

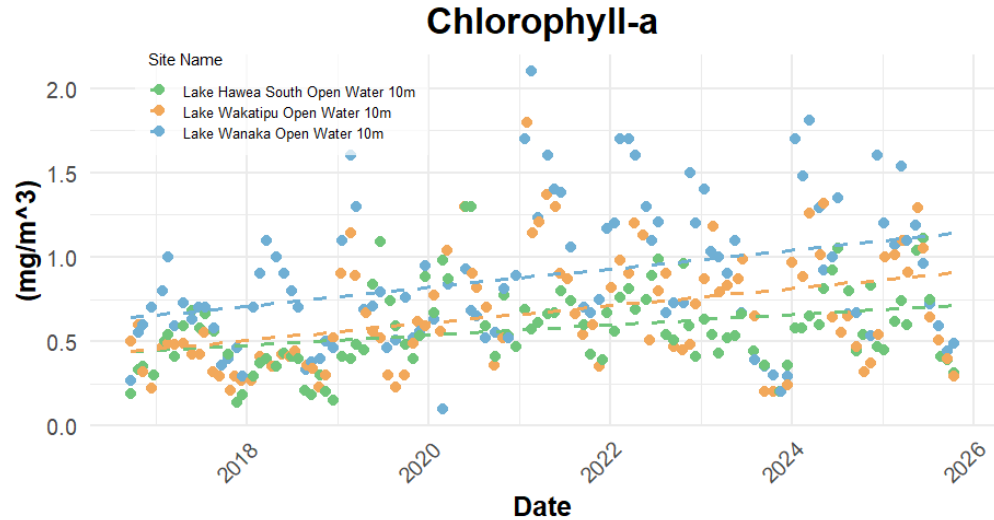


Otago Deep Water Lakes Research and Monitoring Proposal

Otago Deep Water Lakes Technical Advisory Group
Council Workshop – 10th June 2026

Background

- Concerns about lake health from community, galvanised by chlorophyll-a trends
 - [2022 WAI Wānaka summary report](#)
- PCE wrote to ORC in 2022 enquiring about lake management
 - [2022 PCE Letter](#)
- In response, ORC supported creation of a multi-agency Technical Advisory Group (TAG)
 - [2022 ORC Response](#)
- TAG programme is supplementary to existing science, monitoring, compliance, catchment, and policy work undertaken in Upper Lakes area.



Purpose and Structure

Reports to Otago Deep Water Lakes Management Working Group with wide representation

- Councillors, mana whenua, WAI Wānaka, DoC, MfE, ORC CE

Defined Terms of Reference:

- Otago's three deep lakes
- Identify key research questions
- Develop a coordinated research programme to inform evidence based management

Parallels with Bay of Plenty and Waikato Regional Council supported lake programmes



TAG Membership

Currently 16 members:

- ORC Science staff, University of Otago and Waikato, Earth Sciences NZ, Bioeconomy Science Institute, DoC, MfE, Wai Wānaka, consultants, Env. Southland

Broad mix of technical backgrounds in lake science, ecology, land use, hydrodynamics, economics, water quality, catchment processes, modelling, decision making science and stakeholder engagement



Progress to Date

- TAG formed in April 2024
- ~Monthly online meetings, with two in-person workshops

Two reports to Council

- Information review and knowledge gaps (Dec 2024)
 - [Environmental Science and Policy Committee, page 90](#)
- Potential research proposals (June 2025)
 - [Science and Resilience Committee, page 8](#)



Review and Gap Analysis

- The TAG reviewed existing monitoring, research, datasets, models and local knowledge to assess whether the current evidence base was sufficient for long-term lake management

The review identified five major themes where additional knowledge is needed to support proactive lake management.



1 BUDGETS & PHYSICAL PROCESSES

Understand how water, nutrients, carbon and other key elements move and cycle within the lakes and catchments.



2 FOOD WEBS & ECOLOGICAL PROCESSES

Understand how ecosystems function and how they respond to natural and human-induced changes.



3 HISTORIC & FUTURE TRAJECTORIES

Understand past conditions, current trends and future scenarios to inform resilience, risks and long-term outcomes.



4 LAKE MANAGEMENT & COMMUNITY ENGAGEMENT

Support informed decision-making through science and strengthen community understanding and involvement.



5 MĀTAURAKA MĀORI

Integrate mātauranga Māori and cultural values to support holistic, inclusive and enduring lake management.

Review and Gap Analysis

WHAT WE KNOW vs WHAT WE NEED TO KNOW

We have good information on lake condition,
but limited understanding of how and why it changes.

WHAT WE KNOW (Above the surface)

- ✓ Water quality trends
- ✓ Chlorophyll-a trends
- ✓ Monitoring datasets
- ✓ Lake condition

WHAT WE NEED TO KNOW (Below the surface)

- ? Nutrient pathways
- ? Hydrodynamics and mixing processes
- ? Food web interactions
- ? Climate change responses
- ? Future trajectories
- ? Ecological thresholds and tipping points



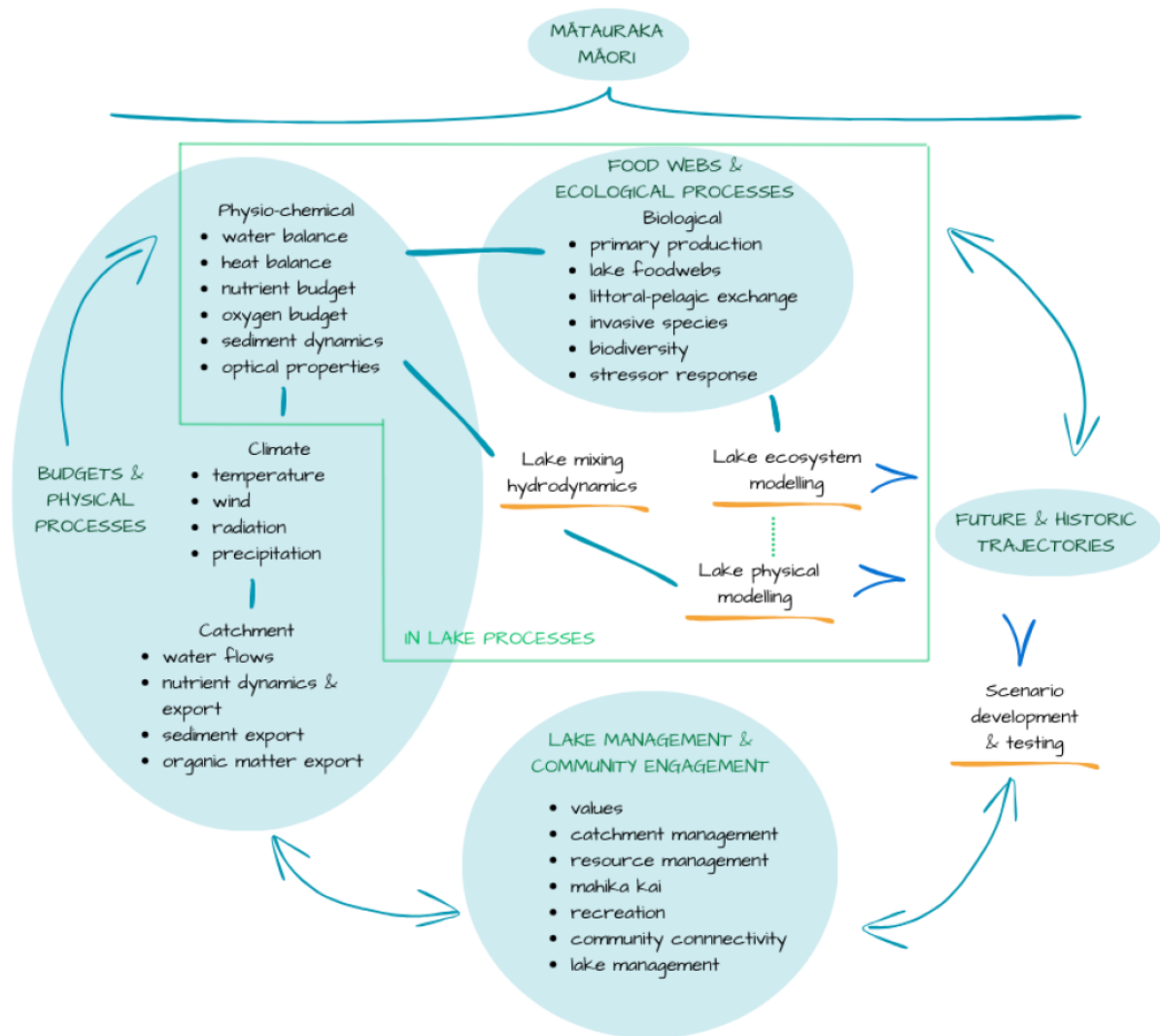
Monitoring tells us what is changing.
Research is needed to understand why.

Review and Gap Analysis

- Key questions that emerged from the review:



How the knowledge gaps are interconnected



Proposal Development

- Three proposals developed to address recognised knowledge gaps
- Proposals ranging from \$2m to \$20m over ~10 year period
- Different levels of understanding at different investment levels

All proposals assume that ORC continues with the existing level of monitoring, and the costed investment would be in addition to current lake monitoring and science programmes



Proposal 1 –Substantial knowledge acquisition

(\$20 Million over 10 years)

Enables proactive evidence-based management through

- focussing on collecting data to inform modelling & minimizing uncertainty
- generating high level of understanding of all three lakes (Wānaka, Whakatipu, Hāwea)

It entails:

- Significant increase in monitoring of lakes and inflowing rivers
- Intensive study of food webs and ecological processes
- Comprehensive lakes history plus detailed history of catchment land use

Some limitations:

- Ambitious to fully link food webs and physical modelling - assumptions will be used to integrate biology into the models

Proposal 2 –Moderate knowledge acquisition (\$7-12 Million over 10 years)

Provides evidence base for management with higher uncertainty than Proposal 1 by

- Reducing extent/number of monitored parameters

AND/OR

- Focussing on only one or two lakes

It entails:

- Using modelled climate data rather than field measurements
- Using understanding from one lake or catchment to apply it to another
- Assuming Otago's deep lakes function like other studied deep lakes

Some limitations

- Unlikely to investigate drivers of productivity and food webs of all three lakes

Proposal 3 –Incremental knowledge acquisition

(\$2.5 Million over 10 years)

Informs reactive lake management through

- Relying on expert judgement and/or literature reviews to build knowledge (compared to locally collected data)
- Identifying trends rather than predicting lake response to catchment and climatic changes

It entails:




- Some additional monitoring to ORC's existing programme
- One-off studies and analysing pre-existing datasets

Some limitations:


- Not possible to get comprehensive understanding of physical and ecological processes
- Restricted ability to predict changes in water quality in context of climate and land use changes

COMPARING THE THREE RESEARCH PROPOSALS

Different levels of investment lead to different levels of knowledge, confidence and risk.

 PROPOSAL 1 COMPREHENSIVE PROGRAMME HIGHEST INVESTMENT	 PROPOSAL 2 MODERATE PROGRAMME MODERATE INVESTMENT	 PROPOSAL 3 INCREMENTAL PROGRAMME LOWEST INVESTMENT
<p>✓ ADVANTAGES</p> <ul style="list-style-type: none"> ✓ Addresses all five knowledge-gap themes ✓ Provides whole-of-system understanding ✓ Investigates lake function, resilience and future trajectories ✓ Supports climate change scenario testing ✓ Improves ability to detect early warning signs ✓ Highest confidence for future management decisions ✓ Reduces long-term uncertainty and risk 	<p>✓ ADVANTAGES</p> <ul style="list-style-type: none"> ✓ Investigates some important drivers of change ✓ Lower cost than Proposal 1 ✓ Provides targeted improvements in understanding ✓ May improve some management decisions 	<p>✓ ADVANTAGES</p> <ul style="list-style-type: none"> ✓ Lowest cost ✓ Builds on existing monitoring programme ✓ Maintains long-term datasets ✓ Provides some trend information
<p>! LIMITATIONS</p> <ul style="list-style-type: none"> • Highest upfront investment • Longer programme duration • More complex programme management 	<p>! LIMITATIONS</p> <ul style="list-style-type: none"> • Does not address all knowledge gaps • Reduced understanding of lake-wide processes • Limited ability to understand future trajectories • Some critical uncertainties remain unresolved • May require additional future investment to answer remaining questions 	<p>! LIMITATIONS</p> <ul style="list-style-type: none"> • Limited ability to answer the major TAG questions • Little improvement in understanding lake function • Does not adequately address key knowledge gaps • Remains largely reliant on existing monitoring approaches • High uncertainty remains • Greater risk of missing emerging issues or delayed responses • May result in reactive rather than proactive management
<p>OVERALL ASSESSMENT MOST ROBUST AND LOWEST-RISK OPTION</p> <p>Provides the strongest scientific foundation for managing the lakes over coming decades.</p>	<p>OVERALL ASSESSMENT IMPROVES KNOWLEDGE BUT LEAVES IMPORTANT GAPS</p> <p>Advances understanding, but may not provide sufficient information to confidently manage future pressures such as climate change and catchment development.</p>	<p>OVERALL ASSESSMENT MAINTAINS FOUNDATIONAL MONITORING BUT LEAVES MAJOR GAPS</p> <p>Supports ongoing monitoring and some trend information, but is unlikely to substantially improve our ability to understand, predict or manage future changes in the lakes.</p>



 Proposal 1 requires the greatest investment, but it also provides the highest confidence and lowest long-term risk.
 Proposal 3 is the cheapest option, but leaves most of the key questions identified by the TAG unresolved.

Vote to pursue \$20m research into lakes

■ HAMISH MACLEAN

FIND the money now or face “astronomically expensive restoration efforts” for Otago’s deepwater lakes later, a regional councillor says.

Cr Alexa Forbes, of Queenstown, said the Otago deep water lakes technical advisory group had clearly shown that research to support “proactive management” was far more cost-effective than remediation after degradation was evident.

Voting in favour of the most ambitious research proposal in front of Otago regional councillors was a “no-brainer”, Cr Forbes said yesterday.

And councillors subsequently did vote unanimously in favour of pursuing an up to \$20 million, 10-year monitoring and research effort for Lakes Wakatipu, Wānaka and Hāwea.

Cr Forbes praised the decades-long campaigning by University of Otago fresh water scientist Associate Prof Mare Schallenberg and Guardians of Lake Wānaka president Don Robertson, who she said had both been raising the issue of the lakes’ health “for a long, long time”.

Now, degradation of the lakes was “impossible to ignore”, Cr Forbes said.

“We’ve got multiple interconnected environmental stressors with long-term consequences for biodiversity, for our economies, for our water quality, for our environmental health and for how we live among these lakes,” she said.

“We can’t move forward without evidence.

“We can’t not afford it.

“The report makes the case for strategic research that can prevent astronomically expensive restoration efforts.”

The technical advisory group’s report to the Otago Regional Council’s science and resilience committee yesterday said recent test results had highlighted “concerning patterns and the limitations of the existing monitoring programme”.

Monitoring by the council showed algal biomass in the

lakes had doubled in the past nine years.

Invasive zooplanktonic and phytoplanktonic species had gained a foothold.

And climate change signals had been observed in the region.

However, it was “not clear exactly” why or how this was happening, because the monitoring programme now in place was not able to identify the “stressor-response relationships” at play, which limited its usefulness, the group’s report said.

Cr Elliot Weir said the \$20m price tag for the work was “dwarfed by the economic and social and cultural and aesthetic benefits that those lakes bring”.

“Let’s set this direction today,” they said.

“We do want to take care of these lakes and we’ll invest quite heavily, if necessary, to fill those big knowledge gaps to do so.”

Council chairwoman Cr Gretchen Robertson said other organisations needed to get involved in the work.

“We can’t be the only organisation in this space.”

“And actually, we can’t afford \$20m.

“But this is extremely important.

“These lakes, as Cr Weir has just outlined, are incredibly valued, not just in Otago, but nationally.

“They bring a huge amount to our country in terms of values Kiwis put on them — also international visitors.

“We can’t have them deteriorating.

“Other lakes have got huge investment and research programmes that have been put into them once they’ve got to the point where they’ve deteriorated — we don’t want to have that happening here.”

At the councillors’ request the technical advisory group will now develop a more detailed research and monitoring plan at the \$20m funding level.

The group has also been asked to identify “funding opportunities” apart from the council to pay for the work.

hamish.maclean@odt.co.nz



Stressed out . . . Otago’s deepwater lakes (clockwise from top) Hāwea, Wakatipu and Wānaka need management now rather than “astronomically expensive” restoration later, Otago regional councillors have been told.

Proposal Development

- Three proposals presented to Council in June 2025
- Council requested further work on a proposal at the \$20m level

Final Proposal

- TAG reporting back to Council in July 2026
- Currently refining a comprehensive ~10-year research and monitoring plan
- If Council agrees to proceed, will require formal consultation process for funding
- Full programme implementation will likely require co-funding beyond ORC



Five Focus Areas

Refined from earlier reports

- Lake budgets
- Fundamental physical and ecological lake processes
- Catchment history and future scenarios
- Mātauraka Māori
- Decision support and community engagement



Lake Budgets

What: Quantifying the input, output and internal behaviour of key physical and chemical components of the lake system, including water, heat, oxygen, nutrients and sediment.

How: Expanded monitoring of stream inflows (incl. high flow), rainfall, in-lake measurements. Measuring atmospheric deposition, climate stations, direct lake bed measurements

Why: Critical for understanding lake behaviour, lake and catchment connection, lake response to stressors, and scenario testing.

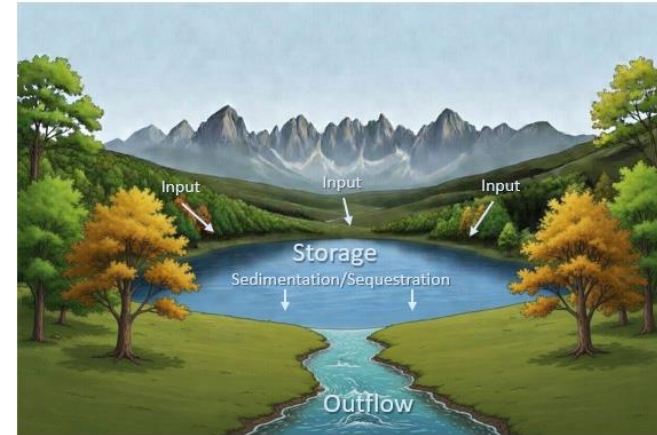
Equation for a simple lake nutrient budget (e.g., in tonnes) calculated between two points in time

$$\text{Change in lake nutrients} = \text{inputs} - \text{outputs} - \text{sequestration} \quad (3)$$

Nutrients in river and groundwater inflows + wet and dry atmospheric deposition + release from sediments + fixation from atmosphere

Nutrients flowing out of the lake outlet

Nutrients lost to lake bed via sedimentation

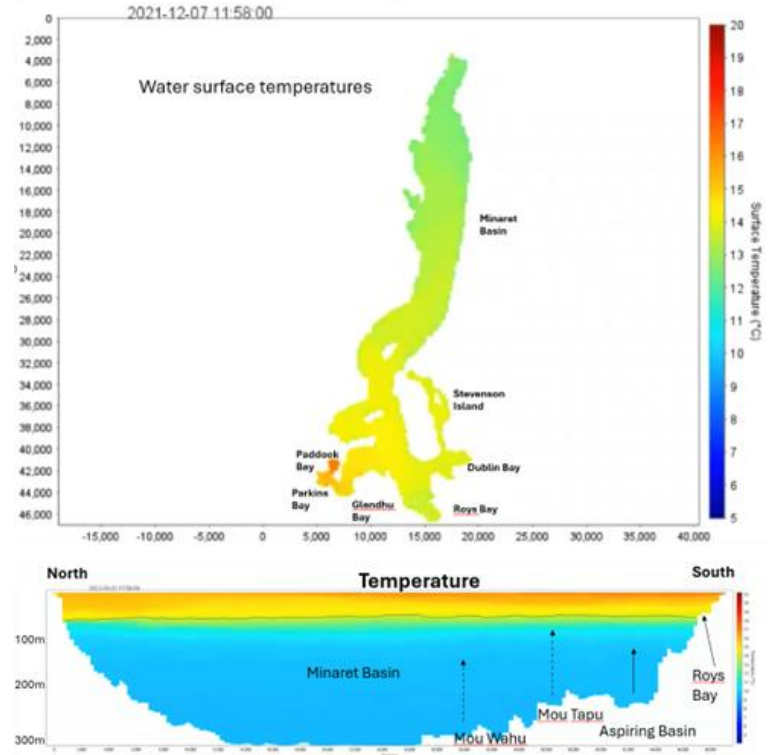


Physics and Water Chemistry

What: Targeted physical measurements, development of three-dimensional hydrodynamic models, and water quality modelling

How: Water column profile measurements, moored instruments for currents. Develop 3-D hydrodynamic models for lake mixing, stratification

Why: Assess connectivity within lakes, transport paths, required for land/climate scenario testing, biosecurity risk assessments



Example model for Lake Wanaka - ESNZ

Ecology, Productivity, Foodwebs

What: Workstream to understand ecological processes, foodwebs, nutrient bioavailability, biomass hotspots, and identify ecological tipping points

How: Targeted research studies on key ecological processes and relationships, development of methods to analyse algae/nutrient relationships, isotope tracing, biomass surveys, assessing ecological changes from current and future invasive species (e.g., lake snow, weeds)

Why: Key lake values (clarity, algae blooms, fish stocks) governed by ecological processes, predicting minimising/impact of invasives, understand lake ecological response to stress (e.g., nutrients/climate change)



Submerged plant surveys





Catchment History and Future

What: Reconstructing how the lakes have changed over time (~1,000 yr), quantifying the effects of changes in land use and land cover, and developing potential future climate and land use development scenarios

How: Analysis of sediment cores from lake bed, reconstructing catchment land use change from historic records. Input climate and development scenarios into lake hydrodynamic and water quality models

Why: Place current lake conditions and trends in context, establish historic catchment nutrient load, quantify time lags, predict effect of plausible future scenarios



Mātauraka Māori

What: Understanding rich source of mana whenua knowledge and observations of lake history, behaviour, species, and Mahika kai. Importance of migratory eels and effects of dams.

How: Collating existing mātauraka Māori for the area to the extent and in a format agreeable to mana whenua. Developing a cultural monitoring programme to complement the technical workstreams.

Why: Mātauraka Māori remains a critical knowledge gap that can increase understanding for how lakes have changed over centuries and puts emerging lake conditions into context. Disruption to eel migration having an unknown effect on populations and lake conditions.

Knowledge Integration, Decision Support System and Community Engagement

What: Workstream to develop a Decision Support Framework (DSF) to support decision makers to implement programme outputs/findings. Public awareness of lake health/fragility and programme outputs.

How: DSF integrates diverse knowledge streams across the research programme into a decision-relevant whole – what does all this information mean – how to interpret it? Targeted programme reporting for local communities.

Why: Building an evidence-based integrated and adaptive approach to environmental governance rather than treating scientific disciplines, policy processes, cultural values and community perspectives separately. Increased community awareness builds understanding/support for future management challenges.

High-Level Programme Sequence

1. Monitoring the initial priority - augmented river, atmospheric and lake measurements enabling the creation of budgets for the lakes.
2. Budgets are used to develop 3D lake models which, paired with catchment nutrient and hydrological models, help understand lake dynamics and water quality.
3. Parallel workstream of monitoring and experiments focus on lake ecology and food webs.
4. Both the physical and ecological work will allow for scenario testing (e.g., how does the lake respond to a predicted environmental change?)
5. Provides the evidence base for decision making processes to enable suitable management regimes for the lakes and their catchments.

Based around consistent funding of ~\$2M/yr over ten years

Deep Lakes Research Timeline



	Year 1	Years 2-3	Years 4-7	Years 8-10
Monitoring / Budgets	Install priority flow, temperature and rainfall sites			
	Additional water quality sampling in rivers and lakes			
	In lake profiles and buoys			
	Climate station installs			
		Atmospheric Deposition monitoring		
		Benthic sampling		
		Event based water quality sampling		
Research and Analysis			Gapfilling Sampling	
	Hydrodynamics, catchment, and nutrient modelling commences			
	Nutrient Cycling, Foodwebs, and Energy Flow Research Projects			
		Historic Trajectories and coring		
				Climate change and Future land use scenarios
	Matauranga integration			
	Decision support Conceptualization			
		Model integration and Decision Support		

Year 1	Years 2-3	Years 4-7	Years 8-10
<ol style="list-style-type: none"> 1. Monitoring installs 2. Formalized conceptual model developed as part of Decision Support Framework 3. Commencement of nutrient cycling/energy flow Ph.D.s 	<ol style="list-style-type: none"> 1. Monitoring sites embedded/refined 2. Working model in Wanaka and model development in other lakes 2. Delivery of first Ph.D. projects 3. Commencement of coring work 	<ol style="list-style-type: none"> 1. Monitoring begins wind back 2. Delivery of operational catchment, lake and water quality models 3. Delivery of second set of Ph.D. projects 4. Conclusion of coring work and historic trajectories 5. Decision Support work commences 	<ol style="list-style-type: none"> 1. Models used for future climate and land use scenarios 2. Delivery of last set of Ph.D. projects 3. Full integration of biophysical information 4. Development of decision support framework to support management decisions
<p>Decisions would be based on current knowledge and formalized conceptual model with expert input.</p>	<p>Decisions would be made based on extrapolation of Wanaka model, earlying findings from foodwebs, and expert opinion</p>	<p>Decisions would be made based on an integrated knowledge base including lake specific models with scenario capability, completed food web studies, and an understanding of historic variation. Studies and models may have uncertainty which could be further reduced.</p>	<p>Decisions would supported by a lake specific studies integrated into a decision support framework which enables evaluating cross discipline (environmental, social, cultural, and economic) trade offs, identifies preferred options, and is underpinned by a robust and completed programme.</p>

Prioritising Informed Management

The proposed package of work aims to provide a sound, evidentiary basis to inform future lake management by:

- Substantially improve our understanding of the fundamental physical and biological processes in the lakes
- Placing the current state of the lakes within the context of their historical, natural ranges of variation
- Identifying when observed changes are of material concern for lake values
- Anticipating future lake responses to realistic changes in stressor levels due to climate, land use, and ecological disruption (e.g., invasive species)
- Enable early identification of risks to the lakes (e.g., the likelihood of the existence of ecological tipping points) where a rapid management response may be appropriate

Prioritising Informed Management

The type of management decisions the programme could inform include:

- Levels of catchment nutrient loads that could adversely affect the lakes
- Underpin controls on catchment land use or development to minimise risk to the lakes
- The best approaches to managing invasive species
- Appropriate adaptations to predicted changes in lake condition or behaviour (e.g., due to climate changes, delayed responses from existing stressors)

Next Steps

- Paper to Council in July seeking endorsement
- If supported, build into LTP consultation process
- Staff to continue to seek funding and support from potential programme partners such as Government agencies, Research Institutes, Universities and other organisations

Thanks to:

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