ofinspections for African Love Grasslove grass at known sitesinfestation locations and surveillance ofin surrounding areas.	#% of monitoringknown locations (20) inspected and surveillance visits undertakensurrounding areas surveyed for African Love Grass.love grass	100%20
Determine appropriate control action when If there is a confirmed sighting of African love grass is confirmed., undertake necessary control action	If presence is confirmed, a decision on appropriate controlControl action is decidedcommenced within five5 working days, of confirmed sighting of African love grass	100%

<sup>&</sup>lt;sup>6</sup> An assessment is either a formal inspection or a monitoring visit.

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<sup>&</sup>lt;sup>7</sup> Currently partnerships are with Whakatipu Wilding Conifer Control Group, and Central Otago Wilding Conifer Control Group and Upper Clutha Wilding Tree Group.

<sup>&</sup>lt;sup>8</sup>-Previous and current African Love Grass infestations around Earnscleugh, Clyde, Omakau, Queensbury and Pisa Moorings.

#### 3.3.3 Nassella tussock

#### Objective

Progressively contain and reduce the geographic distribution or extent of Nassellanassella tussock at known locations<sup>9</sup> within the Otago region to minimise or prevent adverse effects on economic wellbeing and the environment.

Deliverable	KPI	Target
Undertake inspections or monitoring visits of NassellaInspect known locations for nassella tussock at known sites and undertake-surveillance of surrounding	locations (38) inspected and surveillance	<u>38</u> 100%
<u>areas.</u> locations		

Note: Further compliance actions are covered under 3.6 Integrated Programmes and 4.1 Compliance and Enforcement Actions.

## 3.3.4 Old Man's Beard

#### Objective

Progressively contain and reduce the geographic distribution or extent of old man's beard within the Otago region to minimise or prevent adverse effects on economic well-being and the environment.

Deliverable	KPI	Target
Undertake re-inspections for Old Man's	% of non-compliant properties re-inspected	<u>50</u> 100
Beard to support biodiversity outcomes	for Old Man's Beard inspections undertaken	%
across Otago.ascertain compliance	on properties with high biodiversity	
	values. <sup>10</sup>	

Note: Further compliance actions are covered under 3.6 Integrated Programmes and 4.1 Compliance and Enforcement Actions.

## 3.3.5 Spartina and six containment pest plants

## Objective

Progressively contain and reduce the geographic distribution or extent of bomarea, boneseed, bur daisy, cape ivy, perennial nettle, spartina<sup>11</sup> and white-edged nightshade within the Otago region to minimise or prevent adverse effects on economic well-being and the environment.

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<sup>&</sup>lt;sup>9</sup>-Current-Nassella Tussock infestations are identified around Roxburgh/Alexandra (Galloway and Knobby Range areas—approx. 32,000 ha); lower Cardrona Valley (Deep Creek to Riverbank Road — approx. 4,500 ha); Lower Waitaki Valley (Georgetown and Tussocky/Ridge Roads—approx. 4,100 ha).

<sup>&</sup>lt;sup>10</sup> A property with high biodiversity values consists of:

<sup>[1]</sup> Any property that contains (whether fully or partially) a Significant Natural Area (SNA), a QEII covenant or land demarcated as 30% high biodiversity area (Leathwick, 2020).

<sup>[2]</sup> Any property that has a common boundary with a property defined by [1]

<sup>&</sup>lt;sup>11</sup> Spartina containment focuses on Waikouaiti, Karitane and Te Hakapupu/Pleasant River Estuaries.

Deliverable	KPI	Target
Undertake inspections or monitoring visits of spartina at known sites and surveillance of surrounding areas.	# of inspections, monitoring and surveillance visits undertaken for spartina.	<u>12</u>
Determine appropriate control action when spartina is confirmed.	If presence is confirmed, a decision to initiate appropriate control action occurs within five working days.	100%
Undertake re-inspections for bomarea, boneseed, bur daisy, cape ivy, perennial nettle, spartina and white-edged nightshadethe six containment plants to ascertain compliance.	% of non-compliant properties re-inspected within set timeframes for bomarea, boneseed, bur daisy, cape ivy, perennial nettle, and white-edged nightshade.spartina or any one of the six containment plants	100%

 $Note: Further compliance\ actions\ are\ covered\ under\ 3.6\ Integrated\ Programmes\ and\ 4.1\ Compliance\ and\ Enforcement\ Actions.$ 

# 3.4 Sustained control pest programmes

This programme covers well-established legacy pests that are present across Otago and many regions of New Zealand. Although eradication isn't viable, opportunities exist to prevent spread from infested areas to clear areas and to reduce 'externality impacts' on adjoining occupiers' values where those adjoining occupiers are motivated to undertake control.

## 3.4.1 Feral rabbits

## **Regional Focus Programme**

## Objective

Implement sustained control of feral rabbits to ensure population levels do not exceed Level 3 on the Modified McLean Scale in order to minimise adverse effects on production and environmental values within the Otago region.

Deliverable		KPI	Target
Undertake rabbit inspections determine compliance.	to	# of rabbit inspections <u>undertaken in non-outside a-community</u> programme <u>areas.</u>	<b>&gt;</b> 250
		% of non-compliant properties re-inspected for rabbit compliance	100%
		# of <u>rabbit</u> inspections <u>undertaken</u> inengagements with community <del>rabbit</del>	<u>80<del>12</del></u>

12 See Appendix 1 for set timeframes.

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	programme <u>areas.either</u> through re-	
	inspections or continued support	
	% of non-compliant rabbit inspections re- inspected within set timeframes for compliance.	<del>100%</del>
Analyse Monitor trends in rabbit densities.	# of rabbit night count routes completed. and analysed <sup>13</sup>	>30
	# of fly traps <u>routes</u> locations monitored_and analysed	10
	Report on analysis of historical serological data completed by 30 November June 2024.	1
	# of peri-urban areas with fixed photo counts undertaken. Update rabbit proneness map completed by 31 March 2024	<u>2</u> 1
Engage with landowners in community rabbit programmes.	# of communityR+D trials to enhance rabbit programmes <sup>14</sup> where landowner engagement is undertaken.monitoring instigated	<u>5</u> 2
Support community initiatives through Sustainable Rabbit Management Funding.	Funding round is oversubscribed with eligible applications.	Yes/No
Advocate and engage with territorial authorities and Crown agencies on rabbit management <sup>15</sup>	# of territorial authorities and Crown agencies engaged on rabbit management	8

Note: Any compliance actions are covered under 4.1 Compliance and Enforcement Actions.

## 3.4.2 Gorse and broom

## Objective

Implement sustained control of broom and gorse to ensure land that is free of, or being cleared of, broom and gorse does not become infested (primarily in Central Otago and Queenstown Lakes districts) in order to prevent adverse effects on production values and economic well-being.

Deliverable	КРІ	Target

<sup>&</sup>lt;sup>13</sup> Currently there are 17 night count routes. Under the Rabbit Monitoring Plan it is planned there will be 31 routes. The final number is yet to be confirmed until routes are formally surveyed and access agreements in place.

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<sup>14</sup> Active community rabbit programmes are located in Otago Peninsula, Moeraki, Lake Hayes, Gibbston and Queensberry.

<sup>&</sup>lt;sup>15</sup> Namely MPI, DoC, LINZ and Territorial Authorities [WDC, DCC, CDC, CODC, QLDC]

Inspect gorse and broom free areas for	% of non-compliant properties re-inspected	100%	
gorse and broom infestation, including the	within set timeframes in gorse and broom		
use of remote sensing.	free areas.		
			ł
Advocate with occupiers and landowners	# of community meetings delivered on new	4	
on new gorse and broom free areas that	gorse and broom free areas		
come into effect in 2024			

Note: Any compliance actions are covered under 3.6 Integrated Programmes and 4.1 Compliance and Enforcement Actions.

## 3.4.3 Russell Lupin

## Objective

Implement sustained control of the extent of Russell lupin and wild Russell lupin within specified distances from waterways and property boundaries to preclude establishment of wild Russell lupin and to prevent adverse effects on environmental values.

Deliverable	KPI	Target
Implement regional strategy on Russell	% of actions completed by due date as	100%
lupin including communications plan.	described in the Russell lupin strategy.	
Stakeholder engagement	Action plan developed and presented to	<u>1</u> 6
implementedUndertake inspections in one	stakeholders.# of high-risk areas inspected	
highrisk <u>catchment</u> .areas <sup>16</sup>	for Russell lupin	

Note: Any compliance actions are covered under 3.6 Integrated Programmes and 4.1 Compliance and Enforcement Actions.

# 3.4.4 Nodding thistle and Ragwort

# Objective

Implement sustained control of nodding thistle and ragwort on rural zoned land within specified distances of property boundaries throughout the Otago region to prevent their spread in order to minimise adverse effects on production values and economic well-being.

Deliverable	КРІ	Target
Respond to GNR complaints	% of GNR complaints responded to within	100%
<u>around</u> Undertake re-inspections for	one month.% of non-compliant properties	
nodding thistle and ragwort. to ascertain	re-inspected for nodding thistle and	
compliance	ragwort	

<sup>&</sup>lt;sup>16</sup> As listed in the RPMP, at risk areas are: Dart, Rees, Matukituki, Makarora, Hunter and Shotover (downstream of Arthurs point) river catchments.

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Note: Further compliance actions are covered under 3.6 Integrated Programmes and 4.1 Compliance and Enforcement Actions.

# 3.5 Site-led pest programmes

The RPMP site-led programme is about protecting the environmental values at several named sites from the ravages of multiple pests. As a result, the management programme focuses on specific threats to each site and provides for the control of many pests, often those that are not managed elsewhere in the region (e.g. possums, rats).

The RPMP establishes four site-led programmes. For the Operational Plan three of them, Otago Peninsula, West Harbour-Mount Cargill and Quarantine and Goat islands (all within Dunedin City) are grouped, as the same six pest plant species and 15 pest animal species are managed generically across all three places. The fourth site-led programme concerns the LINZ-led management of lagarosiphon (oxygen weed), where different controls are implemented in different lakes. New site-led programmes will be considered via the RPMP in the future.

3.5.1 Otago Peninsula, West Harbour - Mount Cargill and Quarantine and Goat Islands

#### Objective

Otago Regional Council will take a lead role in supporting community groups and agencies in bringing about the desired levels of environmental protection to these sites [Otago Peninsula (9,000 ha), West Harbour-Mt Cargill (12,500 ha) and Quarantine and Goat Islands].<sup>17</sup>

Deliverable	KPI	Target
Confirm site-led plans for the three terrestrial programme areas.programmes around Otago Harbour	Site-led programme plan (including each site-led location) reconfirmed by 30 September 2024.31 July 2023	<u>1</u> 3
Site-led programme plan implemented.	% of actions implemented by 30 June 2025.within defined timeframes for 2023-2024	100%

Note: Any compliance actions are covered under 3.6 Integrated Programmes and 4.1 Compliance and Enforcement Actions.

## 3.5.2 Lagarosiphon

# Regional Focus Programme

#### Objective

 $^{17}$  Refer to RPMP Objectives 6.5.4, 6.5.5 & 6.5.6 respectively for Otago Peninsula, West Harbour-Mt Cargill and Quarantine and Goat Islands

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To support LINZ in controlling lagarosiphon in the region's rivers and lakes by:

- Preventing its establishment in Lake Wakatipu and other regional water bodies
- Progressively reducing its spread in Lake Wanaka and the Kawarau River
- Undertaking sustained control in Lake Dunstan

Deliverable	KPI	Target
Joint planning with LINZ and other	# of meetings attended with LINZ and other	4
stakeholders <u>.</u>	stakeholders <u>.</u>	
Support LINZ in the management and	Funding disbursed as per agreement.	100%
control of lagarosiphon <u>.</u>		
Undertake summer monitoring of water	# of interactions in the 'Check, clean, dry'	650
users at designated sites. 18	programme <u>.</u>	
Undertake monitoring and inspections of	# of <u>bi-annual</u> lagarosiphon monitoring visits	<u>22<del>18</del></u>
freshwater pests.lagarosiphon at	toat priority water bodies <sup>19</sup> to determine the	
designated water bodies that are not the responsibility of LINZ	presence of lagarosiphon.	
responsibility of Env2	# of sites monitored or inspected for	<b>&gt;</b> 40
	freshwater pests.# of lagarosiphon inspections at secondary water bodies	
	mapeetions at secondary water bodies	

Note: Any compliance actions are covered under 3.6 Integrated Programmes and 4.1 Compliance and Enforcement Actions.

# 3.6 Integrated programmes

While the RPMP has five defined programmes, aspects of these programmes are <u>shared or</u> interconnected, <u>such as</u>—especially through <u>associated analysis</u>, <u>common linkages to</u> biodiversity outcomes and <u>engagement with partners and stakeholders</u>associated <u>common analysis</u>. For this Operational Plan, the integration between programmes is an important consideration.

## 3.6.1 Biodiversity Integration

A principal outcome of pest management is to enhance indigenous biodiversity, which informs the prioritisation of biosecurity activities. This is achieved by focusing on high biodiversity focus areas, and their surrounds, that should be safeguarded.<sup>20</sup> (Note: The deliverables in this sub-section cover nonrabbit pests. For rabbit management, refer to Section 3.4.1).

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<sup>&</sup>lt;sup>18</sup> This KPI is dependent on funding being confirmed from MPI. Lakes Dunstan, Wanaka or Roxburgh, and the Clutha/Mata-Au and Kawarau Rivers.

<sup>&</sup>lt;sup>19</sup> Moke Lake; Manorburn, Poolburn, Butchers, Conroys, Falls <u>and</u>; Fraser Dams, <u>Pinders Pond, Blue Lake, Moke Lake, Bullock Creek and</u> Albert Town stormwater detention ponds. <u>They are monitored, at a minimum, twice a year. These and Bullock Creek sites are not overseen by other agencies.</u>

<sup>&</sup>lt;sup>20</sup> As informed by Leathwick J.R. (2020). Indigenous biodiversity rankings for the Otago region. Report prepared for the ORC.

Deliverable	KPI	Target
Undertake pest inspections to progress biodiversity outcomes	# of pest inspections undertaken <sup>24</sup>	<del>1,500</del>
Pest inspections support high biodiversity focus areas and their surrounds	% of pest inspections undertaken in high biodiversity focus areas and their surrounds	<del>40%</del>

# 3.6.2 Shared Pest Programmes

<u>The following are shared or interconnected deliverables related to achieving Aspects of biosecurity outcomes, hence have common approaches that apply across the five RPMP programmes listed above. These deliverables focus on the monitoring and analysis of pests.</u>

Deliverable	KPI	Target
Undertake pest inspections or monitoring	# of pest inspections or monitoring visits	<u>1,500</u>
to progress biodiversity outcomes.	undertaken. <sup>22</sup>	
Re-inspect all non-compliant properties	% of non-compliant <u>properties</u> (or	100%
(or sites) <sup>23</sup> .within set timeframes	sites)inspections re-inspected. within set	
	timeframes <sup>24</sup>	
<u>Undertake</u> Develop and implement a	# of density monitoring visits to sites where	<u>25</u> 20
density monitoring visits to assess the	biocontrol agents are presentundertaken	
efficacyplan of biocontrol agentsspecific		
<del>plant species<sup>25</sup></del>		
Prepare Undertake monitoring plans for	A set# of monitoring plans completed by 31	<u>1</u> 20
selectedof pest species & biocontrol	October 2024. visits to pest plant bio-control	
agents.plant bio-control release sites <sup>26</sup>	<del>release sites</del>	
Analyse pest trends based on inspection,	Report on 'State of Pest Management in	<u>1</u> 10
monitoring and surveillance	Otago' submitted to Council before 31	
data. Undertake visits to nurseries and	March 2025.# of nurseries and pet shops	
pet shops to advocate and inspect for	visited	
biosecurity compliance		

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<sup>&</sup>lt;sup>24</sup> This is in addition to any inspections listed elsewhere in this Operation plan for specific pests

 $<sup>\</sup>underline{^{22}}$  This target excludes rabbits which are listed above.

<sup>&</sup>lt;sup>23</sup> Generally, pest compliance is done or a property basis however for some pests, the location is a site that is not a property (e.g. lagarosiphon)

<sup>&</sup>lt;sup>24</sup>-Timeframes to achieve compliance for plant pests is three months from the inspection with the exception of Old-Man's Beard which is six weeks between Oct-Feb. A re-inspection is undertaken within three weeks of this timeframe being expired.

<sup>&</sup>lt;sup>25</sup>-Namely, African Love Grass, Old Man's Beard, Nassella Tussock, Spartina, Russell Lupin

 $<sup>^{26}</sup>$  Namely for various bio-controls for Ragwort , Gorse, Broom, Old Man's Beard, Nodding thistle

Selected pests <sup>27</sup> (whose presence has	Control actions for the selected pests are	100%
been confirmed) are appropriately	completed by 30 June 2025.% of	
controlled. Undertake an advocacy and	deliverables enacted from the advocacy and	
education programme to encourage	education programme.	
awareness as to public responsibilities to		
<del>pest management</del>		

# 3.6.<u>2</u>3 Pest Programme Engagement

The management of pests extends beyond justis wider than the ORC. \_Due to this, it is essential to engage with partners and stakeholders to promote and achieveaction biosecurity outcomes. These engagements This engagement is to explain the rules as they pertain to these agencies, to advocate for their increased action and for the agencies to have consistent biosecurity outline their work programmes with the RPMP.

Deliverable	KPI	Target
Engage with crown agencies and territory authorities on pest management. 28	# of communication engagements with listed agencies at least once annually.	10
Support and educate occupiers, landowners and community groups to undertake best practice pest control.	# of community events attended to support best practice pest management.control	<u>812</u>
Develop an Otago Marine Biosecurity programme	Otago Marine Biosecurity Programme presented to Council by 30 June 2025	<u>1</u>
Collaborate with neighbouring regional councils on freshwater and marine pests.	# of collaborations with otherneighbouring regional councils.	4
Collaborate with Kāi Tahu on biosecurity issues and support them to be involved in biosecurity initiatives.	# of collaborations with Kāi Tahu on biosecurity issues.	<u>4</u> 2
Undertake visits to pet shopsSupport schools with key messages, information and nurseries to advocate and inspect for tools relating to biosecurity compliance.	# of pet shops or nurseries visited.# of school programmes attended to provide awareness on biosecurity	10

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<sup>&</sup>lt;sup>27</sup> The selected pests are the six exclusion pests, rooks, spiny broom, wallabies, African love grass and spartina.

<sup>&</sup>lt;sup>28</sup> Namely MPI, DoC, LINZ, KiwiRail, Waka Kotahi, Territorial Authorities [WDC, DCC, CDC, CDC, QLDC]

# 4.3. 4. RPMP Administration

# 4.1 Compliance and Enforcement Actions

As the RPMP is a rules-based approach to pest management, there is need to ensure actions are taken to ensure compliance. The specific approach to compliance and enforcement is covered in the ORC Biosecurity Compliance and Enforcement Policy. To achieve this, the following actions will be delivered.

Deliverables	KPI	Target
Effective administration of compliance a		
Provide occupiers and landowners with the declared pest status following an inspection.	% of occupier/landowner advised of inspection status within three weeks of the inspection.	75%
	% of occupier/landowner advised of inspection status within six weeks of the inspection.	100%
Continued non-compliance, as confirmed by enforcement criteria, is addressed through issuing a Notice of Direction	Any Notices% of eligible non-compliant properties issued with a Notice of Direction are issued within 20 working days after re-inspection.	100%
Pest enquiries <sup>29</sup> are responded to in a timely manner as appropriate to the risk	% of exclusion pest enquiries responded to within 24 hours.	100%
of the pest.	% of eradication pest enquiries responded to within three working days.	100%
	% of all pest enquiries responded to within 10 working days.	100%

<sup>&</sup>lt;sup>29</sup> Enquiries are defined as either 'reports, sightings, notifications and <u>complaints.complaints'</u>

# 5.4. <u>5.</u> Glossary

For the purposes of this operational plan, the following definitions are provided. Further definitions can be found in the RPMP and the ORC Biosecurity Compliance and Enforcement Policy.

Assessment: An inspection or monitoring visit.

**Boundary:** refers to a line or surface in a geographical space the delineates the <u>surface horizontal or vertical</u> extent <u>between two (or more) adjoining of a land parcels parcel.</u>

Compliant: refers to when a rule in the RPMP is adhered to.

**Default Action:** means work undertaken by the management agency to carry out pest control when a 'Notice of Direction' or 'Compliance Order' has not been complied with by an occupier, under section 128 of the BSA. The management agency can then recover costs and expenses reasonably incurred under section 129 of the BSA.

**Known** <u>site-location</u>: refers to a location that has a historical or current record of the pest being present. For ease of monitoring, a known <u>site-location</u> can include a buffer radius of up to 50 metres.

**Inspection:** means a site visit (normally defined by a property) to determine compliance to RPMP rules undertaken by <u>an a warranted officer as</u> authorised <u>person as defined</u> under the Biosecurity Act 1993.

Landowner: has the same meaning as occupier in the Biosecurity Act 1993.

Land Parcel: is a unique area of land, identified by the cadastral survey plan showing the legal boundaries, location, dimensions and area, along with the unique legal description (appellation).

**Location:** refers to a geographical point on the surface of the earth. This will typically be identified by the GPS co-ordinates of northing and easting. For New Zealand, most common projections are the New Zealand Traverse Mercator or World Geodetic 1984).

**Management agency:** has the same meaning as in the Biosecurity Act 1993, specifically "means the body specified as the management agency in a pest management plan or a pathway management plan". For the purposes of the RPMP and Operational Plan, Otago Regional Council is the management agency for pests to be controlled in the Otago region.

Management Plan: refers to a landowner/occupier agreement to manage selected pests as explained in the respective monitoring plan.

Modified McLean Scale: this scale assesses rabbit population levels (see RPMP, Appendix 2).

**Monitoring:** means work undertaken to determine the trend and prevalence and/or trend of a pest. This will normally be in-person visit to a location but can use remote sensing tools. Monitoring differs from inspection in that no subsequent enforcement is undertaken.

Monitoring Plan: refers to a detailed description of how selected pests will be targeted to achieve the objectives of the RPMP.

**Notice of Direction (NOD):** means the actions required and notice issued pursuant to section 122 of the Biosecurity Act 1993. A NOD can require a person to take action to address pest plant or animal problems or to comply with a rule in an RPMP.

Occupier: see landowner.

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**Non-compliance:** refers to any breach in a RPMP rule, upon a formal inspection.. Non-compliance is liable for enforceable under the provisions of the BSA. For clarification, a breach of a RPMP rule does not have to be widespread across a property and may relate to a single location (or a defined area) within a property. Due to the potential of spread, the whole property is deemed non-compliant even if the infestation is localised.

Operational plan: means a plan prepared by the Management Agency under Section 100B of the Act.

**Pest:** has the same meaning as in the Biosecurity Act 1993: "an organism specified as a pest in a pest management plan."

**Property:** For the purposes of this plan, a property is an extent of land that is either [1] under unique ownership (whether individual, joint, partnership or corporate) or [2] is managed as a single operational entity. A property can be made up of one or more adjoining land parcels (see land parcel).

**Surveillance:** means work undertaken to determine the status (presence <u>and extent</u>) of pest species. This can be in-person or, <u>increasingly</u>, use remote sensing tools.

Surveillance Plan: describes the approaches used to determine the presence, or extent, of pest species. A surveillance plan may cover a number of pest species.

**Surrounding area:** means a wider area surrounding a known sites pest infestation. This is variable depending on context of the pest but, at a minimum, includes all adjoining properties to the property with the pest infestation. A property is considered adjoining even if it is separated by a road, paper road, waterway or easement. A designated surrounding area does not prevent pest assessments inspections from being carried out in non-surrounding areas.

**Water body:** means fresh water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area.

**Wilding conifer:** wilding conifers are any introduced conifer tree, including (but not limited to) any of the species listed in Table 3 of the RPMP.

**Zero level/zero density:** where the pest is not detectable in an area, however the pest may continue to appear afterwards due to plant seed sources or animal migration from an unmanaged area.

# **Appendix**

# <u>Appendix 1: Timeframes associated with Biosecurity Inspections</u>

Compliance Type	<u>Plants</u>	Rabbits
Work Request	Three months; except six weeks for Old Man's Beard between Oct-Feb.	May-Dec: six months; Jan-Apr: three months
Notice of Direction	Three months; except six weeks for Old Man's Beard between Oct-Feb.	One year

# Notes:

- 1. Where suitable, poisoning for rabbits is best in winter, hence the one-year timeframe for Notices of Direction ensures there is at least one winter to undertake control before re-inspection.
- 2. Timeframes are based on the date the letter was sent, not when the inspection was undertaken.
- 3. Re-inspections occur within a three-week period after the timeframe expires.

# 9.7. Biosecurity Compliance and Enforcement Policy

**Prepared for:** Environmental Implementation Committee

Report No. GOV2404

Activity: Governance Report

Libby Caldwell, Manager Environmental Implementation

**Author:** Murray Boardman, Performance and Delivery Specialist

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**Endorsed by:** Gavin Palmer, General Manager Operations

**Date:** 8 May 2024

#### **PURPOSE**

This report seeks to the approve an updated version of Biosecurity Compliance and Enforcement Policy that applies to the Otago Regional Pest Management Plan (RPMP) and the statutory requirements of the Biosecurity Act (1993) ('the Act').

#### **EXECUTIVE SUMMARY**

- [2] The current Compliance and Enforcement Policy was set to be reviewed in March 2024. Based on the review, an updated Biosecurity Compliance and Enforcement Policy ('the Policy') is proposed (Attachment 1). The review did not identify there is a need for a significant rewrite. However, the review did conclude that some changes were justified to improve consistency and alignment with evolving procedures.
- [3] The updated policy sets out the approach and principles by which the Otago Regional Council (ORC) promotes and undertakes compliance and enforcement under the RPMP and the Act. This policy outlines how the compliance and enforcement is managed to ensure a consistent and integrated approach.
- [4] The Policy is based on the statutory requirements under the Act and the operational requirements of the RPMP. It is consistent with ORC's RMA Compliance and Enforcement, the Regional Sector Strategic Compliance Framework, case law direction and a review of sector best practice for compliance and enforcement activities and policies.

# **RECOMMENDATION**

That the Environmental Implementation Committee:

- Recommends that the Council approves and adopts the revised Biosecurity Compliance and Enforcement Policy.
- 2) **Notes** that the policy will be reviewed in March 2027.

# **BACKGROUND**

The ORC is responsible for compliance monitoring and enforcement of legislation and related statutory instruments pertaining to the Biosecurity Act (1993). As part of this responsibility, ORC has developed the RPMP which establishes rules to manage pests under the authority of the Act.

- [6] The current Biosecurity Compliance and Enforcement Policy was formally adopted by Council on 23 June 2021.<sup>1</sup> At the time it was adopted, the policy was the first in the country to be specifically prepared for biosecurity.
- Prior to this, the policy guidance for compliance and enforcement related to biosecurity was administered using approaches under the Resource Management Act (1991) (RMA). However, compliance and enforcement provisions of the Biosecurity Act (1993) differ from the RMA so having a separate compliance and enforcement policy for biosecurity was the preferred approach.<sup>2</sup>
- [8] The current Compliance and Enforcement Policy was set to be reviewed in March 2024.

#### **DISCUSSION**

- [9] The review was open to any outcome. Hence, the review could range from rolling over the current Biosecurity Compliance and Enforcement Policy to a significant rewrite.
- [10] During the review, it was identified that the current policy still met the requirements of the Act and RPMP. Due to this, it is recommended that no significant rewrite is needed. However, the review noted that some changes were justified to improve consistency and alignment with evolving procedures.
- [11] Key changes to the revised policy include correcting legislative references, clarifying informal and formal actions, aligning the factors related to decision-making to current procedures and general editing for improved clarity.
- [12] The principles set by the policy provides a framework that is used to build and improve biosecurity operational practices. The policy is frequently used to develop, or revise, new procedures, and systems (e.g., standard timeframes, criteria for NOD decisions, refining Officer recommendations, aligning biosecurity priorities, enhancing data collection tools).
- [13] A comparison document has been provided to show the changes made to the policy (Attachment 2).

# **OPTIONS**

- [14] Option 1 Approve the revised Biosecurity Compliance and Enforcement Policy.
- [15] Option 2 Do not approve revised Biosecurity Compliance and Enforcement Policy and continue with the current policy.
- [16] Option 1 is recommended as it ensures the compliance and enforcement policy is up-to-date and that ORC's approach to compliance and enforcement remains transparent. There is no perceived risk to adopting this policy. Rather, taking Option 1 is more likely to reduce any potential risk by improving the consistency, clarity, and coherence of the policy.

# **CONSIDERATIONS**

<sup>&</sup>lt;sup>1</sup> Refer to Council Resolution CM21-132 adopting the resolutions of the Implementation Committee meeting on 9 June 2021.

<sup>&</sup>lt;sup>2</sup> Refer to Implementation Committee Agenda, 9 June 2021, Section 7.2, page 26-31.

# **Strategic Framework and Policy Considerations**

[17] This report considers the adoption of the Biosecurity Compliance and Enforcement Policy which supports ORC's vision for Otago by working towards an environment that supports healthy people and ecosystems and community resilience in the face of risk, such as biosecurity risk.

#### **Financial Considerations**

[18] While there are no financial costs to adopting the policy, the policy does outline cost recovery for persistent non-compliance.

# **Significance and Engagement**

[19] There are no implications for significance and engagement.

# **Legislative and Risk Considerations**

- [20] Compliance, monitoring, and enforcement activities are a mandatory function under the Act, and case law has provided guidance and direction on factors to consider when considering enforcement action. The Biosecurity Compliance and Enforcement Policy is based on case law guidance and the Act requirements.
- [21] A policy on compliance and enforcement reduces the risk of legal challenge over process issues.

#### **Climate Change Considerations**

[22] There are no implications for climate change.

# **Communications Considerations**

[23] Once adopted, the policy will be made available publicly on the Council's website.

# **NEXT STEPS**

[24] Once adopted, the policy will be incorporated into the standard operating procedures of biosecurity and will be implemented accordingly.

# **ATTACHMENTS**

- 1. ORC Biosecurity Compliance Enforcement Policy May 2024 [9.7.1 11 pages]
- 2. Comparison between Revised and Current Biosecurity Complianc [9.7.2 17 pages]



# **Biosecurity Compliance and Enforcement Policy**

Biosecurity Act (1993)
Otago Regional Pest Management Plan 2019-29



Version 2: Effective from [Insert Date]

Environmental Implementation Committee - 8 May 2024

#### 1. INTRODUCTION

The Otago region covers 12% of New Zealand's land area and is the third largest region in New Zealand. The region has a high level of endemism, meaning that certain species are only found in this region. Otago also features a wide range of geography and ecosystems, from alpine regions, glacial lakes, grasslands, forests, and a dramatic coastline. This leads to Otago being one of the most biodiverse regions in New Zealand. The indigenous biodiversity contributes to our health, our economy, and our social and cultural wellbeing. The Otago landscapes and geography are a key attraction to those who visit the region and supports the agricultural sector as key drivers of Otago's economic development.

Broadly, the environment encompasses the ecosystems that include people and their communities, natural and physical resources, and the resulting amenity values. These, in turn, influence, and are influenced by, the prevailing aesthetic, cultural, economic, and social conditions. However, the environment of the region is increasingly under threat by harmful organisms. These organisms can have a detrimental effect and adverse impact on the natural environment and human wellbeing.

All land occupiers, including crown<sup>1</sup>, public and private entities, are responsible for effectively managing the spread of animal and plant pests. Under the Biosecurity Act (1993) ('the Act'), the Otago Regional Council (ORC) is empowered to enforce action to ensure pests are managed appropriately. To achieve this, the Otago Regional Pest Management Plan (RPMP), under the provisions of the Act, provides the scope to undertake inspections and enforcement action to ensure compliance with given regulations.

This policy sets out the approach and principles by which the ORC ensures compliance with the Act and the RPMP. This policy is intended to ensure a fair and reasonable, consistent and robust approach to compliance and enforcement by ORC.

#### 2. DETERMINATION OF COMPLIANCE

Section 154N of the Act sets down instances where non-compliance is deemed to be an offense and is liable for enforcement. Of particular relevance to the ORC, section 154N(19) states that non-compliance with a RPMP rule, or any part thereof, creates an offence under the Act.

The Act does not provide guidance on the scale, or threshold, of non-compliance. Therefore, non-compliance is, in effect, any breach of the Act or RPMP rule, irrespective of scale. This means non-compliance does not necessarily have to be widespread across a property and may relate to a single location (or a defined area) within a property.

# 3. PRINCIPLES TO ACHIEVING EFFECTIVE COMPLIANCE

ORC's preferred approach is to use informal means to achieve compliance (e.g., through education, consultation, work request and negotiation). The emphasis here is to foster

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<sup>&</sup>lt;sup>1</sup> Under Section 69(5) of the Biosecurity Act (1993), the Crown is only liable to meet its responsibility for pest management under the 'Good Neighbour Rule'.

**Biosecurity Compliance and Enforcement Policy** 

voluntary cooperation for a common goal. This is, ultimately, the most cost-effective approach for occupiers and landowners.

When informal options have not led to compliance, ORC will progressively, yet fairly and reasonably, undertake enforcement action as provided for by the Act. The provisions of the Act are clear and straightforward. By following standard processes, enforcement actions undertaken under the Act have proven to be robust and able to withstand legal challenge<sup>2</sup>.

# The Eight Principles of Compliance and Enforcement

The underlying principles to ORC's approach to compliance and enforcement action are:3.

**Transparency** – We will provide clear information and explanations to the community, and those being regulated, about the standards and requirements for compliance. We will ensure the community is kept informed about the actions taken by us to address the non-compliance of biosecurity rules.

Consistency of process – Our actions will be consistent with the legislation and within our powers. Compliance and enforcement outcomes will be consistent and predictable for similar circumstances. We will ensure that our staff have the necessary skills and are appropriately trained, and that there are effective systems and policies in place to support them.

**Fair**, **reasonable and proportional approach** – We will apply regulatory interventions and actions appropriate for the situation. We will use our discretion justifiably and ensure our decisions are appropriate to the circumstances, and that our interventions and actions will be proportionate to the seriousness of the non-compliance and the risks posed to people and the environment.

**Evidence-based and informed** – We will use an evidence-based approach to our decision making. Our decisions will be informed by a range of sources, including robust science, regulated parties, information received from other regulators, community members, industry and interest groups.

**Collaborative** – We will work with and, where possible, share information with other regulators (e.g. Ministry for Primary Industries) and stakeholders to ensure the best compliance outcomes for our region. We will engage with the community, those we regulate and government to explain and promote biosecurity requirements and achieve better community outcomes.

**Lawful**, ethical and accountable – We will conduct ourselves lawfully and impartially and in accordance with these principles, relevant policies and guidance. We will document and take responsibility for our decisions and actions. We will measure and report on our regulatory performance.

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<sup>&</sup>lt;sup>2</sup> Hayes v Environment Waikato, District Court Manukau CIV-2009-057-000319, 21 March 2011.

<sup>&</sup>lt;sup>3</sup> These principles are adapted from the Compliance and Enforcement Special Interest Group (CESIG) Regional Sector Strategic Compliance Framework 2019-2024.

**Biosecurity Compliance and Enforcement Policy** 

**Targeted** – We will focus on the most important issues and problems to achieve the best biosecurity outcomes. We will target our regulatory intervention at non-compliances that pose the greatest risk to biosecurity. We will apply the right tool for the right problem at the right time.

Responsive and effective – We will consider all alleged non-compliances to determine the necessary interventions and actions to minimise impacts on the community and maximise deterrence. We will respond in an effective and timely manner in accordance with legislative and organisational obligations.

# 4. METHODS TO ACHIEVE COMPLIANCE

The ORC has a 'spectrum' approach to encouraging positive behaviour change and ensuring the highest levels of compliance possible. The ORC's approach to ensuring compliance with the RPMP is based on '4Es model'<sup>4</sup> of Enable, Engage, Educate and Enforce:

- Enable provide opportunities for occupiers and landowners to be exposed to best practice and regulatory requirements. Link regulated parties with appropriate pest management industry.
- Engage consult with occupiers and landowners, stakeholders and community on
  matters that may affect them. This will require maintaining relationships and
  communication until final outcomes are reached. This will facilitate greater understanding
  of challenges and constraints, engender support and identify opportunities to work with
  others.
- Educate alert occupiers and landowners to what is required to be compliant and where
  the onus lies to be compliant. Education should also be utilised to inform community and
  stakeholders about what regulations are in place around them, so that they will better
  understand what is compliant and what is not.
- Enforce when non-compliance is identified then enforcement tools and actions are available to ensure the RPMP intentions are achieved. Enforcement outcomes should be proportional to individual circumstances of the breach and culpability of the party.

When non-compliance with the RPMP is observed, ORC will inform the occupiers and landowners of the work required. This proactive approach is to encourage compliance, however, the Act is a robust law that provides for significant enforcement action should non-compliance be persistent. ORC's approach and use of enforcement actions depends on the issue, context and seriousness of the breach as illustrated below<sup>5</sup>:

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<sup>&</sup>lt;sup>4</sup> The 4Es model is adapted from the CESIG Regional Sector Strategic Compliance Framework 2019-2024.

<sup>&</sup>lt;sup>5</sup> Influencing behaviour change is based on the CESIG Regional Sector Strategic Compliance Framework.

#### **Biosecurity Compliance and Enforcement Policy**

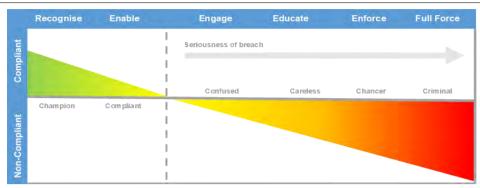


Figure 1: Enforcement Progression

# 5. THE COMPLIANCE AND ENFORCEMENT PROCESS

The Chief Executive of the ORC, acting as Principal Officer under the Act, has authority to appoint authorised persons for the purposes of exercising the functions, powers and duties under the Act. An authorised person (sometimes referred to as a 'warranted' officer) is permitted to enter private property (excluding a house or marae) for the purpose of assessing compliance with the Act and RPMP. Authorised persons receive specific training and are familiar with their statutory obligations before carrying out any enforcement functions.<sup>6</sup>

The initial phase of compliance and enforcement is to undertake an inspection. Inspections can be scheduled, in response to a complaint, or based on professional observation. When inspecting a private property, the rights of the occupier and landowner will be respected. ORC staff must ensure that all entry to private property is done so lawfully. However, under the Act inspections can be undertaken without providing prior notice to the occupier or landowner.

If the occurrence or density of pest infestation exceeds the rules as set out in the RPMP, then compliance and enforcement action will be implemented to ensure compliance with the RPMP rules. If a property is deemed to be non-compliant, occupiers and landowners will have a given timeframe to undertake the required work before a re-inspection is carried out. A re-inspection is undertaken to ascertain whether compliance with the rules of the RPMP rules has been achieved and to determine if any further actions are required. Re-inspections can occur throughout the compliance and enforcement process until compliance is achieved.

#### **Informal and Formal Actions**

The options for enforcement action will depend on the pest species in question and the individual circumstances of each case. Informal actions (not covered in the Act) to encourage compliance include verbal and written advice. Formal actions are available by law through the enforcement mechanisms prescribed in the Act. The administrative

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<sup>&</sup>lt;sup>6</sup> ORC authorised persons gather data and information in keeping with best practice detailed in *Basic Investigative Skills* for Local Government.

approaches taken with respect to compliance and enforcement will follow the standard operating practices detailed in the ORC Biosecurity Compliance Operating Procedures.<sup>7</sup>

In brief, the compliance and enforcement options that follow a non-compliant inspection are:

- Informal Actions are focused on providing education and incentive-based responses to allow the occupier or landowner to become better informed and develop their own means to achieve compliance. Informal actions will be detailed through a 'Work Request' letter.
- Formal Actions are forward-looking to provide clear direction of action required to ensure compliance. Formal actions will be detailed through:
  - a. Legal notices (e.g., Notice of Direction), followed by, if needed,
  - b. Default action or Prosecution.

Figure 2 shows the progression of compliance and enforcement, while Table 1 describes the compliance and enforcement actions in more detail. With respect to legal enforcement, while prosecution remains an option, the most common action will be default action.

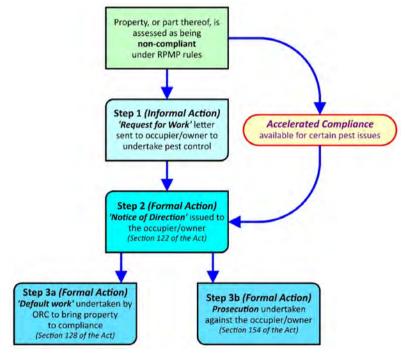


Figure 2: Sequence of primary actions for compliance and enforcement under the Act.

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<sup>&</sup>lt;sup>7</sup> The ORC Biosecurity Compliance Operating Procedures action this Policy and are contained in a comprehensive set of guidelines and manuals. The Procedures build upon, and implement, the 'Eight Principles of Compliance and Enforcement' outlined in this Policy. They are reviewed and updated regularly to incorporate ongoing business improvement, changes in technology, and system enhancement within Biosecurity operations.

Table 1: Description of Compliance and Enforcement Actions

	Description of action	Potential impacts for the liable party	When this action is appropriate
		Work Request	
actions	Following an initial inspection, a work request alerts occupiers and/or landowners to the pest issue, the rules and their responsibilities under the RPMP, and gives them a timeframe to achieve compliance without formal enforcement.	This is a non-formal process and as such has no legal implication. However, it does start the path towards possible formal action if the work request is not completed as required.	A work request is issued after the initial inspection when a property is deemed non-compliant. <sup>8</sup> This is normally the extent of the action required when dealing with cooperative parties who are motivated to do the right thing but lack the knowledge or skills
Informal actions	A work request provides the opportunity to proactively prevent further spread, to remedy, or to mitigate the effects of non-compliance. Biosecurity Officers can provide guidance around rules, regulations, and pest management options to help parties to achieve compliance.		necessary to achieve and maintain compliance.
		Notice of direction (NOD)	
	Under the Act, an authorised person has the power to give directions to control pests. This is enacted though a Notice of Direction (NOD). A NOD is the first level of formal enforcement action under the Act. Once issued, a NOD can be extended, varied or cancelled depending on circumstances and actions taken.	A NOD requires a person to take action to address plant and animal pest problems that breach a rule in an RPMP. The NOD is the formal acknowledgement of noncompliance. Non-compliance with a NOD is an offence under the Act and can lead to further enforcement actions, such as default work or prosecution.	A NOD may be issued:  [1] When compliance has not been achieved following informal actions; or  [2] After the initial inspection where a priority pest issue needs to be addressed using the accelerated compliance process as described in Section 5 of this policy.
		Default Work	
Formal actions	Under the Act, the regional council has the power to undertake default work when a NOD or a compliance order has not been complied with. Default action occurs when the ORC legally undertakes the necessary work to ensure the pest noncompliance has been dealt to. Other than in the most extreme cases, this will be the most punitive action taken to enforce the Act.	This is legally enforceable action and requires the occupier/ landowner to provide access for the work as directed, arranged and costed by the ORC. The action to undertake default work does not need court approval.  All costs will be charged to the occupier/landowners. Non-payment of costs can lead to a statutory land charge being placed on the property. More details on cost recovery are given in Section 7 of this policy.	This action can be taken following non-compliance with an enforcement document (e.g., a Notice of Direction (NOD) and/or a compliance order).

<sup>&</sup>lt;sup>8</sup> A Work Request does not apply if the non-compliance is being dealt to through the accelerated compliance pathway (see Section 5)

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	Description of action	Potential impacts for the liable party	When this action is appropriate
		Prosecution	
Formal actions, cont.	A prosecution is a process followed through the criminal courts to establish guilt or innocence and, if appropriate, the court will impose sanctions.  Biosecurity Act matters are heard by a District Court Judge.  All evidential rules and standards must be met for a prosecution under the Act.	A successful prosecution will generally result in a conviction, a penalty imposed (imprisonment and/or fines as specified in the Act), and consideration to costs of the investigation.  A prosecution forms part of the history of non-compliance and will be considered if there are future incidents of non-	following non-compliance with
_	proceduler ander the rice.	compliance.	

# **Additional Compliance Powers**

Other compliance powers include:

- Declaration of a restricted place: The Act provides the ability to issue a Restricted Place Notice to prevent the removal or introduction of any organism or good to any place, and may direct that specified organisms and goods be isolated, confined or stored and identified. A Restricted Place Notice is useful and relevant for RPMP work where, for example, the movement of gravel from a place containing pests to a noninfested place needs to be stopped to avoid the pests spreading.
- Declaration of a controlled area: The Act provides the ability to publicly declare a
  specified area to be controlled. The notice may restrict, regulate or prohibit the
  movement into, within, or from the controlled area of specified organisms, organic
  material, risk goods or other goods and/or require the goods be treated or subject to
  specified processes. While this enforcement power exists for regional councils, it has
  limited relevance for RPMP compliance.
- Compliance Order: Under the Act, an authorised person may serve a compliance order
  requiring an individual or legal entity to cease doing something or prohibit the person from
  starting something, doing something again, or having something done that will contravene
  biosecurity law. Non-compliance with a compliance order is an offence under the Act and
  can lead to further enforcement actions. A compliance order is an alternative to the Notice
  of Direction. While it is available as an enforcement option, the ORC uses the Notice of
  Direction as its standard enforcement document.

# 6. ACCELERATED COMPLIANCE PROCESS

When there is need to respond to a high-risk pest management issue (e.g. rapid increase in wallaby sightings accompanied by landowner apathy, or to curtail the increase in a priority pest, such as rabbits), this policy provides for the compliance process to be accelerated. An accelerated compliance process means that if a property is deemed to be non-compliant following a first inspection, the ORC can bypass the informal action (Step 1 in Figure 2) and issue a Notice of Direction (Step 2 in Figure 2).

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#### **Biosecurity Compliance and Enforcement Policy**

Accelerated compliance may be applied to priority pests (as identified in the current Biosecurity Operational Plan), high-risk situations, and to any current or potential exclusion programmes. An accelerated compliance process prioritises the risk to environmental, economic and landscape values, including supporting control efforts of others, while being mindful of the increased operational requirements.

# 7. ENFORCEMENT DECISION

The ORC takes a rational and principled approach to regulation. In general, the ORC advocates a policy of education and co-operation towards compliance. However, the ORC recognises that there are times when the use of formal enforcement measures is necessary.

The process for taking enforcement action against biosecurity non-compliance is clearly laid out in the Act. The Act provides a robust enforcement framework, with only one known case filed.<sup>9</sup> This decision was in favour of the regional council in question as they had shown good process, provided accurate documentation, taken relevant photographs, and kept good, clear records.

# Factors considered in enforcement decision-making processes:

The factors leading to an enforcement decision are context dependent as each non-compliance situation is unique, including:

- > Alignment with biosecurity priorities
- Impact on environment and areas of high biodiversity
- > Extent of infestation (grade and area)
- Change in infestation grading between inspections
- Impact on neighbour/community control activity
- > Equity (consistent, equity of enforcement in the neighbourhood and across region)
- Individual circumstance (personal/property specific)
- > Past/present/planned control activity
- > Officer comments & recommendations
- > Other external circumstances (e.g., flooding, drought, lockdown)

The responsibility and discretion to take compliance and enforcement action, or not, sits solely with those delegated to make such decisions in the regulatory agency<sup>10</sup>. Decision-making processes are standardised and robust to ensure equitable and consistent implementation. These decisions include:

- > The appropriate party to pursue;
- The appropriate enforcement tools to use in the circumstances; and

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<sup>&</sup>lt;sup>9</sup> Hayes v Environment Waikato, District Court Manukau CIV-2009-057-000319, 21 March 2011.

<sup>&</sup>lt;sup>10</sup> New Zealand Law Commission 'Prosecution decisions and the discretion to prosecute' <a href="http://www.nzlii.org/nz/other/nzlc/report/R66/R66-5.html">http://www.nzlii.org/nz/other/nzlc/report/R66/R66-5.html</a>

#### **Biosecurity Compliance and Enforcement Policy**

➤ Whether to extend, vary or withdraw an enforcement action that has been commenced.

ORC is required to exercise this discretion in a way that is reasonable and consistent with the principles of the Act and the requirements of natural justice.

Where prosecution is being considered, the ORC will follow the Solicitor General's Prosecution Guidelines, including the evidential and public interest tests.

# 8. COST RECOVERY

The Act gives ORC the power to recover the costs associated with its compliance monitoring obligations. This is provided for under section 135(3) and section 129 of the Act. In Otago, charges are not currently applied to informal actions, such as a scheduled inspection or a re-inspection when the property has become compliant.

# **Recovery of Non-Compliance Costs**

Councils, as management authorities, have the statutory right to use a variety of charges to recover costs incurred in administrating the RPMP. This can include fixed charges for issuing notices, hourly rates, estimates of advanced work and reasonable costs. Fees and charges that may be recovered are listed in the current Long-Term Plan or Annual Plan and are reviewed annually. In setting its cost recovery model, ORC is conscious that costs associated with monitoring should fall onto those resource users who are subject to monitoring, as opposed to the general ratepayer. For any prosecutions, ORC reserves the right to seek recovery of allowable legal costs.

# **Recovery of Default Work Costs**

Under the Act, the actual and reasonable cost of default work can be recovered by the ORC as a debt due. This is normally done through an invoice. Failure to pay can result in compounding interest being added to the debt, and ultimately a lien can be place on the property that prevents owners dealing with the title to their property until the debt associated with the lien has been resolved.

# **Biosecurity Compliance and Enforcement Policy**

Policy owner	Manager,	Manager, Environmental Implementation		
Superseded Version #	1.0	9 June 2021	Initial policy	
Proposed Version #	2.0	8 May 2024	Reviewed and updated for consistency and clarity	

Next Review Date	March 2027	

Cover Photo: Australian Young Mine Water wheel Carrick Range, Bannockburn (Credit: Gary Smith)

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# **Biosecurity Compliance and Enforcement Policy**

Biosecurity Act (1993)

Otago Regional Pest Management Plan 2019-29

Version 2: Effective from [Insert Date]

# **Biosecurity Compliance and Enforcement Policy**





Date-approved 9-June-2021	
Review date March 2024	
Policy-owner Manager-Environmental Implementation	
Version	1.0

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I

#### 1. INTRODUCTION

The Otago region covers 12% of New Zealand's land area and is the <a href="third-second">third-second</a> largest region in New Zealand. The region has a high level of endemism, meaning that certain species are only found in this region. Otago also features a wide range of geography and ecosystems, from alpine regions, glacial lakes, grasslands, forests, and a dramatic coastline. This leads to Otago being one of the most biodiverse regions in New Zealand. The indigenous biodiversity contributes to our health, our economy, and our social and cultural wellbeing. The Otago landscapes and geography are a key attraction to those who visit the region and supports the agricultural sector as key drivers of Otago's economic development.

Broadly, the environment encompasses the ecosystems that include people and their communities, natural and physical resources, and the resulting amenity values. These, in turn, influence, and are influenced by, the prevailing aesthetic, cultural, economic, and social conditions. However, the environment of the region is increasingly under threat by harmful organisms. These organisms can have a detrimental effect and adverse impact on the natural environment and human wellbeing.

All land occupiers, including crown<sup>1</sup>, public and private entities, are responsible for effectively managing the spread of animal and plant pests. Under the Biosecurity Act (1993) ('the Act'(BSA), the Otago Regional Council (ORC) is empowered to enforce action to ensure pests are managed appropriately. To achieve this, the Otago Regional Pest Management Plan 2019-2029 (RPMP), under the provisions of the ActBSA, provides the scope to undertake inspections and enforcement action to ensure compliance with given regulations.

This policy sets out the approach and principles by which the ORC ensures compliance with the <u>Act</u> <u>and RPMP as provided by</u> the <u>RPMPBSA</u>. This policy is intended to ensure a fair and reasonable, consistent and robust approach to compliance and enforcement by ORC.

# 2. <u>DETERMINATION OF PRINCIPLES TO ACHIEVING EFFECTIVE</u> COMPLIANCE

Section 154N of This policy defines non-compliance as 'any breach of a rule as stated in the Act sets down instances where RPMP, for which an exemption has not been given'. Under the provisions of the BSA, non-compliance is deemed to be an offense and is liable for enforcement. Of particular relevance to the ORC, section 154N(19) states that non-compliance with a RPMP rule, or any part thereof, creates an offence under the Act.

The <u>ActBSA</u> does not provide guidance on the scale, or threshold, of non-compliance. Therefore, non-compliance is, in effect, any breach of <u>the Act or</u> RPMP rule, irrespective of scale. This means <u>non-compliance</u> breach of a RPMP rule does not necessarily have to be widespread across a property and may relate to a single location (or a defined area) within a property to be deemed non-compliant.

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<sup>&</sup>lt;sup>1</sup> Under Section 69(5) of the Biosecurity Act (1993), the Crown is only liable to meet its responsibility for pest management under the 'Good Neighbour Rule'.

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# 3. PRINCIPLES TO ACHIEVING EFFECTIVE COMPLIANCE

ORC's preferred approach is to use informal means to achieve compliance (e.g., through education, consultation, work request for work and negotiation). The emphasis here is to foster voluntary cooperation for a common goal. This is, ultimately, the most cost-effective approach for occupiers and landowners.

When informal options have not led to compliance, ORC will progressively, yet fairly and reasonably, undertake enforcement action as provided for by the <u>ActBSA</u>. The provisions of the <u>ActBSA</u> are clear and straightforward. By following standard processes, enforcement actions undertaken under the <u>ActBSA</u> have proven to be robust and able to withstand legal challenge<sup>2</sup>.

# The Eight Principles of Compliance and Enforcement

The underlying principles to ORC's approach to compliance and enforcement action are:3.

**Transparency** – We will provide clear information and explanations to the community, and those being regulated, about the standards and requirements for compliance. We will ensure the community is kept informed about the actions taken by us to address the non-compliance of biosecurity rules.

Consistency of process – Our actions will be consistent with the legislation and within our powers. Compliance and enforcement outcomes will be consistent and predictable for similar circumstances. We will ensure that our staff have the necessary skills and are appropriately trained, and that there are effective systems and policies in place to support them.

Fair, reasonable and proportional approach — We will apply regulatory interventions and actions appropriate for the situation. We will use our discretion justifiably and ensure our decisions are appropriate to the circumstances, and that our interventions and actions will be proportionate to the seriousness of the non-compliance and the risks posed to people and the environment.

**Evidence-based and informed** – We will use an evidence-based approach to our decision making. Our decisions will be informed by a range of sources, including robust science, regulated parties, information received from other regulators, community members, industry and interest groups.

Collaborative – We will work with and, where possible, share information with other regulators (e.g. Ministry for Primary Industries) and stakeholders to ensure the best compliance outcomes for our region. We will engage with the community, those we regulate and government to explain and promote biosecurity requirements and achieve better community outcomes.

Lawful, ethical and accountable – We will conduct ourselves lawfully and impartially and in accordance with these principles, relevant policies and guidance. We will document and take

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<sup>&</sup>lt;sup>2</sup> Hayes v Environment Waikato, District Court Manukau CIV-2009-057-000319, 21 March 2011.

<sup>&</sup>lt;sup>3</sup> These principles are adapted from the Compliance and Enforcement Special Interest Group (CESIG) Regional Sector Strategic Compliance Framework 2019-2024.

#### **Biosecurity Compliance and Enforcement Policy**

responsibility for our decisions and actions. We will measure and report on our regulatory performance.

**Targeted** – We will focus on the most important issues and problems to achieve the best biosecurity outcomes. We will target our regulatory intervention at non-compliances that pose the greatest risk to biosecurity. We will apply the right tool for the right problem at the right time.

Responsive and effective – We will consider all alleged non-compliances to determine the necessary interventions and actions to minimise impacts on the community and maximise deterrence. We will respond in an effective and timely manner in accordance with legislative and organisational obligations.

# 43. METHODS TO ACHIEVE COMPLIANCE

The ORC has a 'spectrum' approach to encouraging positive behaviour change and ensuring the highest levels of compliance possible. The ORC's approach to ensuring compliance with the RPMP is based on '4Es model'<sup>4</sup> of Enable, Engage, Educate and Enforce:

- **Enable** provide opportunities for occupiers and landowners to be exposed to best practice and regulatory requirements. Link regulated parties with appropriate pest management industry.
- Engage consult with occupiers and landowners, stakeholders and community on matters that may affect them. This will require maintaining relationships and communication until final outcomes are reached. This will facilitate greater understanding of challenges and constraints, engender support and identify opportunities to work with others.
- Educate alert occupiers and landowners to what is required to be compliant and where the
  onus lies to be compliant. Education should also be utilised to inform community and
  stakeholders about what regulations are in place around them, so that they will better
  understand what is compliant and what is not.
- Enforce when non-compliance is identified then enforcement tools and actions are available
  to ensure the RPMP intentions are achieved. Enforcement outcomes should be proportional to
  individual circumstances of the breach and culpability of the party.

When non-compliance with the RPMP is observed, ORC will inform the occupiers and landowners of the work required. This proactive approach is to encourage compliance, however, the ActBSA is a robust law that provides for significant enforcement action should non-compliance be persistent. ORC's approach and use of enforcement actions depends on the issue, context and seriousness of the breach as illustrated below<sup>5</sup>:

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<sup>&</sup>lt;sup>4</sup> The 4Es model is adapted from the CESIG Regional Sector Strategic Compliance Framework 2019-2024.

<sup>&</sup>lt;sup>5</sup> Influencing behaviour change is based on the CESIG Regional Sector Strategic Compliance Framework.

# **Biosecurity Compliance and Enforcement Policy**

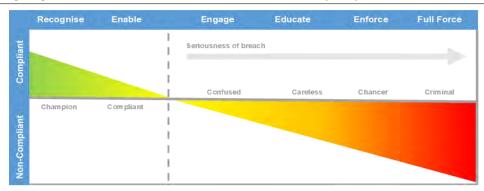


Figure 1: Enforcement Progression

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# 54. THE COMPLIANCE AND ENFORCEMENT PROCESS

The Chief Executive Officer of the ORC, acting as Principal Officer under the Act, has the authority to appoint authorised persons for the purposesissue staff with warrants of exercising the functions, powers and duties under the Act. An authorised person (sometimes referred to as a 'warranted' authority. A warranted enforcement officer) is permitted to enter private property (excluding a house or marae) for the purpose of assessing compliance with the ActBSA and RPMP. Authorised persons Warranted staff receive specific training and are familiar with their statutory obligations before carrying out any enforcement functions.<sup>6</sup>

The initial phase of the compliance and enforcement is to undertake an inspection. Inspections can be scheduled, in response to a complaint, or based on professional observation. When inspecting a private property, the rights of the occupier and landowner will be respected. ORC staff must ensure that all entry to private property is done so lawfully. However, <u>under the Act</u> inspections can be undertaken without providing prior notice to the occupier or landowner.

If the occurrence or density of pest infestation exceeds the rules as set out in the RPMP, then compliance and enforcement action will be implemented to ensure compliance with the RPMP rules. If a property is deemed to be non-compliant, occupiers and landowners will have a given timeframe to undertake the required work before a re-inspection is carried out. A re-inspection is undertaken to ascertain whether compliance with the rules of the RPMP rules has been achieved and to determine if any further actions are required. Re-inspections can occur throughout the compliance and enforcement process until compliance is achieved.

#### **Informal and Formal Actions**

The options for enforcement action will depend on the pest species in question and the individual circumstances of each case. Informal actions (not covered in the Act) to encourage compliance include verbal and written advice. Formal actions are available by law through the enforcement mechanisms prescribed in the <a href="ActBSA">ActBSA</a>. The administrative approaches taken with respect to compliance and enforcement will follow the standard operating practices detailed in the ORC Biosecurity Compliance <a href="Operating Procedures.">Operating Procedures.</a>. The Administrative approaches taken with respect to compliance Operating Procedures.

In brief, the compliance and enforcement options that follow a non-compliant inspection are:

- Informal Actions are focused on providing education and incentive-based responses to allow the occupier or landowner to become better informed and develop their own means to achieve compliance. Informal actions will be detailed through a 'Work Request'Request for Work' letter.
- 2. **Formal Actions** are forward-looking to provide clear direction of action required to ensure compliance. Formal actions will be detailed through:

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<sup>&</sup>lt;sup>6</sup>-Warranted ORC <u>authorised persons</u>-staff gather data and information in keeping with best practice detailed in *Basic Investigative Skills for Local Government*.

<sup>&</sup>lt;sup>7</sup> The ORC Biosecurity Compliance Operating Procedures action this Policy and are contained in a comprehensive set of guidelines and manuals. The Procedures build upon, and implement, the 'Eight Principles of Compliance and Enforcement' outlined in this Policy. They are reviewed and updated regularly to incorporate ongoing business improvement, changes in technology, and system enhancement within Biosecurity operations.

# **Biosecurity Compliance and Enforcement Policy**

- a. Legal notices (e.g., Notice of Direction), followed by, if needed,
- b. Default action or Prosecution.

Figure 2 shows the progression of compliance and enforcement, while Table 1 describes the compliance and enforcement actions in more detail. With respect to legal enforcement, while prosecution remains an option, the most common action will be default action.

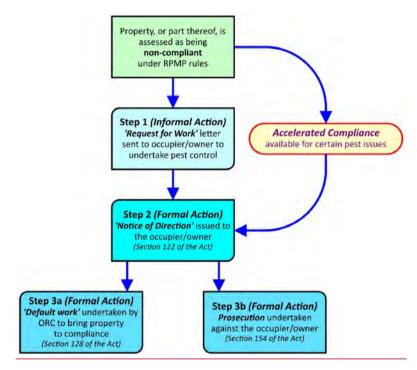


Figure 2: Sequence of primary actions for compliance and enforcement under the Act.

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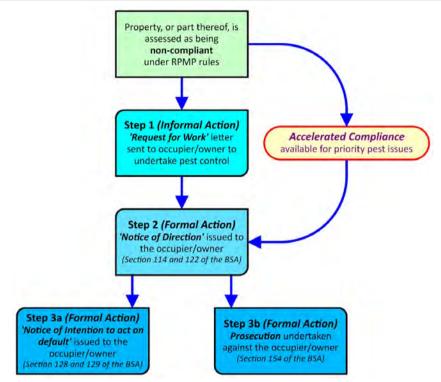


Figure 2: Sequence of primary actions for compliance and enforcement under the BSA

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Table 1: Description of Compliance and Enforcement Actions

		Description of action	Potential impacts for the	When this action is
			liable party	appropriate
	<u>-</u> i u		Work Request	
ľ		Request for Work Letter		A work request
		Following an initial inspection, a work request this letter alerts occupiers and/or landowners to the pest issue, the rulesproviding an opening for dialogue and their responsibilities under the RPMP, negotiation on timeframes and gives them a timeframe to achieve compliance without formal enforcement expectations.  A work request This letter provides the opportunity to proactively prevent further spread, to remedy, or to mitigate the effects of noncompliance.  Biosecurity Officers The Council can provide guidance around rules, and regulations, and pest management options to or help parties to achieve compliance.  If needed, a reminder letter can also be issued to ensure the request for work is progressing as required.	and as such has no legal implication. However, it does start the path towards possible formal action if the work request for work—is not completed as required.	This letter is issuedprovided after the initial inspection when a property is deemed non-compliant. <sup>8</sup> This is normally the extent of the action required when dealing with cooperative parties who are motivated to do the right thing but lack the knowledge or skills necessary to achieve and maintain compliance.
			Notice of direction (NOD)	

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<sup>&</sup>lt;sup>8</sup> A <u>Work Requestrequest for work letter</u> does not apply if the non-compliance is being dealt to through the accelerated compliance pathway (see Section 5).

# **Biosecurity Compliance and Enforcement Policy**

	Description of action	Potential impacts for the liable party	When this action is appropriate
-, =		Work Request	
	Notice of direction (NOD)		
nal actions	Under the ActBSA, an authorised person has the power to give directions to control pests. This is enacted though a Notice of Direction (NOD). A NOD is the first level of formal enforcement action under the ActBSA. Once issued, a NOD can be extended, varied or cancelled depending on circumstances and actions taken.	A NOD requires a person to take action to address plant and animal pest problems that breach a rule in an RPMP. The NOD is the formal acknowledgement of noncompliance. Non-compliance with a NOD is an offence under the Act and can lead to further enforcement actions, such as default work or prosecution.	A NOD may beis issued:  1. [1] When there has been no (or ineffective) action to rectify a state of noncompliance has not been achieved following informal actions; or  2. [2] After the initial inspection where a priority pest issue needs to be addressed using the accelerated compliance process as described in Section 5 of this policy.
Formal actions <del>(cont.)</del>	to cease doing something or pro	This is legally enforceable action and requires the occupier/landowner to provide access for the work as directed, arranged and costed by the ORC. The action to undertake default work does not need court approval.  All costs will be charged to the occupier/landowners. Non-payment of costs canwill lead to a statutory land charge	mething, doing something again,

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	Description of action	Potential impacts for the liable party	When this action is appropriate
		<u>Prosecution</u>	
Formal actions, cont.	Prosecution  A prosecution is a process followed through the criminal courts to establish guilt or innocence and, if appropriate, the court will impose sanctions.  Biosecurity ActBSA matters are heard by a District Court Judge. All evidential rules and standards must be met forin a BSA prosecution under the Act.	generally result in a conviction, a penalty imposed (imprisonment and/or fines as specified in the Act), and consideration to costs of the investigation.  A prosecution forms part of the history of non-compliance and will be considered if there	AProsecution may be pursued following non-compliance with an enforcement document (e.g., a NOD). However, under ORC standard operating procedures prosecution is pursued onlymay be considered appropriate when the factors listed in exceptional casesSection 6 of this policy indicate that are deemedthe matter is sufficiently serious to warrant intervention by -criminal law.

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# **Additional Compliance PowersEnforcement**

Other compliance powers include: There are two further formal enforcement options available:

- Declaration of a restricted place: The ActBSA provides the ability to issue a Restricted Place
  Notice to prevent the removal or introduction of any organism or good to any place, and may
  direct that specified organisms and goods be isolated, confined or stored and identified. A
  Restricted Place Notice is useful and relevant for RPMP work where, for example, the
  movement of gravel from a place containing pests to a non-infested place needs to be stopped
  to avoid the pests spreading.
- **Declaration of a controlled area:** The <u>ActBSA</u> provides the ability to publicly declare a specified area to be controlled. The notice may restrict, regulate or prohibit the movement into, within, or from the controlled area of specified organisms, organic material, risk goods or other goods and/or require the goods be treated or subject to specified processes. While this enforcement power exists for regional councils, it has limited relevance for RPMP compliance.
- Compliance Order: Under the Act, an authorised person may serve a compliance order requiring an individual or legal entity to cease doing something or prohibit the person from starting something, doing something again, or having something done that will contravene biosecurity law. Non-compliance with a compliance order is an offence under the Act and can lead to further enforcement actions. A compliance order is an alternative to the Notice of Direction. While it is available as an enforcement option, the ORC uses the Notice of Direction as its standard enforcement document.

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#### 5. ACCELERATED COMPLIANCE PROCESS

When there is need to respond to a <a href="https://misksignificant">high-risksignificant</a> pest management issue (e.g. rapid increase in wallaby sightings accompanied by landowner apathy, or to curtail the increase in a priority pest, such as rabbits), this policy provides for the compliance process to be accelerated. An accelerated compliance process means that if a property is deemed to be non-compliant following a first inspection, the <a href="https://www.orchor.org/nc.gov/

Accelerated compliance <u>may be appliedwill apply</u> to priority pests (as identified in the current Biosecurity Operational Plan), <u>high-risk situations</u>, and to any current or potential exclusion programmes. An accelerated compliance process prioritises the risk to environmental, economic and landscape values, <u>including supporting control efforts of others</u>, while being mindful of the increased operational requirements.

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# 6. ENFORCEMENT DECISION

The ORC takes a rational and principled approach to regulation. In general, the ORC advocates a policy of education and co-operation towards compliance. However, the ORC recognises that there are times when the use of <u>formal enforcementpunitive</u> measures is necessary.

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The process for taking enforcement action against biosecurity non-compliance is clearly laid out in the <u>ActBSA</u>. The <u>ActBSA</u> provides a robust enforcement framework, with only one known case filed.<sup>9</sup> This decision was in favour of the regional council in question as they had shown good process, provided accurate documentation, taken relevant photographs, and kept good, clear records.

<u>Factors considered in While the BSA maybe viewed as being less visible than the Resource Management Act, it could lead to greater penalties for those who are persistently non-compliant.</u>

Some factors to take into account when considering enforcement <u>decision-making</u> processesaction:

- What were, or are, the actual adverse effects on the environment?
- What were, or are, the potential adverse effects on the environment?
- What is the value or sensitivity of the environment or area affected?
- Is the non-compliance a result of deliberate, negligent, or careless action?
- What degree of due care was taken and how foreseeable was the non-compliance?
- Was there a failure to act on prior instructions, advice or notice?
- What efforts have been made to achieve compliance?
- What has been the effectiveness of those efforts?
- Is this persistent non-compliance or has there been previous enforcement action taken against the landowner or occupier?
- Is the non-compliance manifestly different to other observations of non-compliance?
- Are there any extenuating factors that has led to the non-compliance?

The factors leading to an enforcement decision <u>are will be</u> context dependent as each non-compliance situation is will be unique, including:

- > Alignment with biosecurity priorities
- Impact on environment and areas of high biodiversity
- Extent of infestation (grade and area)
- Change in infestation grading between inspections
- Impact on neighbour/community control activity
- > Equity (consistent, equity of enforcement in the neighbourhood and across region)
- —Individual <u>circumstance</u> (<u>personal/property specific</u>)
- Past/present/planned control activity

Hayes v Environment Walkato, District Court Manukau CIV-2009-057-000319, 21 March 2011.	
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# Officer comments & recommendations

Other external circumstances (e.g., flooding, drought, lockdown) will also be considered to achieve a fair and reasonable outcome.

The <u>responsibility and</u> discretion to take <u>compliance and</u> enforcement action, or not, sits solely with those delegated to make <u>such</u> decisions in the regulatory agency<sup>10</sup>. <u>Decision-making processes are standardised and robust to ensure equitable and consistent implementation</u>. These decisions include:

- The appropriate partydefendant to pursue;
- The appropriate enforcement tools to use in the circumstances; and
- Whether to extend, vary or withdraw an enforcement action that has been commenced.

ORC is required to exercise this discretion in a way that is reasonable and consistent with the principles of the ActBSA and the requirements of natural justice.

Where The prosecution is being considered, the ORC will follow the test:

The Solicitor\_General's Prosecution Guidelines, including provides direction on what factors should be considered before a decision to prosecute is made. The first part of the test is the evidential test for prosecution and requires a legal assessment of whether:

- The evidence relates to an identifiable person (whether natural or legal).
- The evidence is credible.
- The Council can produce the evidence before the court, and whether it is likely it will be admitted by the court.
- The evidence can reasonably be expected to satisfy an impartial jury (or judge), beyond a reasonable doubt, that the individual has committed a criminal offence; the individual has given any explanations and, if so, whether the court is likely to find the explanations credible in the light of the evidence as a whole.
- There is any other evidence the Council should seek out which may support or detract from the case.

Once it has been established that there is sufficient evidence to provide a reasonable prospect of conviction, the test for prosecution requires a consideration of whether the public interest tests requires a criminal prosecution. Prosecution is required if it is in the interest of the public, with the predominant consideration being the seriousness of the offence — the Public Interest Test.

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<sup>&</sup>lt;sup>10</sup> New Zealand Law Commission 'Prosecution decisions and the discretion to prosecute' http://www.nzlii.org/nz/other/nzlc/report/R66/R66-5.html

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#### COST RECOVERY

The <u>ActBSA</u> gives ORC the power to recover the costs associated with its compliance monitoring obligations. This is provided for under section 135(3) and section 129 of the <u>ActBSA</u>. In Otago, charges <u>aredo</u> not currently <u>applied apply</u> to informal actions, such as a scheduled inspection or a re-inspection when the property has become compliant.

# **Recovery of Non-Compliance Costs**

Councils, as management authorities, have the statutory right to use a variety of charges to recover costs incurred in administrating the RPMP. This can include fixed charges for issuing notices, hourly rates, estimates of advanced work and reasonable costs. Fees and charges that may be recovered are listed in the current Long-Term Plan or Annual Plan and are reviewed annually. In setting its cost recovery model, ORC is conscious that costs associated with monitoring should fall onto those resource users who are subject to monitoring, as opposed to the general ratepayer. For any prosecutions, ORC reserves the right to seek recovery of allowable legal costs.

# **Recovery of Default Work Costs**

<u>Under the Act, the The actual</u> and reasonable cost of default work <u>can</u> is to be recovered by the <u>ORC as a debt due.Regional Council.</u> This is normally done through an invoice. <u>Failure to pay can result in compounding interest being added to the debt, and ultimately a lien can However, when this is not paid, a statutory land charge may be <u>placeplaced</u> on <u>the property that prevents owners dealing with the title to their to recover the costs of default work. This means the costs incurred will be paid if the property <u>until the debt associated with the lien has been resolved.</u></u></u>

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Policy owner	Manager,	Environmental Imple	mentation
Superseded Version #	1.0	9 June 2021	Initial policy
Proposed Version #	2.0	8 May 2024	Reviewed and updated for consistency and clarity

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<u>Cover Photo:</u> Australian Young Mine Water wheel Carrick Range, Bannockburn (Credit: Gary Smith) is sold or re-financed.

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