Microplastics in New Zealand urban ponds and effects on amphibians raised in ponds with microplastics

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Microplastics are increasingly being recognised to negatively impact many organism groups and to represent a serious threat to ecosystems. Nevertheless, research into the effects of microplastic pollution on amphibians, a globally important bioindicator group, is minimal, with most research undertaken in highly artificial laboratory settings, with mixed results. This study aimed to establish the extent of microplastic contamination of pond environments in New Zealand, and the consequences of this for amphibian metamorphosis, survival and body condition. A nation-wide survey of urban ponds across New Zealand revealed widespread microplastic contamination of the water and sediment fractions in these environments. We then conducted an outdoor field-realistic experiment using 42 outdoor pond mesocosms investigating the impact of microplastics on amphibians. Tadpoles of Rawlinsonia ewingii (Southern brown tree frog) were raised and monitored under different concentrations of secondary polyethylene microplastic fragments, followed by studying frogs that had metamorphosed from each of these treatments for five months. Results confirmed the tadpoles ingested microplastic fragments, and tadpole survival and metamorphosis rates declined with increasing microplastics concentration. Amphibians are a globally threatened group of organisms with a wide range of factors endangering their survival. Microplastics have emerged as a threat to ecosystems in the past few decades and our research helps address the impact of microplastics on amphibians by applying a real-world approach to studying this risk.

Instream sediments contribute to low flow concentrations of E. coli in rivers

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Swimming in the rivers and lakes of New Zealand is a valued recreational activity. Nevertheless, surface water quality across the country often exceeds current safe swimming guidelines for Escherichia coli concentrations. An important source of E. coli is diffuse runoff from agricultural land. Stores of E. coli within streambed sediments are recognised as a contributing source of elevated E. coli concentrations in water during high-flow events. There has been a growing suspicion that these sediment stores may also influence E. coli concentrations during base-flow conditions - when most swimming activity occurs. Conventional catchment modelling approaches, which do not consider instream sediment stores, predict that E. coli concentrations should decrease to zero after several days of low flow conditions (in the absence of direct inputs). However, in the absence of obvious direct inputs, measured concentrations do not go as low as predicted by the several models and never to zero.

In this study, over a three-year period beginning in October 2023, we sampled stream water and sediments fortnightly at 14 sites within a Palmerston North catchment. These data have shown that there is a strong correlation between the E. coli concentrations in the streambed sediments and in the water column across the catchment. We used a catchment model Soil-Water-Assessment-Tool (SWAT) to include the dynamics of E. coli stores in streambed sediments that could be resuspended during both base- and storm-flow conditions. Hydrology in SWAT was calibrated using 20-years of flow data from the catchment and farm management practices were based on typical pastoral grazed farm inputs. The SWAT model generated E. coli concentrations in faecal deposits, soils, and in surface runoff that were analogous to values in the published literature. We then calibrated the SWAT model with the fortnightly measured data from sample sites in the catchment. The inclusion of instream sediment stores of E. coli in SWAT was found to be necessary for matching the measured E. coli concentrations in water during base-flow conditions. Further modelling scenarios and streambed E. coli measurements will investigate the dynamics of E. coli in the streambed and how this interacts with the effectiveness of mitigation options required to achieve swimming water quality guidelines.

Periphyton Risk Assessment under the new National Wastewater Standards

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A Periphyton Risk Assessment (PRA) must now be included in any resource consent application to discharge treated wastewater to a hard-bottomed river, under the Water Services (Wastewater Environmental Performance Standards) Regulations 2025 ('WEPS'). The PRA must be prepared by a Suitably Qualified and Experienced Person (SQEP), then reviewed and certified by a second SQEP. The consent authority must also review the PRA as part of its decision on the consent application.
The WEPS require that an overall periphyton "risk category" (from low to very high) be determined, which classifies the risk of "excess periphyton establishment and growth"; however, these terms are not defined in either the WEPS or its associated guidance. Further, whilst some compulsory considerations are listed in the regulations, fundamental drivers and assessment tools of periphyton growth downstream of point-source discharges appear to be missing or misunderstood in both the regulations and the guidance.
Undertaking technical assessments under new legislation is always a tricky exercise as we lack established practice and methodologies. Having been directly involved in several of the first PRAs prepared under the WEPS, we will share our experience of how we (1) approached the definition of key terms, (2) structured our assessment, and (3) managed the review and certification process in different situations.
Excess periphyton and risk categories were defined by reference to specified numerical thresholds and expected exceedance frequency based on values and characteristics of the site. It is essential that these definitions are clarified and agreed with the reviewers before progressing to the PRA itself.
We suggest a structured approach to PRA, composed of two main components: (1) assessing the sensitivity of the receiving environment by considering key drivers and control factors of periphyton growth at the site, and (2) assessing the potential of a proposed discharge regime (quality, quantity and timing) to cause or contribute to excess periphyton.
In our view, the assessment approach, and its complexity and depth, must be consistent with the situation at hand. For example, a "first principles" qualitative approach is warranted in cases where a discharge is demonstrably not causing, or contributing to, excess periphyton and the future discharge will cause a qualitatively lesser periphyton risk. However, a more complex approach, which may require in-depth, site-specific predictive assessment, is warranted in situations where the discharge is currently causing excess periphyton and/or is proposed to change significantly in the future. We propose a flowchart approach to support decisions on potential methods and approaches in different situations.
Last, we will present how we managed the review and certification process, based on a stepped review at specified completion levels: 0% (methodology), 50% (preliminary outputs), 75% (draft outputs) and 95% (formal review and certification).

New Zealand agriculture – reframing dominant narratives and myths to reorient sustainable freshwater management

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In Aotearoa New Zealand's agricultural sector there exist a proliferation of narratives around farming, what it means, what makes good farming, and increasing productivity. These narratives perpetuate various myths about farming that can preclude change and lock in the status quo – particularly where it comes to improving environmental performance and freshwater quality. When this status quo is challenged, agricultural industry actors, including lobby groups, industry peak bodies, banks, government, and farmers themselves unleash various versions of these myths (for example, you can't be green if you aren't in the black), which then place the nexus of conflict between farmers, consumers, and communities, rather than the system itself that powerful actors with agricultural interests have perpetuated.

The paper looks at work undertaken within the 'Moving the Middle' programme, a social-science-led initiative centred on reframing narratives to support farmers to engage in more sustainable land management. We outline six dominant assemblages of narratives determined from a Q Sort exercise with 80 farmers, rural professionals, industry representatives, and policy makers. The Q Sort analysis helps reveal various tensions and myths that impede sustainable change, as well as showing various 'touchpoints' that can potentially encourage diverse small steps towards sustainable farming, improved freshwater management, and better farming futures. This work has informed the development of a serious game as a tool to help 'provoke' farmers to rethink and reframe the narratives, and to open space for dialogue about shifting the status quo of farming practices and impacts on vital shared resources such as freshwater.

Do SEV-based riparian offsets deliver the ecological gains predicted at consent? An empirical assessment across Auckland stream restoration sites.

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The Stream Ecological Valuation (SEV) framework is widely used in Aotearoa New Zealand to quantify ecological function and determine Environmental Compensation Ratios (ECRs) for riparian restoration associated with freshwater consenting. While SEV predictions underpin offset calculations and "no net loss" outcomes, there has been little empirical evaluation of whether predicted ecological gains are subsequently realised.

This study compared predicted and observed SEV scores for 13 riparian restoration reaches established as environmental offsets across the Auckland region between approximately 8 and 15 years ago. Sites represented farmland, urban and industrial catchments. Standard SEV field and desktop assessment protocols were applied, and observed SEV scores were compared with those predicted during the original consenting process. Differences (ΔSEV = observed − predicted) were analysed using non-parametric statistical tests.

Observed SEV scores were lower than predicted at every site assessed, with a mean ΔSEV of -0.140. The difference was statistically significant (Wilcoxon signed-rank test: $V = 0$, $p < 0.001$). Although farmland sites showed the largest average deficit and industrial sites the smallest, differences among land-use categories were not statistically significant. The greatest shortfalls occurred within habitat provision and biogeochemical functions, consistent with the time required for riparian vegetation to develop mature canopy structure. Field observations also identified incomplete or failed planting at several sites, indicating that implementation failure contributed to lower-than-predicted ecological outcomes.

The findings highlight opportunities to strengthen SEV-based offsetting by shifting from implementation-based to outcome-based consent conditions, which need to be supported by independent ecological verification, adaptive management where predicted outcomes are not achieved, and restoration designs that prioritise rapid recovery of key ecological functions such as riparian shading and habitat provision. These measures would improve confidence that offset programmes deliver the ecological gains needed to support freshwater management and no-net-loss objectives.

What to do and in what order: practical decision frameworks for on-the-ground restoration practice

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Restoration ecology has developed sophisticated frameworks for deciding where to restore, weighing spatial trade-offs across candidate sites with considerable analytical sophistication. Far less guidance exists for the equally pressing question practitioners face once a site is chosen: given several technically feasible methods and multiple co-occurring stressors, what should be done first? Existing prioritisation tools that address method selection tend to require GIS expertise, specialist software, or spatially resolved datasets that are rarely available to practitioners working with limited budgets and resources on the ground.

I argue that simple, transparent decision tools - specifically weighted decision matrices - offer a practical and underused bridge between complex prioritisation theory and everyday restoration practice. Drawing an explicit analogy with Maslow's hierarchy of needs, I propose that restoration methods should be sequenced according to an ecological hierarchy: foundational abiotic conditions (e.g. water quality) must be secured before higher-order interventions (e.g. biotic translocations, community-level restoration) can succeed. I then demonstrate how a weighted decision matrix (scoring candidate methods against criteria such as stressor relevance, cost-effectiveness, technical feasibility, persistence, and co-benefits) operationalises this hierarchy, using a hypothetical multi-stressor riparian case study. Critically, criterion weights shift as restoration progresses, embedding the matrix within an adaptive management cycle rather than a one-off decision.

Weighted decision matrices require no specialist software, GIS capacity, or large budgets, yet they make trade-offs explicit, support stakeholder dialogue, and generate a transparent, revisable record of decision logic, directly addressing the persistent gap between restoration science and practice and offering a low-barrier tool that practitioners can adopt immediately.

Why are our lakes getting greener? The hidden clues in plankton communities and nutrient fractions

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Chlorophyll a is widely used as an indicator of algal biomass in lake monitoring programmes. Across Canterbury, long-term monitoring shows chlorophyll concentrations have increased in many high-country lakes over the past two decades. While some of these increases coincide with rising nutrient concentrations, others occur without corresponding changes in routinely monitored nutrients, raising questions about the processes driving these trends.

Long-term records of phytoplankton and zooplankton community composition, and nutrient fractions such as dissolved organic nitrogen and phosphorus, have not traditionally been included in routine lake monitoring. However, we have measured these parameters in several representative high-country lakes over the past decade, providing a more complete picture of lake ecology and nutrient dynamics.

In this presentation, we use these intensive monitoring datasets to investigate the mechanisms underlying long-term chlorophyll trends across Canterbury's high-country lakes. The results show that increasing chlorophyll can arise through different ecological pathways in different lakes, highlighting the limitations of relying on standard water quality indicators alone. We discuss how plankton community composition and nutrient fractionation improve our ability to interpret long-term trends and consider the value of incorporating these measurements into routine lake monitoring programmes.

Why is Lake Hood blooming? Unravelling cyanobacterial dynamics and their drivers

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Lake Hood is a 115-ha artificial lake in Mid-Canterbury, Aotearoa New Zealand, constructed in 2002 and widely used for recreation, including rowing, swimming, and water-skiing. During the past three summers the lake has experienced cyanobacterial blooms, resulting in repeated public health warnings and the complete closure of the lake to recreational use during the summer of 2024/25. While routine water quality monitoring has been undertaken for many years, the spatial and temporal dynamics of bloom development, persistence, and decline remain poorly understood. Multiple potential drivers have been proposed, including external and internal nutrient loading, limited water circulation, and the influence of non-native fish and macrophyte communities.

To better understand bloom dynamics and their environmental drivers, an intensive 18-month monitoring programme was initiated in November 2025. Weekly sampling is being conducted at ten sites distributed across the lake, including inlet and outlet locations, canal areas, and sites identified by the local community as particularly susceptible to blooms. Monitoring includes in situ measurements of key physicochemical variables, phycocyanin fluorescence as an indicator of cyanobacterial biomass, and microscopy-based identification and biovolume estimation of cyanobacterial taxa. Monthly water quality monitoring is also being undertaken at the inlet and outlet and is supplemented by a long-term water quality record extending back to 2005. In addition, temperature and dissolved oxygen loggers have been deployed at the deepest point of the lake to investigate thermal structure, oxygen dynamics, and their influence on nutrient cycling.

Data collected to date indicate that the cyanobacterial community is dominated by Dolichospermum circinale and Dolichospermum spiroides. During the 2025/26 summer bloom season, elevated cyanobacterial biomass, upto 12 mm3/L, was largely confined to the water-ski lake, with only occasional high concentrations observed within canal sections. Analysis of long-term water quality data suggests that nitrogen is generally abundant within the water column, whereas phosphorus availability may be the primary factor limiting bloom development. The average N:P ratio measured near the lake outlet during summer for past three years is 43:1. Periods when phosphorus concentrations increase appear to coincide with conditions favourable for bloom formation. Preliminary data from the 2025/26 summer suggest cyanobacterial biovolume began increasing when TP exceeded 0.014 mg/L, with a full bloom response observed at 0.025 mg/L. Analysis of the data indicates that an important source of phosphorus is inflow from the river during high rainfall events, which delivers sediment-bound phosphorus to Lake Hood. We hypothesise that periods of low oxygen concentration near the lakebed may promote phosphorus release from sediments, providing an additional internal nutrient source.

This presentation will provide an overview of findings to date and highlight ongoing work, including hydrodynamic modelling to better understand circulation patterns and investigations into the environmental triggers for akinete germination from lake sediments. Together, these studies aim to improve understanding of bloom initiation and persistence and support the development of effective management strategies for Lake Hood.

What is an algal bloom in a river? Diverse algal bloom types necessitate diverse research and management needs in flowing waters

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Algal blooms in freshwater ecosystems degrade critical ecosystem services provided by rivers, streams, and lakes, such as habitats that sustain biodiversity, irrigation and drinking water, and areas of significant cultural and recreational value. While planktonic algal blooms have been a major environmental issue studied in lakes, estuaries, and oceans for decades, algal blooms in rivers have only recently become an emergent environmental issue of broad scientific and management concern. Yet the meaning of the phrase “harmful algal bloom” in a river is often indistinct, making management and research priorities on this topic unclear. The complexity of river networks, which can include shallow waters, impoundments, and flow modifications, results in diverse bloom-like phenomena depending on the specific characteristics of sites within the network. In this talk, we define key types of algal blooms in rivers and discuss their differences and similarities, including benthic toxin-producing (i.e., harmful) cyanobacterial mats, nuisance benthic filamentous algal blooms, and planktonic blooms, either originating from within rivers or upstream lentic water bodies (i.e., reservoirs or lakes). Impacts from these different types of bloom events are on a spectrum from nuisance to harmful. We draw on recent literature to evaluate the potential of different tools to detect, quantify, predict, and manage these diverse bloom types (e.g., remote sensing, in-situ sensors). Finally, we outline key research priorities to better understand and predict the spatial extent, temporal dynamics, and ecological consequences of algal blooms in rivers.

Following the money: Investments in lake repair in Aotearoa New Zealand

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In recent years central and local government have invested millions of dollars into freshwater restoration in an effort to address declining water quality and biodiversity, and create employment opportunities. This has included large grants to improve the health of some of Aotearoa New Zealand's most degraded lakes. However, lake restoration is both ecologically and socio-politically challenging due to the role of lakes as receiving environments, the magnitude of land use change required to improve water levels or nutrient flows, and histories of Māori land alienation. The scale of lake degradation, and of recent investments in addressing it, raises important questions regarding how such effort is understood and prioritised. Here we present initial insights from a nationwide analysis of trends in lake restoration investment and activities over the last 15 years, investigating the creation of new freshwater futures in Aotearoa. Our results reveal the spatial concentration of lake restoration investment, and apparent mismatches between restoration problem framings, objectives and practices. These findings echo critiques of restoration as more aesthetic than ecological, and as subsidising land development. Our findings also highlight sources of hope, however, including Māori leadership in lake restoration and the growing inclusion of social and cultural dimensions in restoration planning. By drawing attention to how restoration contributes to remaking social as well as ecological worlds, this analysis highlights opportunities for more holistic and just decision making.

Re-wetting techniques for Peatlands affected by lateral drainage

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[1]Collaborations, [2]Collaborations

Remnant peat wetlands are often surrounded by agricultural land where networks of drains help to lower water levels to improve production. Drainage impacts extend beyond agriculture land, affecting neighbouring wetlands. Reductions in water levels lead to weed invasion, peat decomposition, reduced carbon sequestration and a release of carbon to the atmosphere.

Recent studies in New Zealand highlighted that ongoing drainage continues to reduce the ecological health of these wetlands, and release carbon to the atmosphere from the vast stores of peat.

Restoration may seem practically simple, through the blocking of a drain to raise water levels, however this has hydrological implications, primarily the flooding of upstream and neighbouring land. The Department of Conservation were interested in restoration techniques that have been applied internationally, that allowed peatlands to be restored, and lateral drainage reduced without impacting nearby agricultural land.

Collaborations worked with a local civil engineering company, and a number of international experts from Denmark and Ireland to review large scale peatland rewetting projects, considering their adopted methods and costs involved. This information was compiled into a shortlist of preferential techniques, with an approximate $/linear metre cost rate developed and applied to two New Zealand case studies; Moanatuatua Peat Bog in Waikato Region and Toetoe (Awarua) Scenic Reserve in Southland.

This presentation will detail the methods that can be used to reduce lateral drainage, showcase international examples, and apply the approximate costs (and challenges) to a hypothetical case study.

Does diversity beget diversity? Testing cross-boundary biodiversity cascades with replicated virtual river networks

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Ecosystems are rarely closed, and subsidies of nutrients, detritus, and prey are ubiquitous across diverse biomes. Streams and their riparian zones are reciprocally subsidised: terrestrial litter fuels in-stream detrital food webs, while emergent aquatic insects return energy to terrestrial predators. Despite decades of biodiversity-ecosystem functioning (BEF) research within single ecosystems, direct tests of whether biodiversity change propagates across ecosystem boundaries remain rare. One proposed pathway is a cross-boundary "diversity begets diversity" cascade, whereby higher donor-ecosystem diversity stabilises or diversifies resource supply to a recipient ecosystem, in turn supporting greater recipient diversity. Mechanistic tests of this pathway remain scarce, since isolating donor diversity from confounding disturbance and productivity gradients is difficult in real, unmanipulated catchments.

We present a spatially explicit, stage-structured food web model built to provide exactly this kind of controlled test. The model is constructed on Optimal Channel Networks — synthetic river catchments that reproduce the branching structure of real networks while remaining fully controllable and free of confounding disturbance history. It couples riparian litter inputs, basal resource compartments, aquatic insect functional feeding groups, and a riparian spider community that varies in its reliance on the aquatic subsidy. Our simulations contrast a diverse native New Zealand riparian forest (five common species, including māhoe and rewarewa) against a pine monoculture, replicated across independent network realisations, with total annual litter mass held identical between scenarios so that only litterfall phenology and species composition differ — not subsidy quantity.

We predicted that (i) the diverse forest's staggered, multi-species litterfall would stabilise detrital resource supply and increase aquatic insect diversity and emergence duration relative to the more pulsed monoculture input; (ii) this would generate a measurable community-level portfolio (insurance) effect against temporal variability in resource supply and thermal forcing, contingent on response diversity among consumer taxa; and (iii) elevated aquatic insect diversity would in turn elevate riparian spider richness, with the strength of this cascade contingent on individual spiders' reliance on the aquatic pathway.

By replicating the forest contrast across independent virtual catchments rather than a fixed set of field sites, this approach decouples riparian forest diversity from the disturbance and productivity gradients with which it is inevitably confounded in real landscapes, while retaining ecological realism through explicit competition, predation, and thermal forcing of consumer dynamics. We discuss how this framework complements ongoing empirical tests of the same pathways, and its implications for riparian restoration and planting design — including whether diverse, multi-species riparian plantings can enhance in-stream biodiversity and ecosystem resilience beyond what depauperate plantings provide.

Protecting lamprey during river works: lessons learnt from Canal Reserve Drain

Dr Greg Burrell[1], Dr Cindy Baker, Dr Ben Crichton, Mr Derek Gerber, Mr Clinton Webb
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Lamprey, kanakana, or piharau (Geotria australis) are a threatened species that are infrequently seen in New Zealand rivers. Adult lamprey live in the ocean and enter freshwater to breed, living 12-16 months before spawning. To date, spawning sites have only been documented in two New Zealand streams, one under boulders and the other within bedrock cavities. In this presentation, we describe how significant lamprey habitat was protected during instream works in a highly modified environment.

Proposed upgrades to a bridge and intersection prompted a fish survey in Canal Reserve Drain, a timber-lined tributary of the Pūharakekenui/Styx River in Christchurch. The survey found very high densities of ammocoetes within the drain, indicating the presence of lamprey spawning nearby. This discovery prompted further investigations by NIWA (now Earth Sciences NZ), including electric fishing to delineate ammocoete habitat and trapping and radio tracking of migrating adults, to find spawning sites. Although no spawning sites were found, the survey results gave confidence that a modified version of the intersection upgrade could continue, which entailed avoiding the significant ammocoete habitat, and minimising the length of the culvert extension to avoid potential spawning habitat. Subsequent monitoring of ammocoetes and migrant adults indicated that adult lamprey could pass through the extended culvert and were still successfully spawning upstream.

Following the intersection upgrade, attention moved to replacing the dilapidated timber lining of Canal Reserve Drain. Spawning habitat trials were undertaken in the drain using stacked rocks, paving tiles, timber alcoves, and PVC tubing. Spawning did not occur on any of these artificial habitats, so the focus switched to protecting potential spawning habitats, informed by radio tracking results. Drain habitat was not otherwise enhanced, to minimise the attraction to other fish species, particularly predatory eels. Other mitigation measures included the use of hardwood timber to avoid potential odour impacts from treated timber, timing works to avoid lamprey migration, maintaining flow past potential spawning habitats throughout the works, and inspecting behind the timber lining for lamprey.

The timber lining renewal was split across two phases, with radio tracking used after the first phase to confirm lamprey entered the drain after some of the new lining had been added. This was undertaken to reduce the 'all or nothing' risk to lamprey in a highly modified setting with many unknowns. Tagged lamprey were tracked to similar locations to the previous survey, providing confidence that the second phase of relining could continue.

Lessons learnt include the value of doing ecological surveys early in the design process to avoid costly redesigns, and the importance of clear communication with all levels of the construction team (ecologists, engineers, and all contractors) throughout the project. The combination of radio tracking of adults and electric fishing surveys of ammocoetes was invaluable for identifying habitats requiring protection and informing design decisions. Equally important was the continued monitoring of lamprey throughout successive stages of construction, which provided confidence that mitigation measures were effective and enabled potential impacts to be identified and addressed before they could threaten this significant lamprey population.

Beyond Business as Usual: Delivering Freshwater Ecology Under Emergency Works and Recovery Legislation

Danielle Cairns[1]
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As severe weather events become more frequent and impactful across Aotearoa New Zealand, infrastructure recovery programmes are increasingly being delivered under alternative legislative pathways, including the emergency works provisions of Section 330 of the Resource Management Act 1991 (RMA) and post-disaster Orders in Council, creating new challenges and opportunities for freshwater ecology practitioners.

Cyclone Gabrielle caused widespread damage across Te Tairāwhiti (Gisborne) and Te Matau-a-Māui (Hawke's Bay) in February 2023, resulting in significant damage to transport infrastructure and impacts on freshwater environments. The Transport Rebuild East Coast (TREC) alliance was established to provide recovery and rebuild works across the state highway and rail networks under accelerated delivery timeframes.

This presentation explores what it means to undertake freshwater ecology work under alternative legislation pathways. It examines how these frameworks differ from the business-as-usual (BAU) consenting and environmental management processes typically associated with major construction projects, where assessment, design, consenting and mitigation are often undertaken over extended timeframes and what "best practice" looks like in an emergency recovery context.

Using examples from the TREC project, the presentation will discuss the practical implications of operating under emergency legislation, including compressed decision-making timeframes, context of baseline information, seasonal constraints on ecological surveys and recovery, and the need to provide practical, timely and context specific advice to design and construction teams to enable critical recovery works. The experience highlighted the importance of rapid ecological assessments, risk-based decision making, and close collaboration between ecologists, engineers, regulators and iwi partners to protect environmental values while supporting urgent recovery objectives. While legislative requirements and delivery pressures differ from BAU projects, the fundamental principles of freshwater ecology effects management remain unchanged. As severe weather events become more frequent and recovery programmes increasingly rely on emergency legislative mechanisms, these experiences provide valuable insights for freshwater practitioners to better support design and construction teams working within the emergency work environment.

Restoring Native Fish Refuges Through Trout Eradication: The Boundary Creek Story

Mr Pete Ravenscroft[1], Mr Ciaran Campbell[1]
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Introduced brown trout (Salmo trutta) are widely recognised as one of the principal threats to New Zealand's indigenous freshwater fish fauna, particularly non-migratory galaxiid species. Through predation, competition for resources, and behavioural exclusion, trout have contributed to widespread declines in the abundance and distribution of native fish throughout many river systems. In response to these impacts, Otago Regional Council initiated a long-term trout removal programme in Boundary Creek, Kye Burn. Over a four-year period 3,236 brown trout were removed from a 11km reach of Boundary Creek, to secure a population of threatened Central Otago roundhead galaxias (Galaxias anomalus).

Trout removal was undertaken using intensive backpack electrofishing, with repeated surveys systematically targeting all accessible stream habitats. The primary objective was to remove introduced trout and reduce predation pressure on native fish populations, thereby improving conditions for the persistence and recovery of threatened galaxiids. Over multiple years, significant effort was invested in surveying, removing, and monitoring trout populations.

The programme represents the largest known freshwater salmonid removal operation conducted using electrofishing methods in New Zealand. Through sustained and targeted effort, Otago Regional Council has potentially achieved the eradication of trout from Boundary Creek, demonstrating that complete removal of an introduced salmonid population is possible within suitably isolated stream systems. This outcome represents a significant milestone for freshwater conservation in New Zealand and provides one of the few documented examples of successful trout eradication from a natural waterway.

Post-removal monitoring has shown a positive response from indigenous fish populations, including increased abundance, recruitment, and occupancy of native galaxiids within the treated catchment. The removal of trout has reduced predation and competitive pressures, allowing native fish to utilise habitats that were previously inaccessible or occupied by trout.

Beyond the direct benefits to native biodiversity, the project has provided valuable information on the techniques, effort, costs, and long-term commitment required to undertake large-scale invasive fish removal. The work demonstrates that intensive electrofishing can be an effective management tool for protecting threatened freshwater species and restoring ecological integrity where introduced trout are a primary limiting factor.

The successful eradication of trout from Boundary Creek and significant reductions achieved within the Kye Burn provide a compelling conservation case study for New Zealand. These outcomes highlight the potential for targeted invasive fish management to reverse biodiversity decline, restore native fish refuges, and support the long-term recovery of threatened freshwater species. The project provides an important model for future freshwater restoration initiatives throughout Otago and elsewhere in New Zealand.

Conservation status of freshwater fishes in Otago

Mr Ciaran Campbell[1], Dr Richard Allibone[2], Dr Nicholas Dunn[3], Mr Daniel Jack[4], Mr Pete Ravenscroft[1], Dr Scott Jarvie[1]

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Threat assessments play an important role in monitoring biodiversity and informing conservation action. The New Zealand Threat Classification System (NZTCS) is a national system used to assess the conservation status of species found in the wild in Aotearoa New Zealand. While the NZTCS provides national perspectives for conservation action and biodiversity trends, it can overlook pressures and trends at smaller scales, such as within regions. Department of Conservation and regional council ecologists have jointly developed the Regional Threat Classification System (RTCS) to assist local authorities to meet statutory responsibilities, including to maintain indigenous biodiversity, manage habitats of indigenous freshwater species habitats, and provide conditions for the recovery of threatened freshwater species. The RTCS captures regional population size and trend with insights to distribution to monitor trends and management effectiveness. Using the RTCS, we undertook the first conservation status assessment of freshwater fish taxa in the Otago Region. A total of 43 species were identified in the Otago Region, including 18 assessed as Regionally Threatened and four species assessed as Regionally At Risk. Otago serves as a national stronghold for eleven freshwater fishes, nine of these were endemic to the Region. Here we present the results of our assessment and how the Otago Regional Council plans to use the results to inform our work programmes.

Declining sediment nutrient release rates and long-term water quality recovery in Lake Rotorua

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Recovery of eutrophic lakes often involves a combination of catchment and in-lake management interventions. However, the long-term response of internal nutrient loading to restoration efforts remains poorly understood. Lake Rotorua is a large (80 km²) polymictic lake in the Bay of Plenty region which has undergone extensive restoration and catchment management over the past two decades. Lake management efforts have included wastewater diversion to land disposal, improving land nutrient management, and the addition of over 1000 tons of aluminium to two lake inflows, resulting in a marked improvement in lake water quality. To investigate whether sediment nutrient release rates have changed following long-term restoration, in situ nutrient release rates were measured using a novel benthic chamber design and compared with measurements collected in 2003 when water quality of Lake Rotorua was at its poorest.

Preliminary results indicate substantial reductions in summer ammonium and dissolved reactive phosphorous (DRP) release rates compared to 2003. Mean ammonium release rates declined from 578 to 0.4 mg/m²/day (99%) at 15 m depth, while mean DRP release rates declined from 9 to 0.16 mg/m²/day (98%). Dissolved reactive phosphorous release rates were depth-dependent, with mean release rates greatest at 10 m (0.29 mg/m²/day) and least at 20 m (0.1 mg/m²/day). This is in contrast to 2003 observations, which found release rates were highest at 20 m and lowest at 10 m. These patterns may reflect thermocline dynamics, whereby sediments at intermediate depths have experienced fewer prolonged anoxic periods and consequently less phosphorus release, allowing larger mobile phosphorus pools to persist. These findings suggest that reductions in sediment nutrient release have accompanied the long-term water quality improvements of Lake Rotorua, but the importance of alum mediated phosphorus binding and depletion of the mobile sediment phosphorus pool in relation to these improvements remains uncertain.

The Effects of Freshwater Acidification on Microalgal Ecophysiology and Community Composition: A Systematic Review

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Ongoing emissions of CO_2 are altering the carbonate chemistry of oceans and freshwater systems alike. High inputs of terrestrial and catchment-derived carbon result in most freshwater environments being supersaturated with respect to the atmosphere. However, increases in atmospheric CO_2 can still lead to freshwater acidification, as pH levels decrease due to equilibrium shifts in dissolved inorganic carbon (DIC) components. Biological activity within freshwater environments naturally fluctuates across diel, seasonal, and hydrological cycles. Moreover, interactions between local climatic conditions and soil chemistry further complicate predictions of the long-term responses of freshwater ecosystems to sustained anthropogenic pressures

To form a general understanding as to how microalgae and cyanobacteria, the basis of these ecosystems might respond, we conducted a synthesis of the literature. From the original 4,136 candidate papers published between 1932–2025, 218 were selected as relevant for further analysis. The selected studies focused on either microalgae and/or cyanobacteria from an ecological point of view, by observing their ecophysiological or community-level responses to natural, induced or anthropogenic acidification. The selected studies encompassed a broad range of freshwater environments, including lakes, rivers, reservoirs, streams and ponds.

The experimental methods used in each study were classified as; field, laboratory cultures, mesocosms or models, with more than half the total works including a field component (126). Most of these observations were carried out in Europe (46) and North America (43) followed by Asia (29), leaving South America (7) and Africa (1) trailing behind, while the phytoplankton communities of Australasia (0) appear to be virtually unexplored.

The individual findings were largely defined by the local and experimental conditions, yet several broad phytoplankton groups displayed common responses. If freshwater systems were exclusively affected by increases in dissolved CO_2 and reductions in pH – the components of freshwater acidification - a decline in the relative importance of cyanobacteria and diatoms and a corresponding increase in filamentous green algae and dinoflagellates was a common response. The degree of similitude between future expected and observed phytoplankton communities remains context dependent. These data provide insight into the possible composition and physiological characteristics of microalgal and cyanobacterial communities in a high CO_2-world, to help inform targeted restoration and adaptive water-management strategies.

Short term biological reorganisation in Lake Tūtira following Cyclone Gabrielle

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Climate change is projected to increase the frequency and intensity of extreme storm events, adding additional strain to freshwater ecosystems already stressed by anthropogenic activities. Extreme storm events can immediately increase sediment and nutrient yields through surface erosion and catchment runoff, disrupting the light, temperature, and nutrient regimes in lakes. Lake biological communities are structured by these physiochemical properties, meaning changes in a lake's physical and chemical structure can generate biological shifts across the whole lake ecosystem. Despite this potential response, we currently know very little about how lake biological communities may be impacted by extreme storm events.

This study explores the biological community responses to Cyclone Gabrielle (13th-14th February 2023) in Lake Tūtira, a lake situated in the north-eastern Hawkes Bay region (Aotearoa New Zealand). To explore the biological impacts following Cyclone Gabrielle, monthly 1L water samples were collected over 22 months and analysed using environmental DNA techniques. Community metabarcoding was used to target the 16S rRNA, 18S rRNA, CO1, and rbcL genes to characterise compositional changes in the bacterial, eukaryotic, and plant communities. These analyses were complemented by high-frequency physiochemical monitoring from the lake buoy to assess changes in water quality and lake dynamics after Cyclone Gabrielle. Most biological communities showed significant shifts following Cyclone Gabrielle, with the largest changes occurring around 30-weeks after the event. Notable responses included a shift to favour diatom and ciliate communities, coinciding with a decrease in the relative abundance of cyanobacterial and dinoflagellate communities until 30-weeks after the event. These biological reorganisations were associated with elevated turbidity in Lake Tūtira after Cyclone Gabrielle. Collectively, these results will provide a greater understanding on the short- and long-term biological consequences of extreme storm events, helping to improve future management strategies to safeguard these ecosystems.

Warming the way: does a warmed attractant flow have the potential to enhance the elver trap and transfer program?

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Dams threaten the upstream migration of elvers worldwide, limiting the extent to which they can access suitable habitat. Trap-and-transfer programmes in New Zealand aim to address this problem, but there is little research on efficiency. Given the impacts of temperature on the performance and navigation of eurythermal species, this study aimed to test the effects of temperature on attraction into traps and climbing success. Two experiments were conducted, one using a rheotaxic choice chamber to test temperature selection and the other using a replicate of a trap-and-transfer trap to simulate climbing success under different temperatures. It was found that Anguilla australis consistently selected for a warmed attractant flow, whilst Anguilla dieffenbachii did not. Neither species showed better climbing performance under warmer temperatures, although a shallower slope was shown to strongly influence climbing success. These results indicate that a warmed attractant flow should be trialed to increase efficiency in trap-and-transfer programmes, although more research is needed before this becomes widely applied.

Capturing transect data of Te Awa o Waikato

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The MBIE-funded Safeguarding Te Mana of Te Awa o Waikato from emerging climatic pressures research programme, led by Lincoln Agritech, aims to gain an understanding of the impact increasing atmospheric CO_2 will have on freshwater systems already suffering from varying degrees of degradation. While a large part of the programme is dedicated to long-term, high-resolution monitoring sites around Lake Karāpiro, a mobile instrument installed in a ¼-scale jet boat allows us to capture data and samples from locations of interest along the whole river.

The mobile sonde records continuous data as the boat moves across the river and the live feed enables us to trigger sample collection when desired. Recorded analytes of interest include temperature, pH, dissolved oxygen, conductivity, CO_2, chlorophyll-a, phycocyanin and dissolved organic matter fluorescence. Samples taken for laboratory analysis cover a wide range of analytes including alkalinity, nutrients, metals, anions and ^{13}C-DIC.

The locations sampled in the winter 2026 campaign span from the headwaters at Lake Taupō to the start of the river delta at Tuakau, with the aim to repeat measurements during different seasons to gain an understanding of the temporal variability as well as longitudinal variation.

Initial results suggest that the near-pristine water leaving Lake Taupō rapidly alters via exchange of geothermal fluids and gases with the riverbed (e.g. Ohaaki, Orakei Korako), with lower pH values, higher conductivity and higher CO_2 levels resulting. By the time the water reaches Hamilton, pH values partially recover via CO_2 efflux, but not returned to Taupō levels, suggesting retention of volcanogenic CO_2, corroborated by ^{13}C-DIC mixing analysis.

Cross-sectional transects of the river, particularly at the geothermally influenced locations reveal hotspots (e.g. CO_2 concentrations ranged 2,100 – 3,500 ppm at Orakei Korako) while other locations have stable concentrations (e.g. 1,070 – 1,135 ppm CO_2 measured at the Narrows, near Hamilton). For comparison, CO_2 levels at Lake Taupō ranged 500 – 540 ppm, slightly above atmospheric levels (424 ppm at Baring Head, Wellington).

This ongoing work aims to further our understanding of the spatial and temporal variation in chemistry along the awa, and the potential impact of climate change on CO_2 via atmospheric exchange and metabolic enhancement.

Evaluating freshwater expert panels: good science, good advice, good decisions?

Dr Joanne Clapcott[1], Dr Alexandre Magnan[1]
[1]Cawthron Institute

Independent expert panels are increasingly used by regional councils to navigate complex freshwater decisions involving scientific uncertainty, competing values, multiple knowledge systems and changing regulatory requirements. Many of us have participated in these panels, investing considerable time in reviewing evidence, debating uncertainty and developing recommendations. Yet we rarely have the opportunity to step back and ask: did the process work, and did our advice make a difference?

This project evaluated freshwater expert panel processes in Aotearoa New Zealand to identify practical lessons for future panels. An evaluation framework was developed drawing on literature around expert elicitation, science advice and panel governance. Three panel processes were then examined as case studies. Panel documentation, including terms of reference, panel reports, council reports and meeting records, was reviewed, followed by semi-structured interviews with council representatives, panel chairs and participants.

The evaluation considered effectiveness across dimensions including relevance, credibility, legitimacy, influence on decision-making, usability of outputs, value for money, and integration of multiple knowledge systems. The analysis explored what worked well, what did not, and how panel design, composition, independence, governance and communication shaped the process and its outcomes.

The findings identified common strengths and challenges across the case studies and characteristics associated with credible, trusted and useful expert processes. Drawing on both the evaluation and our own experience as participants in expert panels, we reflected on what the findings mean for scientists around the table and for the agencies commissioning their advice.

Ultimately, the project asked not only whether expert panels produced good science, but what made that science useful, influential and worth the considerable effort involved?

Investigating the relationship between land cover and periphyton across Aotearoa New Zealand rivers

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Periphyton are key primary producers in freshwater ecosystems, forming the basis of aquatic food webs and responding to changes in water quality and habitat. Periphyton abundance and community composition are influenced by multiple interacting environmental variables, making it challenging to disentangle the relative importance of individual drivers. Land-use can alter hydrological, physical and biogeochemical processes across catchments, influencing river ecosystem structure and function. Understanding relationships between periphyton and land-use is therefore important for freshwater monitoring, management and restoration. For example, national legislation requires periphyton abundance is monitored and data utilised in limit-setting to maintain or improve the life-supporting capacity of waterways.

In this study, monitoring data from fifteen regional councils were collated and standardised to create a comprehensive national periphyton dataset for Aotearoa New Zealand, encompassing sites with varying record lengths and spatial distribution. The database spans seven hydrological years (2017-2024) utilising monthly observations from 269 sites with biomass (chlorophyll-a) data and 327 sites with periphyton cover data. We assessed measured periphyton biomass and cover against different land cover types at both catchment and local (defined as the three upstream river segments) scales, as well as assessed compliance with National Policy Statement for Freshwater Management (NPS-FM) attribute bands. In addition, flow and water-quality metrics were compiled for two regions, Manawatū-Whanganui and Southland, to enable a more detailed investigation of environmental drivers.

Most (94%) monitoring sites were graded better than the NPS-FM national bottom line (200 mg chl-a/m2) and the majority were graded A (43%) and B (38%) bands. Results showed that catchment-scale land-use variables were stronger predictors of periphyton biomass and cover than local-scale land-use measures. The most notable land cover difference was that native land cover showed a strong negative relationship with periphyton biomass. However, overall, land cover was only a weak predictor of periphyton biomass and cover with the best performing linear models explaining 31% and 18%, respectively. In the Manawatū-Whanganui and Southland regions, flow and water-quality data were moderately strong predictors of periphyton biomass with the best performing linear models explaining between 44-46%.

These findings highlight that variables other than land cover may have a stronger influence on periphyton, such as water quality, flow, and climate – whilst land use can affect these variables, site-specific nuances are likely more important than generalised land-use categories. The national standardised dataset also provides a foundation for future investigations of periphyton states and trends.

Ngā Awa and river restoration for climate resilience.

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Catchment-scale river restoration for climate resilience incorporates down-scaled climate projections into planning processes. Assessment of climate vulnerability informs prioritisation of ecosystems and species for restoration. Geomorphic analyses identify risks and opportunities for restoration such as erosion vulnerability and characterising corridors within which the river can be managed, providing predictability for planning processes.

Ngā Awa has taken two main approaches to increasing the climate resilience of river catchments in collaboration with a range of partners in each catchment. Both Ngā Awa Taiari and Ngā Awa Doubtless Bay take a catchment-scale approach to river restoration and climate resilience. We focus on DOC's mandate of protecting threatened ecosystems and species and aim to complement the priorities of other agencies and stakeholders. Where possible we address mana whenua priorities as guided by our Treaty Partners.

In the Taiari (Taieri) catchment, Otago, we have progressed from evaluating the latest climate projections, to a 'Climate Change Vulnerability Assessment' (CCVA) of freshwater ecosystems and values, to our most recent focus on management options for the most vulnerable ecosystems (upland wetlands) and species (non-migratory galaxias). In parallel, climate resilience strategies have been work-shopped and research continues, assessing the vulnerability of the coastal Waipōuri Waihora lake-wetland complex to sea level rise. Another project is assessing restoration options for Tunaheketaka (Taiari Lake) - a drained wetland in the upper Taiari that was once a significant mahika kai site. The information has been incorporated into the Otago Regional Council-led Taiari Catchment Action Plan process through a variety of pathways.

In Doubtless Bay (Northland) climate resilience has been addressed through a focus on revegetation options – rather than via a CCVA. We collaboratively developed a holistic assessment of 12 options that would build resilience to drought, wildfire, sea level rise and flooding. We focussed in on 8 case studies with a view to supporting uptake of the advice including a 2-day field workshop with the community. A StoryMap website makes a suite of geospatial analyses (e.g., wildfire vulnerability) accessible to the catchment community. An ongoing collaboration with the Auckland University of Technology is adding geospatial analyses by graduate students (e.g., nature-based solutions) to the information available to the catchment restoration group He Rāngai Maomao and other stakeholders. Fluvial geomorphic analysis of a lowland riparian restoration site has guided plantings planned for sites prone to bank slumping. Another project is exploring restoration options for Lake Ohia; a unique gumland wetland at the base of Karikari Peninsula, Doubtless Bay that hosts a suite of rare native species. Current restoration recommendations include weed & pest control, improved hydrological management, providing managed access, addressing knowledge gaps (including salinisation analysis) and reducing illegal dumping. Restoration of Lake Ohia would enhance climate resilience of the sub-catchment through decreased fire risk, and local mitigation of drought and floods.

Common themes across the catchments include the importance of wetland restoration for flood and drought mitigation, weed and pest control, and restoration to reduce fire risk.

Financing Freshwater Futures

Mr Ben Youngman, Mr David Cox
[1]Morphum Environmental

In 2024 the Parliamentary Commissioner for the Environment (PCE, 2024) made the case that most environmental issues relating to land use are best managed at catchment scale with the input of local communities and land users. This premise has been borne out over the last decade, as public investment, community-led governance and multi-agency collaboration have enabled catchment initiatives across Aotearoa New Zealand to build ecological ambition, social licence and coordinated restoration.

However, many catchment programmes have developed these strengths faster than durable financing systems, often relying primarily on grant funding. As major central government funding contracts, the challenge is not only to diversify funding streams, but to establish institutions capable of accessing and coordinating multiple investment streams, sustaining delivery, and demonstrating outcomes over intergenerational timeframes.

This presentation highlights Te Hoiere Project as a case study of that transition. Te Hoiere is a community-led, multi-partner initiative founded on 'ki uta ki tai' principles and focused on restoring the mauri of land, freshwater and estuarine system while supporting community wellbeing and livelihoods. Since 2019, more than $13 million has been invested in delivering riparian planting, fencing, wetland restoration, fish passage assessment, sediment and cultural monitoring, species recovery, environmental education, and native nursery development, informed by applied research.

The contraction of grant funding now places at risk both these gains and the project's capacity to sustain this effort at a meaningful ecological scale. This study, funded by the Department of Conservation Nga Awa Programme, a longstanding project partner, sought to understand what combination of finance mechanisms, governance arrangements and evidence systems could support Te Hoiere's transition from a grant-dependent project to a durable catchment-scale investment programme, with a focus on emerging sustainable financing instruments. Screening involved the review of international and domestic financing instruments, semi-structured stakeholder engagement, sector analysis, and participatory prioritisation with the project governance and working groups based on agreed criterion.

Fiscal, market-based, philanthropic and community-based mechanisms were evaluated for relevance, suitability and feasibility within the local economic, political and cultural context. The analysis generated a shortlist of instruments across funding types for further investigation, but found that no single mechanism offered sufficient scale, durability, equity and administrative feasibility. Finance also lacks legitimacy without transparent governance, credible monitoring and an equitable distribution of costs and benefits. The principal constraint was therefore institutional rather than technical.

The proposed response is a three-part institutional architecture: a formalised governance structure with legal business status, an annual catchment health report, and a 'Water Fund'. Together, these are designed to coordinate decision-making, integrate environmental, social, and economic evidence, and efficiently pool public, private, philanthropic, and market-based finance for prioritised restoration.

Te Hoiere illustrates the confluence required for freshwater futures in Aotearoa: science, Mātauranga Māori, community stewardship, local government, environmental markets, and private capital, cooperating within shared governance. Its national relevance lies not in offering a universal funding formula, but in demonstrating that catchment restoration must be financed and governed at a scale commensurate with the ecological systems it seeks to restore.

Monitoring in Motion: Adapting Freshwater Monitoring for Te Wai Takamori o Te Awa Kairangi

Dannie Cullen, Rombout Ruiterkamp
[1]AECOM, [2]Stantec

Te Wai Takamori o Te Awa Kairangi is a transformational project for Te Awa Kairangi ki Tai - Lower Hutt. It includes crucial flood protection and river restoration work, improvements to public transport including the New Melling Station, walking & cycling routes, local roads and the SH2 Melling Interchange, the New Melling River Bridge as well as urban revitalisation of the Lower Hutt city centre and a new pedestrian bridge over the river. A core component of this work is managing ecological effects on Te Awa Kairangi/Hutt River, particularly for indigenous fish, macroinvertebrates, and riverbed condition. To support this, an Ecology Management Plan established a comprehensive freshwater monitoring programme, with baseline surveys completed in 2023-2024 across seven 500 m reaches and a control site upstream of Kennedy Good Bridge. Consent conditions initially prescribed intensive, reach-based monitoring at fixed intervals before, during, and following construction.

Subsequent changes to project delivery resulted in the programme of works being split across several projects (rather than seven discrete river reaches), with intermittent construction activity anticipated within the river corridor over an extended timeframe. In response, a revised monitoring programme was developed to prioritise long-term ecological oversight over short-term, reach-specific assessments and this presentation outlines the rationale, design, and expected benefits of the revised monitoring programme.

Key preliminary results from baseline and construction-phase monitoring are also presented, including findings from fish salvage and relocation, indigenous fish surveys, macroinvertebrate communities, and riverbed condition. The presentation also evaluates the usefulness and suitability of trigger thresholds for active management responses, particularly for indigenous fish and riverbed monitoring. It outlines how these thresholds have been refined to ensure the monitoring programme supports effective management actions.

This work provides a practical example of adapting freshwater monitoring to complex infrastructure programmes, with lessons applicable to other large-scale river projects in Aotearoa.

High-frequency greenhouse gas dynamics along a within-lake depth gradient. Physical structure versus ecological production in a small stratifying lake

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Small lakes contribute disproportionately to global methane emission, and much of it arrives in short events rather than steadily. In stratifying lakes methane accumulates below the thermocline and is released when the water column allows, so it need not reach the atmosphere where it was produced. Weekly sampling resolves that a pulse occurred but not its size, duration or origin, and chamber campaigns resolve space or time, rarely both. We asked how much of the seasonal variation in emission is set by physical structure and how much by ecological production, and on what timescale the two can be compared.

We instrumented one small eutrophic Danish lake (Lake Ormstrup, 12.9 ha, mean depth 2.5 m, maximum 5.5 m) grading from a deep eastern basin into a shallow western basin, giving a depth gradient under one weather regime, catchment and water chemistry. From 25 April to 8 October 2025 we ran five low-cost automatic floating chambers along that gradient, logging methane and carbon dioxide every two seconds, a buoy carrying six thermistors between 0.3 and 4.5 m and two oxygen optodes, two dissolved methane sensors in the deep and shallow basin, and four littoral stations recording temperature and oxygen at two depths. Littoral metabolism was estimated by free-water oxygen, and water column stability by Schmidt stability and the Lake Number.

The lake stratified from late April until early October, with the Lake Number above one into September apart from brief windows of weak stability. On-lake wind measurements showed gridded wind overestimating by about threefold, and correcting for that moved the mixing classification from 66 to 22 percent of the season, so mixing metrics for small sheltered lakes are sensitive to the wind product used. The two gases peaked at opposite ends of the same lake. Methane flux was highest over the deep basin rather than the shallow littoral zone, while carbon dioxide flux was highest in the shallow west and negative over the deep basin, which was therefore a methane hotspot and a carbon dioxide sink at once. A single station would misrepresent both, and in opposite directions.

The dissolved methane records distinguish the basins by shape rather than by level, the deep basin smooth through most of the season and then carrying a few large excursions in late summer, the shallow basin persistently spiky.

The ecology ran on a shorter period. Littoral gross primary production averaged 3.55 mg O2 L-1 d-1 (station range 3.25 to 3.87), the stations were net heterotrophic on 62 percent of days, and chlorophyll rose more than tenfold into late June before collapsing, so that signal covered roughly six weeks of a season stratified throughout. Physical structure and ecological production therefore act on different timescales, weeks to months against a few weeks, which may be why studies disagree.

Event-scale attribution is in progress. Resolving space and time together changes the answer a small lake gives about its greenhouse gas balance, which matters as warming lengthens the stratified season.

Stream order and altitude interact to determine the amount of suitable habitat within a tributary for a threatened endemic galaxiid fish.

Mr Isaac Davies[1], Professor Gerard Closs[2]
[1]Horizons Regional Council, [2]University of Otago

In dendritic stream networks, small, low order streams usually represent the greatest proportion of the total stream network, dominating the amount of available habitat with increasing distance upstream. However, whilst low-order headwater streams may dominate the proportion of streams within the overall stream network, their suitability as habitat for many organisms declines with increasing altitude.

In this study we examined the abundance of the nationally threatened Clutha flathead galaxiid in low-order headwater streams across an altitudinal gradient in the upper Mata Au / Clutha River catchment. Within a tributary, the amount of habitat suitable for Clutha flathead galaxiids was defined as the length of stream network upstream of second order – third order confluences and <1000 metres in altitude. This definition was based on an assessment of Clutha flathead galaxiid distribution using the NZFFD. At finer scales, reach and microhabitat scale variables were also assessed for their influence on both adults and juveniles of the species.

At the catchment scale, the best predictor of adult Clutha flathead abundance was the extent of low stream-order habitat <1000 metres in altitude upstream of the sampling point within the stream network. Generally, populations of Clutha flathead galaxias were more extensive and occurred at higher densities as the extent of suitable upstream low-order stream network increased. At finer spatial scales, Clutha flathead galaxiid distribution and abundance across multiple age classes was also associated with various microhabitat factors, including greater low velocity backwater habitat.

Overall, this study highlights how the position of streams in the river network may influence species distribution and abundance at landscape scales. In mountainous landscapes, most of the low-order stream network may be at high altitudes, often exceeding altitudes suitable for fish. In contrast, tributaries that drain lower altitude landscapes may contain a greater extent of low-order streams that can support headwater fish species. Understanding how altitude and stream order interact can assist in targeting management into areas where larger and more resilient fish populations can be maintained.

Eel fishery restoration at Lake Moawhitu, D'Urville Island

Neil Deans[1], Dr David Kelly
[1]Ngāti Koata Trust

Ngāti Koata, with DOC and other partners, has been restoring a previously farmed lake/wetland catchment at Moawhitu for the last two decades. Data from the lake monitoring programme is outlined. Potentially negative influences including algal blooms and floods have occurred over the period, and positives like the recent alum dosing of the deeper lake-bed to lock up phosphorus. The overall response of fish populations, water quality and lake macrophytes is modest, if variable, improvement. The ultimate measure of success for Ngāti Koata will be a limited cultural harvest of tuna/eels from the lake.

Urban catchment community restoration: Tyers Stream Restoration Group, Wellington

Neil Deans[1], Lynn Cadenhead
[1]Tyers Stream Restoration Group

Wellington's urban catchments have a range of community groups seeking to undertake various forms of restoration including stream rewilding, water quality improvement, aquatic biodiversity, restoring fish passage and connectivity, weed and pest management, catchment revegetation, education about stormwater management and improved land use planning. An example is the Tyer's Stream group from Khandallah, undertaking a variety of tasks to measure biodiversity, improve habitat and increase visibility of a highly modified and partially concealed small stream. Its fishery, invertebrate, hydrological, planning and biodiversity have been measured, and some modest revegetation of a small reserve undertaken, as summarized below.

1. Links science, land and water planning and community in an urban catchment.
2. Tyers Stream Group aims to:

- Understand Tyers Stream biodiversity within its wider Waitohi catchment;
- Understand what affects the stream;
- Sustain the stream's biodiversity by responding to significant urban pressures; and
- Plant a pukatea/kahikatea forest in the alluvial stream margin behind a historic arched concrete dam in a scenic reserve.

3. Work undertaken to date includes:

- Science - what instream species are present and why? eDNA, invertebrate sampling, electric fishing, habitat value/description.
- Planning - What land and water planning is needed to retain habitat? How to influence District or regional Plan review, resource consents, politicians, especially regarding limiting the increase in impermeable surfaces. Submissions at a local, regional and national level especially on the rewriting of WCC's District Plan
- Community - how to educate, engage and influence, increase awareness. Public talks, public tours, annual planting, regular plant releasing and weeding trips.

Integrated Catchment Management in Practice: Braiding Knowledge Systems

Dr Markus Dengg[1]
[1]Otago Regional Council

The health of NZ waterways, terrestrial ecosystems, soils, wetlands, estuaries and the ocean is governed through a range of national legislation, policy statements, environmental standards, regional plans and resource consent requirements. While these provide a framework for environmental protection, there is space to operate outside the regulatory system, improving environmental outcomes. The Otago Regional Council (ORC) is currently running an Integrated Catchment Management programme, where the community, ORC, mana whenua and industry stakeholders co-develop individual catchment action plans. These plans are designed to provide communities with direction and focus through shared ecosystem values, the identification of pressures that act on these values, and the development of strategies and actions that can be undertaken to mitigate the pressures. The process follows the Conservation Standard framework, providing a systematic approach for identifying priorities, developing actions, and measuring success. The information basis for values, pressures and actions sits on 3 pillars. Local community knowledge and lived experience, mana whenua Mātauranga and whakapapa and scientific information gained through long-term datasets, empirical observation and evidence-based research. This presentation will show how community knowledge and scientific information can be braided together to support catchment action planning for improved environmental outcomes.

Informing catchment water quality management through identification of faecal sources and microbial health hazards

Dr Megan Devane[1], Dr Margaret Leonard[1], Dr Carla Eaton[1], Dr Beverly Horn[1], Dr David Wood[2], Mr Anthony Pita[3], Professor David Hayman[3], Dr Brent Gilpin[1]
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Catchment management of our freshwater sites is important for the health and wellbeing of New Zealanders, including for freshwater recreation and as a source of our drinking water. Additionally, there is a significant economic impact on domestic and international tourism, implementation of water quality improvements, and treatment technologies for drinking water. The Ministry for the Environment commissioned work in 2017, to undertake a microbiological survey of NZ freshwater to inform future water management strategies and water quality guideline assessments.
Over four years, 1,041 water samples were collected from 71 freshwater sites across New Zealand. Sites with known potential faecal inputs were chosen to explore the relationships between microbiological indicators and pathogens. Control sites of less impacted sites and avian-only sites were also included. Indicators tested were faecal indicator bacteria: Total coliforms, Escherichia coli and enterococci; microbial source tracking (MST) markers: human, ruminant and avian. Pathogens tested were bacteria: Campylobacter jejuni, Campylobacter coli, Salmonella, Shiga toxin-producing Escherichia coli (STEC) and protozoan: Cryptosporidium and Giardia.
A third of water samples had less than 130 Escherichia coli/100 mL, and a third more than 550 E. coli/100 mL assuring a broad range of contamination concentrations. Multiple faecal sources were identified by MST markers in 70% of samples. Human faecal material was identified in 35% of samples, wild bird faeces in 80% and ruminant sources in 66% of samples. The ranges of MST marker concentrations for each source-type has aided assessments of dominant faecal source contributions at individual locations.

Campylobacter were isolated from 68% of samples and the majority of Campylobacter were C. jejuni with C. coli detected in 13% of samples. Salmonella were detected in up to 19% of samples, and STEC: stx1 or stx2 genes in 20 – 30% of enrichments from water samples of one litre, however, concentrations of each organism were generally <1/100 mL.
Cryptosporidium and Giardia were detected in 50% and 69% of samples respectively, but only 1% and 3% of samples had greater than 10 Cryptosporidium or 10 Giardia/10 L, respectively.
Generalised linear mixed model (GLMM) analysis indicated that increasing concentrations of E. coli and enterococci were positively associated with increases in the detection of Campylobacter, Salmonella and STEC, but not Cryptosporidium or Giardia. This is likely due to environmentally persistent but very low concentrations of Cryptosporidium and Giardia.
C. jejuni was associated with human, wild bird and ruminant faecal sources. Salmonella and Giardia were potentially more associated with human sources and STEC with ruminant sources. Cryptosporidium prevalence did not differ significantly between MST-identified sources reflecting its environmental persistence and broad host range. The data was suitable for use in generating Quantitative Microbial Risk Assessments for Campylobacter, Cryptosporidium and Giardia concentration distributions for a given concentration of E. coli or enterococci.
This study produced a current, high–quality New Zealand–specific evidence base for assessments of catchment management. The findings strongly suggest that health hazards (pathogen concentrations) can be inferred from measurements of indicator organisms and/or microbial source tracking (MST) markers.

Wetland Plant Communities Influence the Amounts and Characteristics of Dissolved Organic Matter Leached into Estuaries

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Wetlands in ICE catchments play a major role in storing carbon, cycling nutrients, and affecting adjacent downstream water quality. Wetland vegetation affects the quality of wetland soil, and rootzone soil quality in turn affects the properties of the water-soluble organic matter (WSOM) leaching into adjacent surface waters. However, despite this link between the wetlands and water quality, there is less information available on the effect of wetland types, especially the wetlands with plant monocultures, on the quality of leachable organic matter

This study aimed to investigate differences in the quantity and characteristics of potentially leachable soil organic matter associated with dominant wetland plant species in Otago ICE catchments. We compared Apodasmia similis (oioi), Phormium tenax (flax), Typha sp. and Carex sp. monocultures based on dissolved organic carbon (DOC), soil carbon and nitrogen characteristics, and the optical properties of WSOM.

Three replicate monoculture sites were selected for each plant type using wetland habitat and ICE catchment mapping. Surface soils were collected from the root zones during spring 2025. WSOM was extracted from the soils using ultrapure water at a 1:10 soil-to-water ratio, followed by shaking, centrifugation and filtration. DOC, total soil carbon (C%), nitrogen (N%) and C/N ratios were measured. Absorbances (nm) and absorbance ratios 254, 260, 250:365 and 240:420 were used to assess differences in the aromaticity, hydrophobicity and apparent molecular characteristics of the dissolved organic matter. Differences among plant types were assessed using one-way ANOVA followed by Tukey's tests.

DOC concentrations varied significantly across the four vegetation types, with oioi soils showing the highest values, along with the highest soil C% and N%. The optical measurements showed clear differences in dissolved organic matter characteristics between vegetation types. Oioi had the highest A254 and A260 values (mean A254 = 0.446 ± 0.057, A260 = 0.482 ± 0.065, while Typha had the lowest absorbance values (A254 = 0.115 ± 0.057, A260 = 0.122 ± 0.058). Oioi also showed markedly lower A250:A365 (0.864 ± 0.157) and A240:A420 (1.891 ± 0.294) ratios compared with the other plant types, suggesting a greater contribution of aromatic and structurally complex DOM. In contrast, Typha exhibited the highest A250:A365 (1.330 ± 0.179) and A240:A420 (3.309 ± 0.758) ratios, indicative of comparatively lower molecular weight, less humified DOM. Vegetation type was the strongest factor associated with DOC variation ($F = 6.64$, $p = 0.0014$).

These results show that soils associated with different wetland plant species leach different amounts of dissolved organic matter with different chemical characteristics into ICEs. Oioi was associated with higher DOC, carbon and nitrogen concentrations and more aromatic and structurally complex dissolved organic matter. This suggests that vegetation composition may influence the type and amount of organic carbon mobilised from wetland soils into nearby waters. The findings advance our understanding of the role of wetland vegetation in carbon and nutrient cycling.

Keywords: Wetland vegetation
Dissolved organic matter (DOM)
Soil carbon and nitrogen
Optical properties
Plant monocultures

Global consent for wetland restoration: Queen Elizabeth Park, Kāpiti Coast.

Melanie Dixon[1], James Blyth[1]
[1]Collaborations

Greater Wellington Regional Council's Recloaking Papatūānuku programme is restoring formerly grazed areas within regional parks throughout the Wellington Region. As well as extensive planting – in the order of 50-70 hectares per year – the programme also includes re-wetting of eight former wetland areas (29.3 hectares in total) within the southern portion of Queen Elizabeth Park (Kāpiti Coast). The wetlands have been substantially degraded through over a century of drainage, grazing, cultivation and soil modification. However, peat soils (in some places up to 3.4m) still exist and regular flooding indicated the potential for restoration.

These wetlands are hydrologically isolated from one another (except during larger floods) and have varying levels of artificial drainage, resulting in each wetland requiring its own restoration approach. Consent was required for wetland restoration works and Collaborations led the development of a 'Global Consent' application, which enabled the council to undertake restoration across a range of sites when funds and timing allowed, through a single set of consent conditions.

A central element of the restoration approach is the reinstatement of natural hydrological processes. Hydrological modelling was used to identify opportunities to raise water levels through simple interventions such as removing culverts, installing weirs and bunds, and partially blocking drainage channels. Rather than creating permanent open water bodies, the objective is to restore seasonal wetness and groundwater levels within 0.5m of the surface. Another central element was to maintain and improve fish passage wherever possible.

Consent for this project was granted in 2025. A Wetland Restoration Plan (WRP) was approved, and physical works (including planting) was undertaken in early 2026 for four wetlands.

It is hoped that lessons learned throughout the lifecycle of this project (consultation, design, consenting, and implementation) will help develop a simple, low-cost methodology that could be applied to wetland restoration projects elsewhere. This potentially includes the use of global wetland consents.

Learning from Lake Restoration: Towards a Relational Approach

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Restoration presents a valuable opening to think through our relationships with lakes, and our hopes for lake futures. Lakes have been described as archives and mirrors for how they can store and reflect back to us our relationships with them and their surrounding landscapes. Where lakes have been made inaccessible and inhospitable through colonial settlement, deforestation and intensifying land use, these reflections can be hard to face. Within lake restoration discourses, there are calls to repair and revitalise these relationships, alongside addressing the biophysical issues of ecological degradation. Indigenous and more-than-human scholarship highlight relational modes of engagement with places, emphasising the importance of ongoing relationships of responsibility and reciprocity. In this talk I draw on these conversations to consider what it might mean to do restoration with lakes, where restoration becomes more a practice than project, and lakes are recognised as lively, active participants. To do so, I explore lake restoration as a relationship-based practice formed through the interactions of particular people, places, histories and waters. Drawing from ongoing research with two lakes and interviews with those involved in their restoration, I offer some initial reflections on how people-lake relationalities can provide a means of thinking through how restoration is conceptualised and undertaken. This approach provides a frame for viewing the diverse outcomes of restoration both within and beyond the lakes themselves, and better understanding the impacts as they reverberate through the social, cultural, political and ethical dimensions that are unique to each lake and its communities. This research suggests that attending to relationships and relationalities, and foregrounding lakes as active entities invites a critical and reflexive perspective on restoration, one that may serve to support and enhance the collaborative approaches needed to enhance te mana o te wai.

Connecting with Awa: Collaborative Monitoring

Jessica Hiscox, Natalie Gilligan, Christopher Drake[1]
[1]Auckland Council

Te Whakaorangatanga o te Wai, led by Ngāti Whātua Ōrākei, provides a powerful example of how local government can work in genuine partnership with mana whenua to support the restoration of freshwater ecosystems while strengthening the exercise of kaitiakitanga. Te Kaunihera o Tāmaki Makaurau/Auckland Council (Environmental Evaluation and Monitoring Unit and Healthy Waters) have the privilege of supporting this iwi-led programme through a collaborative approach that seeks to build a more holistic understanding of the ecological and cultural health of six urban awa within Te Kahu Tōpuni o Tuperiri.

To date, two joint hīkoi have been undertaken across six awa. At each awa, Ngāti Whātua Ōrākei shared tribal hītori, and landscape context, reconnecting people to place and highlighting the significance of these waterways. Whānau undertook Mauri assessments, evaluating indicators of stream health, such as whether they would swim or drink from the awa, whether it provides sustainable kai resources, and whether they can sense the wai. This opened up kōrero, with kaumātua sharing mātauranga and reflecting on how environmental changes have altered their relationship with, and impacted their ability to harvest, live with, and use these waterways.

To complement these assessments, Te Kaunihera collected samples for E. coli, eDNA, and macroinvertebrates and undertook stream ecological valuations. Te Kaunihera staff shared information on the stormwater and wastewater systems within Te Kahu Tōpuni o Tuperiri, including investigations of wastewater cross-connections impacting the receving awa. The data from these assessments are being used alongside the Mauri assessments to support a joint understanding of the awa and to develop options for future restoration projects. Early investigations have already proven valuable, identifying a misconnected wastewater pipe that has been remediated.

This presentation reflects on the lessons learned from working in partnership with Ngāti Whātua Ōrākei to enable iwi-led environmental restoration. It highlights how collaborative approaches that recognise mana whenua leadership and integrate multiple knowledge systems can give practical effect to Te Mana o te Wai, delivering healthier waterways and stronger, more enduring partnerships.

Finding The Right Flow. Use of two Instream Flow Models to inform river management for species of conservation concern.

Faline Drummond[1]
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Instream flows, environmental flows, and ecological flows are all broadly synonymous terms used to describe the flow regimes needed to sustain healthy and functioning aquatic ecosystems. Instream flow modelling integrates knowledge from multiple disciplines such as hydraulics, ecology, and geomorphology to understand how changes in river flows affect ecosystems. The modelling approach (e.g., 1D/2D, software) depends on the question being addressed, the spatial and temporal scales of interest, and the computational tools and data resources available.

We present the results of two instream flow models that were developed to assess how the operation of a large hydroelectric dam is affecting species of conservation concern in the South Saskatchewan River, Canada. The first model assessed the inundation risk to larval burrows of the At-Risk Gibson's tiger beetle (Cicindela formosa gibsoni), while the second assessed whether there were suitable habitat to support the different life-stages of Lake Sturgeon (Acipenser fulvescens). Each model was developed in HEC-RAS 2D using a terrain derived from bathymetric LiDAR and calibrated using local gauge data. A range of flow scenarios were simulated and modelled water depths and velocities extracted and compared with species-specific biological thresholds.

For Gibson's tiger beetle, a relatively simple inundation model was used to determine the flows required to inundate larval burrows along the South Saskatchewan river margin. The dam typically operates between 42.5 and 250 m^3/s, with a target open-water season flow of 70 m^3/s. Results indicated that in an average year there was low risk that burrows would be inundated. Estimated inundation thresholds ranged from >256 m^3/s for lower-elevation burrows to >1120 m^3/s to inundate all burrows.

For Lake Sturgeon, a more complex habitat model was developed across approximately 362 km of river between Gardiner Dam and the confluence of the North and South Saskatchewan Rivers ("The Forks"). Habitat was assessed at both meso (riffle-run-pool) and micro-scales (depth, velocity, substrate) and a preliminary Habitat Suitability Index was developed. Lake Sturgeon populations need sufficient spawning, foraging and overwintering habitat over an area free of barriers to be self-sustaining. Under the existing flow regime, habitat was limited with Lake Sturgeon extirpated from 288 km of river. All identified spawning and overwintering habitat occurred within approximately 74 km of The Forks. Increasing flows increased the availability of overwintering habitat but spawning habitat remained scarce, in part due to low hydraulic complexity in prairie rivers. Even so, it was clear that the existing flow regime was negatively impacting Lake Sturgeon habitat in the South Saskatchewan River.

This work demonstrates how instream flow modelling can be adapted to address diverse ecological questions and inform flow management. The results provide ecological information to be considered alongside other water-use needs during provincial water management decision-making. Our approach reflects one of a range of modelling approaches that can be used, with clear potential for application in freshwater management in New Zealand.

The effects of the Corbicula fluminea invasion on zooplankton in the Waikato River

Dr Ian Duggan[1], Dr Karl Safi, Dr Michele Melchior[2], Dr Deborah Hofstra[2]
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The Gold Clam, Corbicula fluminea, was first observed in Aotearoa New Zealand in the Waikato River in April 2023. Initially recorded in Lake Karāpiro, its distribution now extends from Lake Maraetai to Port Waikato. As a highly efficient filter feeder, Corbicula can alter freshwater food webs through the consumption of phytoplankton, bacteria, zooplankton and other suspended particles. While research on bivalve-zooplankton interactions in New Zealand remains limited, studies overseas have demonstrated substantial impacts of dense Corbicula populations on pelagic communities. Following its arrival, Corbicula has attained high densities in parts of the Waikato River, providing an opportunity to assess its effects on local zooplankton assemblages. Recent New Zealand research has focussed on zooplankton interactions with native mussels, whose low abundances likely limit their ecosystem-wide effects. However, the rapid proliferation of Corbicula fluminea throughout the Waikato River has the potential to exert much stronger top-down control on zooplankton communities. We examine here the effects of Corbicula on zooplankton communities in the Waikato River. Zooplankton, including Corbicula larval stages, were sampled on five occasions between 2025 and early 2026 in Lake Maraetai and Karāpiro. Sampling encompassed littoral and riverine habitats, including sites directly above established clam beds. Comparisons with published studies, and spatial patterns in down-river zooplankton distributions, indicate that Corbicula is altering the zooplankton community. Similar to research overseas, all zooplankton taxa are seemingly affected, but in particular the smaller rotifers. Effects from adult Corbicula on zooplankton arise from a combination of reduced phytoplankton (food) abundance as well as direct consumption.

Standardised fish salvage in a less than standard environment - the challenges of salvaging native fish in an urban setting.

Jasmine Dungey[1], Danielle Cairns[1]
[1]Tonkin & Taylor

Aotearoa New Zealand's native fish are an important part of urban waterway biodiversity. Standard fish salvage methodologies are well established and commonly prescribed in native fish salvage and relocation plans to minimise impacts on native fish during instream works. In practice, however, applying these methods in highly modified urban environments can be far from straightforward. Urban streams present some of the most challenging environments for implementing fish salvage and relocation programmes, despite the increasing need for these activities as construction and infrastructure projects expand within developed catchments.

Urban catchments are characterised by extensive impervious surfaces, altered hydrology, constrained stream corridors, and a high density of surrounding infrastructure. These factors can create significant obstacles to successful fish salvage operations. Rapid water-level fluctuations following rainfall events are a particularly common challenge, often resulting in health and safety risks for field teams, overtopping or failure of exclusion structures, and the consequent flooding of dewatered work areas. In some cases, these events require salvage operations to be repeated.

Urban settings also increase the risk of water quality issues. Contaminants and sediment can enter work sites through connected stormwater networks, reducing water quality within salvage areas and potentially affecting fish health during capture and handling. Physical constraints pose additional difficulties; proximity to roads, residential properties, utilities, and other infrastructure can limit access, restrict the placement of exclusion fences and dams, and make stream diversions impractical or impossible (meaning more challenging methods for isolating works areas may be required). The urban environment can also introduce less conventional hazards, including domestic rubbish and other debris within the watercourse, further complicating field operations and increasing health and safety risks.

Beyond environmental and operational constraints, fish salvage practitioners must work closely with construction teams to ensure ecological outcomes are achieved without creating unnecessary programme delays. Balancing the requirements of consent conditions, fish welfare, contractor expectations, and project timelines often requires flexibility, innovation, and pragmatic decision-making in the field.

Drawing on a range of urban fish salvage and relocation projects, this presentation will explore the challenges encountered when attempting to apply standardised methodologies in environments that are anything but standard. We will present examples of some challenging fish salvage operations, discuss modifications and solutions developed to address site-specific constraints, and reflect on lessons learned from both planned and unexpected events. Ultimately, improving these approaches will help deliver better outcomes for native fish, ecological practitioners, and infrastructure projects alike.

Applying freshwater science to farming land use consents: lessons from the Waikākahi catchment

Kimberley Dynes[1]
[1]Environment Canterbury

The Waikākahi catchment is one of Canterbury's most extensively studied agricultural catchments, providing more than two decades of information on the relationship between farm management, nutrient losses and freshwater outcomes. Widespread adoption of Good Management Practices (GMPs), including conversion from border-dyke to spray irrigation, improved effluent management, nutrient budgeting and targeted fertiliser use, has contributed to improvements in phosphorus, sediment, E. coli and water clarity. However, while many of these gains have stabilised, long-term nitrate-N trends continued to increase.

Nitrate-N remains predominantly within the NPS-FM C attribute band but does not meet the catchment-specific plan limits. Conversely, phosphorus concentrations have improved and now generally meet catchment-specific plan limits but remain elevated relative to NPS-FM objectives. Together, these findings indicate that further gains are required to achieve freshwater outcomes. This creates an increasingly common challenge for resource management. In vulnerable environments where shallow groundwater pathways provide direct connections to receiving environments, reductions in modelled nutrient losses do not necessarily remove the risk posed by nitrogen in drainage.

This presentation shows an example of how freshwater science is being used to inform farming land use consents and improve freshwater outcomes. Consent assessments go beyond modelled nutrient losses by considering contaminant pathways, groundwater connections, the sensitivity of receiving environments, and the effectiveness of on-farm mitigations. Using the Waikākahi catchment as a case study, the presentation demonstrates how long-term monitoring and catchment science can be translated into targeted, science-informed consent conditions. This approach balances environmental protection during the ongoing development and adaptation of farming systems.

Serious games at the nexus of agriculture and sustainable freshwater management

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Serious games have been used as a more entertaining, subtle, and effective method for decision-makers to understand land manager behaviour and with decision-makers and land managers to change their behaviour or practices towards more sustainable outcomes. They are becoming increasingly used as a participatory research methodology and decision-making tool with performative potential to shift narratives, worldviews, and social-ecological relationships.
Serious games incorporate more playful elements in order to facilitate generative learning around complex or serious topics in a safe environment. For players, they provide a fun and engaging way to consider and trial different approaches to address wicked problems, without having to deal with real-world consequences. Players can gain an understanding of, and reflect on options, opportunities, and challenges they may face as a consequence of their decisions through facilitated conversations about values, norms, and strategic behaviour. For researchers, serious games provide valuable insights and reflections into individual and collective decision-making that impacts freshwater management.
As part of the Moving the Middle research programme, we developed the Future Farming Challenge game to tackle systemic barriers to sustainable land use and environmental decision-making around farming in Aotearoa New Zealand. The game aims to reveal diverse voices, knowledges, worldviews and lived experiences about farming. This tool enabled researchers to understand how decisions associated with sustainable farming were made by farmers, rural professionals and policy makers. We designed the game to provoke players to question their own values, worldviews, and practices now and into the future through gently reframing strongly held farming narratives and myths. The game has been run in a variety of settings from field days to facilitated government workshops. The game has also been digitised, allowing a much wider audience to play the game as a single player or as a group. We present the key steps in the game design, as well as feedback from players of the game on how it has started work in opening opportunities for enhanced sustainable decision making in farming and freshwater management.

Rewetting and reconnecting riparian wetlands on intensive Waikato dairy farms to improve nutrient attenuation, flood detention, and restore indigenous biodiversity.

Dr Rebecca Eivers[1]
[1]Wai Kōkopu Consulting

Numerous and varied edge of field mitigation measures have been developed in New Zealand to alleviate the negative impacts of intensive agriculture on aquatic environments. More recently landowners have been looking to protect and enhance existing degraded wetlands on farms to achieve desired water quality and biodiversity benefits. However, little research has been caried out to (i) investigate the practicalities of rewetting and restoring degraded wetland areas from retired intensively managed pastures, or (ii) quantify the efficacy of water quality and water quantity treatment.

The aims of this research were to improve water quality, retain and slow flood flows, and enhance indigenous biodiversity on a 140 ha dairy farm in Tatuanui on the Hauraki Plains. Approximately 0.4 ha was retired from pasture to re-create a riparian floodplain wetland along a 175 m reach of a modified watercourse that is a tributary of the Waiharakeke Stream in the Piako River catchment. Approximately 3,500 plants comprised of 20 different wetland and riparian species were planted and a temporary weir created across the modified watercourse to rewet the replanted riparian wetland. A level logger and concrete flume were installed to measure fluctuations in water depth and discharge and for calculation of pollutant loads.

Water quality monitoring of dissolved and particulate forms of nitrogen and phosphorus as well as Escherichia coli was carried out from 2021 to 2024. Initial monitoring revealed mixed results, particularly for phosphorus, however as the wetland matured the consistency and efficacy of treatment performance improved markedly. Patterns in nutrient attenuation including load analyses will be presented along with critical learnings and unforeseen social benefits from this ambitious project.

Prioritising wetland and riparian interventions at subcatchment scales to maximise restoration outcomes, resilience, and success across intricately connected aquatic and terrestrial ecosystems.

Dr Rebecca Eivers[1]
[1]Wai Kōkopu Consulting

Numerous and varied edge of field mitigation measures have been trialled in New Zealand to alleviate the negative impacts of intensive agriculture on aquatic ecosystems. In the Waikato, interventions aimed at improving riparian areas along artificial and/or highly modified watercourses using native Carex spp., coined 'Sedges-on-Edges', and retiring, rewetting and restoring degraded wetland areas from intensively managed pastures, have gained momentum within the farming community.

The Hauraki Plains is one of the most intensively farmed areas in the North Island and is bordered by the Piako and Waihou rivers. The water quality and ecosystem health of both rivers declines significantly from their headwaters to river mouths at the Firth of Thames. Correspondingly, reversing this decline has become a key focus of several stakeholder groups including the Piako Waihou Catchment Trust, Waiharakeke & Friends Catchment Group, Ngāti Haua Mahi Trust, Ngāti Paoa, Dairy NZ, and Waikato Regional and Matamata-Piako District councils. However, with catchment areas of 1,400 km2 and 2,100 km2 for the Piako and Waihou, respectively, choosing where to focus restoration actions has proved a daunting task.

The aim of this project was to develop a method of strategically breaking down such vast catchments into priority locations at subcatchment scales using desktop-based resources including RetroLens, MapsPast, and GIS mapping and spatial analyses. The Waiharakeke Stream was chosen as a focus subcatchment, building on the momentum of several successful wetland and riparian projects and the location of the watercourse in the Piako Catchment. The strategic process developed and methods for prioritising the locations for expanding the 'Sedges-on-Edges' mahi and selective restoration of degraded wetlands will be presented.

Effects of dispersal and habitat characteristics on headwater macroinvertebrate distinctiveness: an in-stream experiment

Lovisa Ekelund[1], Dr Isabelle Barrett[1], Dr James Brasington[1], Dr Nixie Boddy[1], Dr Russell Death[1]
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Headwaters contribute disproportionately to freshwater biodiversity, often supporting unique macroinvertebrate communities. While this pattern is well established, the mechanisms behind headwater distinctiveness remain debated. Existing research has mostly relied on observational surveys, limiting our ability to disentangle the relative effects of dispersal and species sorting on headwater communities. Experimental tests of these mechanisms remain uncommon, particularly under natural field conditions.

This study investigates whether the distinctiveness of headwater macroinvertebrate communities is primarily driven by limited dispersal or by their unique habitat conditions. Specifically, we ask: (1) do headwater macroinvertebrates disperse downstream via drift or aerial flight, and (2) if they do, can they establish in larger streams when suitable headwater habitat is provided?

The experiment was conducted at the University of Canterbury Cass Field Station in the upper Waimakariri catchment. Macroinvertebrate communities were surveyed in two headwater streams (Reservoir and Middle Bush) and in Grassmere Stream immediately downstream of their confluence. To quantify dispersal, drift nets were deployed in both headwaters to measure downstream transport, while sticky traps were positioned along the streams and across the catchment divide to assess aerial movement. Habitat filtering was tested using an in-stream colonisation experiment in Grassmere Stream consisting of 15 experimental baskets representing three headwater habitat treatments: coarse rocks, wood, and a combination of rocks and wood. Baskets remained in the stream for one month over summer before macroinvertebrate colonisation was evaluated.

Together, these complementary approaches allowed us to distinguish whether headwater macroinvertebrate taxa fail to occur downstream because they rarely disperse beyond headwaters or because they are unable to establish in the contrasting habitats of larger streams. By experimentally separating the roles of dispersal and habitat filtering, this study provides new insight into the ecological processes maintaining biodiversity patterns in river networks and improves our understanding of the mechanisms underlying headwater conservation value.

Apparent stability masks limited recruitment in a long lived freshwater mussel: insights from 12 years of citizen science monitoring

Mr Mark Fenwick[1], Miss Sarah-Jane Jensen
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Freshwater mussels present a particular challenge for population assessment because adults are long-lived and can persist for decades, creating an illusion of population stability that masks underlying demographic vulnerability. Here we synthesise 12 years of biennial size frequency monitoring data for the endemic Aotearoa New Zealand mussel Echyridella menziesii (kākahi) at two sites in Lake Wairarapa, New Zealand, collected through an iwi-led, community-focused citizen science programme established in 2015. Size frequency distributions pooled across all survey years revealed adult-dominated size structures at both sites in all years, with a pronounced peak at approximately 60 mm shell length and very few juveniles (individuals smaller than 38 mm). Two episodic departures from this pattern were detected: subadults comprised 17.7% of the population at Western Shore in 2022, and juveniles 3.5% of the population at Northern Shore in 2025. In neither case did the signal persist into the subsequent survey cycle, consistent with episodic rather than sustained recruitment. The independence of these pulses across two sites separated by 12 km, combined with negligible growth rates documented for this species at the study site, argues against explanations based on cohort ageing or dispersal. Juvenile detections in the wider Lake Wairarapa area were spatially confined to stream-adjacent survey zones, suggesting that suitable conditions for recruitment and early survival are highly localised within the lake system. Comparison with size frequency data from other New Zealand lake systems suggests that adult-dominated, recruitment-limited population structures may be characteristic of E. menziesii in modified freshwater environments. These findings demonstrate the value of sustained, long-term citizen science monitoring for detecting episodic demographic signals that would remain undetected by short-term or infrequent surveys and highlight the importance of population structure analysis as a complement to abundance-based assessments in conservation monitoring of long-lived freshwater mussels.

Different Laboratories, Different Answers: Implications for Environmental Monitoring and Decision-Making

Dr Jennifer Gadd[1], Rhian Ingley[1], Dr Laura Buckthought[1], Dr Sharleen Yalden[1], Dr Nadia Dikareva[1], Dr Jane Atoa[1]
[1]Auckland Council

Water quality data underpin many environmental management decisions, including through assessing ecosystem condition, reporting trends, evaluating compliance and informing policy development. These data are generally assumed to be comparable between accredited laboratories using National Environmental Monitoring Standard (NEMS)-prescribed methods. However, Auckland Council's recent laboratory transition challenged this assumption and has revealed important implications for environmental assessment.

In July 2025, Auckland Council changed laboratories after eight years. To understand and manage the effect on long-term datasets, a comprehensive paired sampling programme was established across freshwater streams, lakes, groundwater and saline programmes. Over a 12-month period, water samples were analysed by the outgoing and incoming laboratories. This programme included analytes rarely assessed in paired sampling by other councils (metals, dissolved anions and cations, sediment).

At times the laboratories produced substantially different results for identical environmental samples despite using the same method. Systematic biases occurred across multiple analytes, where one laboratory consistently reported higher or lower concentrations. For a few variables, concentrations differed by up to an order of magnitude. Discrepancies were greatest at low concentrations that push analytical limits, where measurements are more susceptible to contamination, interference, and instrumentation limitations and higher uncertainty.

The implications for environmental monitoring are significant. Even small systematic shifts between laboratories may alter the outcome of trend analysis while remaining difficult to see in naturally variable environmental datasets without paired sampling. Larger differences can influence National Objectives Framework (NOF) state band classifications and assessments of compliance with consent conditions. Laboratory change alone could (in some cases) alter environmental narratives and management responses despite no real environmental change. As water quality datasets are increasingly integrated nationally, accounting for laboratory bias is essential for robust analysis and modelling.

These findings do not diminish the value of environmental monitoring data, but they emphasise the need to explicitly consider analytical uncertainty in our interpretation and decision-making. Cross-laboratory testing using low-concentration environmental samples could improve our confidence in analytical performance. This should be complemented by greater consideration of measurement uncertainty when interpreting trends and assessing compliance. Greater emphasis should also be placed on the magnitude of change, rather than trend direction alone, as apparent trends may fall within analytical uncertainty. If we fail to account for this uncertainty, we risk measuring change in the laboratory rather than change in the environment.

Investigating tuna health and parasite dynamics in a hapū-led research project at Tahaaroa Lakes

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Freshwater ecosystems are under increasing pressure from multiple stressors, and understanding how these changes influence the health of taonga species remains a key challenge. Ngaati Mahuta ki te Hauaauru, through the Tahaaroa Lakes Trust and in collaboration with the University of Otago, Earth Sciences New Zealand, and other research partners, has initiated a hapū-led investigation into tuna (shortfin eel; Anguilla australis) and lake health in the Tahaaroa Lakes, near Kāwhia. This project is funded through a Royal Society Te Apārangi Ngā Puanga Pūtaiao Fellowship, University of Otago Research Grant and a Te Poutama Māori Advancing Research Collaboration Grant, and aims to include mātauranga Māori and scientific approaches to better understand factors influencing tuna and lake health.

One key part of the project focuses on understanding parasite diversity and impacts in tuna, and the role of bird hosts in parasite transmission pathways. To date, we have examined more than 35 tuna from the Tahaaroa Lakes system collected through cultural harvesting, and identified hundreds of parasite specimens. Parasite species identities are being confirmed with DNA analysis, while pathological analyses of tuna tissue and blood assays are being used to investigate tuna responses to infection. In parallel, we are examining bird specimens to determine whether key parasite species identified in tuna are associated with particular avian hosts.

This talk will discuss the co-design and hapū-led research methods, and present preliminary findings on tuna parasite diversity and indicators of fish health responses. This work provides a foundation for understanding parasite dynamics within a culturally significant freshwater system and contributes to broader efforts to monitor and restore the health of taonga freshwater species.

Investigating the extent and impact of Didymo across Fiordland National Park.

Alice Gilbert[1], Professor Christoph Matthaei[1], Professor Ross Thompson[1]
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Landscape-scale changes such as urbanisation, agricultural intensification and deforestation have degraded most freshwater catchments, making large unmodified catchment areas increasingly rare globally. In Aotearoa New Zealand, Fiordland National Park is one such remaining largely intact freshwater landscape. The potential establishment of the invasive, benthic mat-forming diatom Didymosphenia geminata (Didymo) within this region poses a threat to these pristine ecosystems.

Although Didymo has been present in South Island waterways for two decades, existing studies focus mainly on large accessible rivers, leaving key knowledge gaps about invasion dynamics in unmodified environments, and the effects of Didymo on smaller waterways. Abundance, persistence, and ecological impacts of Didymo in remote, flood-prone streams also remain poorly understood. Fiordland therefore provides an ideal model system for studying the impacts of Didymo without the confounding influence of land-use change.

Our study investigates the distribution and ecological effects of Didymo in Fiordland streams, by building on the existing Didymo presence/absence data provided by the Department of Conservation (DOC), with a focus on benthic macroinvertebrate communities (the subject of this presentation) and periphyton communities. The study also represents the first large scale survey of Fiordland's benthic stream communities. Based on the existing research on Didymo in NZ, we hypothesised that high Didymo mat cover will alter invertebrate community structure, reducing the relative abundances of sensitive Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa while favouring tolerant species, as dense mats modify substrate and flow conditions, reducing habitat suitability for sensitive invertebrate taxa. However, we also hypothesised that Didymo mat establishment will be constrained by the flashy, high-disturbance nature of most Fiordland streams, therefore visible Didymo mats will be less common and their impacts on stream invertebrates less marked than in other regions of NZ.

We surveyed 70 stream sites (order 2-4) across Fiordland National Park from February to April 2026. Didymo was measured through mat thickness and cover estimates, two drift samples, and one periphyton sample per site. The Pfankuch bed stability index was determined as a proxy of the flood disturbance regime at each site, as well as a visual estimate of the dominant bed-sediment size classes. Invertebrate communities were observed using standard 5-minute kick-net sampling, and periphyton communities were sampled with a collated rock-scraping sample (10 rocks per site). Several physicochemical variables were also recorded, including dissolved nutrient and oxygen levels.

Bed patches with Didymo cover were present at 17 of 70 sites, and only 4 sites had > 15% bed surface cover (95-30%) of Didymo, in keeping with our second hypothesis. Consequently we revised our first hypothesis to predict that the invertebrate communities will be largely unaffected by Didymo cover at most sites. Invertebrate sample processing is underway and will be completed before the conference, and the results to date (first 30 samples) agree with this prediction. Overall, our findings will clarify impacts of Didymo in pristine, flood-prone waterways and will inform conservation management and biosecurity strategies for Fiordland's freshwater ecosystems.

Where is the management window? Quantifying leads and lags in lake eutrophication

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Lake eutrophication pathways can include multi-decadal lags between increased nutrient loading and measurable changes in lake condition. These lag effects are a fundamental challenge for lake management: by the time deterioration is observed, the best opportunity for intervention may have already passed. Management action taken before substantial ecological change occurs has the greatest potential to halt, and in some cases, reverse lake degradation. However, restricting or ceasing land-use activities is difficult to justify in the absence of observable environmental change. Understanding the duration and structure of these lags is therefore critical for identifying when proactive management should occur, particularly for the approximately 800 mesotrophic lakes in Aotearoa. Previous paleolimnological studies in Aotearoa indicates that some biological communities can respond to catchment disturbance before other indicators of eutrophication. However, the duration and consistency of these lead times are unresolved. Here we quantify the sequence and timing of impacts and biological and functional response across six lakes. We hypothesise that functional indicators exhibit substantial lags following increased nutrient loading, such that lakes can appear functionally stable for long periods following disturbance. We further hypothesise that some biological communities respond more directly to the onset of anthropogenic pressures. We test these hypotheses using paleolimnological reconstructions of impacts and response, from prior to European arrival to the present. Land-use and disturbance histories are derived from historical records and sedimentary proxies, including pollen, trace elements, and physical sediment characteristics. Lake responses are reconstructed using multiple proxies for ecosystem function and biological community composition, including indicators of productivity and redox conditions, fossil diatom assemblages, and environmental DNA metabarcoding of bacterial, microeukaryote and zooplankton communities. Preliminary results indicate lags of up to 70 years between the onset of impacts and functional indicators of eutrophication, including chlorophyll-a and bottom water anoxia. In contrast, biological communities exhibit increased rates of compositional turnover close to the onset of anthropogenic disturbance and up to 60 years prior to functional. These biological changes are sustained to present and are statistically significant and robust within chronological uncertainty. The results suggest that stability in lake functional indicators does not necessarily indicate ecological stability and that further resolving the sequence and duration of these biological and functional responses may reveal a potential window for proactive management.

Region-wide assessment of streambed sediment metal concentrations and ecological metrics

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Understanding the distribution and ecological relevance of heavy metals in deposited fine sediments is essential for assessing stressors in stream ecosystems, particularly in regions influenced by mineralised geology, historic mining, and urban development. This study synthesises sediment and biological data collected during the 2018–2020 summers to evaluate heavy metal contamination across wadeable streams in the Waikato Region and to determine whether any ecological indicators reliably reflect metal related stress.

Sediment samples were analysed for a suite of heavy metals and compared against ANZG default guideline values (DGVs). Spatial patterns were assessed in relation to land use, geology, and regional monitoring network coverage. Biological responses were evaluated using multiple macroinvertebrate metrics, including MCI, QMCI, ASPM, %EPT, EPT richness, and Acid Mine Drainage Index (AMDI), to test whether any metric response consistently aligned with heavy metal concentrations in deposited sediments.

Guideline exceedances were identified for several metals, though their regional extent was limited. An estimated 14% of wadeable stream length exceeded mercury guidelines, 7% exceeded nickel, and 4% exceeded arsenic. Arsenic exceedances were concentrated in the Coromandel, where geology and historic mining influence sediment chemistry. Arsenic above DGV levels is predicted to be a stressor for approximately 55% of Coromandel stream length. Cadmium was the only metal strongly correlated with developed land, aligning with agricultural land-use and showed a positive relationship with overall streambed sediment cover. Across the wider region, heavy metal contamination in deposited fine sediments was not widespread and was generally associated with natural geologies or legacy mining areas.

Biological metric analysis did not identify any indicator that consistently reflected metal related stress in benthic macroinvertebrate communities. Collectively, results suggest that while localised exceedances occur, deposited sediment metals are not a dominant regional driver of ecological condition, although current biological metrics may lack sensitivity to detect metal specific effects.

Out of sync: How extreme weather events reshape temporal coherence between lakes

Megan Hamersky[1], Whitney Woelmer, Jamie Howarth, Deniz Özkundakci
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Lakes exposed to similar climatic forcing often exhibit synchronous physical, chemical and biological dynamics despite differences in their morphology and catchment characteristics. This synchrony, referred to as temporal coherence, provides a measure of how connected lakes are to one another. These connections can provide information regarding how one lake will react to external events which in return could provide information about how lakes in the near-by vicinity will react. During calm weather conditions, lakes near one another will have similar physical conditions to one another, although the level of connectivity will vary based on the individual lake attributes. Extreme weather events have the potential to disrupt these relationships by altering mixing regimes, thermal structure and water quality. However, the extent to which such events modify temporal coherence among lakes remains poorly understood.

This study investigates temporal coherence by calculating the concordance correlation coefficient between lakes in the Bay of Plenty region of Aotearoa – New Zealand using hourly high frequency data over a 5-year period throughout the entire water column. A 21-day rolling window is used to quantify temporal coherence of water quality variables across 7 lakes. In general, we found that temporal coherence fluctuates greatly throughout the year depending on time of year. While the absolute temporal coherence values were relatively low (on a scale from -1 to 1), water temperature exhibited greater coherence during summer (0.21) than winter (0.15), suggesting a consistent seasonal increase in synchrony. When using a centralized weather station to identify extreme weather events (e.g., high wind events), we found that the relationships between the lakes do diverge from the average during these events, although the extent of this divergence depends on the intensity and duration of the event.

This research will improve our understanding of the relationships between lakes and how the environment, such as extreme weather events, could impact lake dynamics. The findings will provide new insights into the resilience of lake ecosystems to extreme weather events and help showcase whether lakes will react to these events in a similar manner with an increase of extreme weather events due to climate change.

Finding a safe operating space: Managing for resilience in temperate North American lakes

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Climate change, nutrient pollution, and invasive species are reshaping freshwater ecosystems worldwide, yet ecological responses often differ among systems. While some waterbodies are vulnerable to habitat loss and fish community shifts, others are surprisingly resilient despite equivalent levels of disturbance. Examining these "bright spots"—places where outcomes exceed expectations in the face of environmental stressors—can identify characteristics of resilient systems and define the safe operating space within which freshwater ecosystems continue to support desired ecological functions. Identifying local characteristics or management actions that influence ecosystem responses to large scale drivers provides a practical framework for identifying management levers that promote resilient freshwater ecosystems.

Drawing on long-term research from temperate lakes in the north-central United States, we synthesize two case studies to illustrate how the safe operating space framework can be used to manage for resilient freshwater habitats and fisheries. First, cisco (Coregonus artedi), a coldwater fish in North America, are vulnerable to habitat loss as warming waters and oxygen depletion reduce cold, oxygenated habitat. Extreme precipitation events exacerbate these impacts by delivering pulses of nutrients and organic matter that accelerate oxygen depletion and can trigger fish kills. Across thousands of lakes, however, we show that lakes experiencing similar climate trajectories can exhibit markedly different rates of habitat loss and fish population declines. While lake morphometry is a key driver of habitat persistence, watershed disturbance can substantially amplify or offset climate impacts across a range of lake types. We leverage these interactions to identify lake-specific watershed conservation targets that maximize the probability of retaining cisco habitat under future climate conditions in the places they are most likely to succeed. Habitat, however, represents only one dimension of resilience. Emerging evidence indicates that population-level variation in thermal tolerance may help explain different responses of cisco to similar reductions in oxythermal habitat. Integrating variation in physiological tolerance and performance alongside habitat projections offers new opportunities to match cisco populations with future habitat conditions and improve long-term persistence. Our second case study demonstrates how the safe operating space concept can directly inform adaptive fisheries management for managing harvest of walleye (Sander vitreus), a popular coolwater fish species for recreational and subsistence harvest. In Mille Lacs Lake (Minnesota, USA), walleye population abundance is influenced by interactions among climate, water clarity, invasive species, and harvest. We show that harvest limits that ignore environmental conditions can increase the risk of overharvest as ecosystems change, whereas linking safe harvest levels to contemporary environmental conditions within the safe operating space allows sustainable harvest that can be adapted as the ecosystem changes due to outside stressors.

Resilience emerges from interacting processes operating across multiple ecological scales, from species-level physiological variation to lake-level variation in morphometry and community composition to broader watershed land use practices and fisheries management strategies. Rather than focusing only on places where freshwater ecosystems are negatively affected, we ask why some systems continue to thrive and how lessons derived from these bright spots can be leveraged to guide freshwater management in a changing world.

How open-source tools can augment eDNA data to drive practical impact for freshwater science

Dr Kiel Hards[1], Mr Nick Snellgrove[1], Dr Petra Muellner[1]
[1]Epi

Environmental DNA (eDNA) is transforming freshwater science by improving our ability to monitor diverse and rare taxa at scale, while also generating large volumes of reusable data across time and space. In Aotearoa New Zealand, public, commercial and community groups are increasingly producing eDNA data to meet local biodiversity and biosecurity monitoring needs. Some of these data are already shared publicly through GBIF, while other datasets are made available with permission through public-facing platforms. This provides huge opportunities for freshwater monitoring, if data silos and technical boundaries can successfully be overcome. However, to realise this opportunity, accessible and reproducible tools are needed to make data sharing, analysis and reporting easier for data owners, researchers and decision-makers. Open-source software, particularly the R language and Quarto publishing system, offers a practical way to support data accessibility, shared capability and flexible analysis while still meeting the scientific complexity of eDNA datasets. As part of Ministry for the Environment-funded projects (now Ministry for Cities, Environment, Regions and Transport) to improve the sharing of eDNA data and analytical outputs, we built the eDNAbridge, a publicly available R package that automates the end-to-end process of submitting eDNA data from sequencing laboratories to global public repositories such as the Global Biodiversity Information Facility. We also developed automated and reproducible reporting tools to visualise regional and national summaries of freshwater ecosystem health, such as the Taxon Independent Community Index (TICI) and Fish Index of Biotic Integrity (FIBI). This talk will showcase how these tools reduce technical friction for data owners and analysts, support more consistent freshwater eDNA reporting, and help turn dispersed monitoring data into evidence that can turn data into impact.

Emerging Climatic Pressures on the Waikato River: acidification, deoxygenation, and an invasive filter feeder

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Rivers are not passive pipes carrying water to the sea, but "the largest biogeochemical nexus between the continents, ocean and atmosphere" (Battin et al., 2023). Through their metabolism rivers release terrestrial carbon to the atmosphere, and in doing so set the acidity and the oxygen content of the aquatic ecosystem. Over the last century that process has changed. Carbon dioxide concentrations in many fresh waters are rising, driving down pH, while warming reduces the oxygen available to aquatic life. Unlike the ocean, where carbon exchange is more predictable, and acidification has been tracked for decades, we have very little idea how far these changes have progressed in fresh water, what sets the pace, or which species and which uses of water are most exposed.

Emerging Climatic Pressures is a five-year MBIE Endeavour programme (2023–2028) working on the Waikato River, Aotearoa New Zealand's longest river and a drinking-water source for well over a million people. The programme asks three questions. How much are acidity and oxygen changing in a large, heavily used river system? What drives those changes across the catchment, from geothermal inputs and land use to lake mixing and weather? And what do the changes mean for freshwater life, for water treatment, and for the people who hold responsibility for the awa?

Answering these questions has required an unusually broad team. We combine continuous, high-frequency sensing of carbon and oxygen in the river and its hydro lakes, climate-controlled sediment incubations, numerical modelling of gas exchange and mixing, genomic work on taonga species, and kaupapa Māori research led with iwi partners on how restoration decisions are made.

Results so far point in a consistent direction. The controls on carbon dioxide in the Waikato hydro lakes switch with the mixing regime, so a routine surface-monitoring approach will not capture the system's behaviour year-round. Acidification measurably weakens the shells of freshwater snails, and shifts the mobility of phosphorus and trace elements at the sediment surface. Most unexpectedly, the arrival of the invasive gold clam (Corbicula fluminea) has added a large biological signal on top of the climatic one, altering water chemistry at scales that matter for drinking-water treatment. The climate signal and the invasion signal are now intertwined, and management will have to deal with both at once.

This presentation gives an overview of the programme, the emerging picture of a large river under combined climatic and biological pressure, and what the work implies for monitoring design and for the decisions facing catchment managers, water suppliers and iwi over this century.

Kākahi in our awa: The search for a taonga species in the rivers of Murihiku.

Kelsi Hayes[1]
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Freshwater mussels play a critical role in both the benthic and filtration processes of freshwater ecosystems across the globe. In Aotearoa, there is an increasing understanding about the importance of kākahi/freshwater mussels in our lakes and our rivers and how this taonga species may be used to build resilience into freshwater environments.

Despite the importance of the species, very little is known about the distribution and abundance of extant populations of kākahi in our unique southern waters. Regional differences in species composition and population dynamics, as well as seasonal climatic variations, mean there are also significant knowledge gaps affecting our ability to implement effective conservation management for kākahi within Murihiku/Southland. The primary aim of my research is to determine the drivers of fluvial distribution of kākahi in Southland.

The first part of my research has involved searching all of the wadeable streams within the Mataura Freshwater Management Unit in Southland for the presence of kākahi. The specific sections of streams that were searched were prioritised based on available public and private eDNA results. eDNA was not available for every stream in the search area but all orders three and four streams within the FMU were searched. Habitat assessments of each site included factors such as the composition of the substrate, bank erodibility, access to shade, riparian margins and vegetation, and land use. Located kākahi populations were counted and individuals found were assessed for both shell abrasion and size.

I found that the majority of the wadeable streams in the search area contained kākahi populations. A lot of these populations appeared to be thriving but a couple of populations were older and essentially functionally extinct. Populations were mostly consistent with eDNA detections but some new populations were discovered in areas where eDNA detection had not taken place. While the historic distribution of kākahi populations has been poorly documented, there is a potential correlation apparent in the universal absence of kākahi from sites with significant histories of substrate disruption, such as from historic gold or coal mining. One of these sites was in the Waikaka Stream, a river named for the abundance of kākahi found within it.

Importantly, most of the located kākahi populations demonstrated clear evidence of juvenile recruitment. The next step in this research is to figure out how this recruitment is occurring and which fish species are helping host the kākahi glochidia. This is likely to be very different in Southland than in the Waikato where previous research on glochidia hosts has been focused.

My research has provided a baseline understanding of kākahi populations in the rivers of the Mataura region of Murihiku. This is critical information that will help to aid the future conservation of this taonga species. In turn, the conservation of kākahi in our awa will help maintain and build the resilience of our freshwater environments for future generations, not just in Murihiku, but right across Aotearoa.

Forecasting thermal stratification in a polymictic lake

Sepideh Heydari[1], Dr Whitney Woelmer[1], Professor Melanie Ooi[1], Lanxi Li[1], Professor Deniz Özkundakci[1]
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Thermal stratification regulates the vertical exchange of heat, oxygen and nutrients, shaping lake ecosystem functioning and cyanobacterial dynamics. In polymictic lakes, stratification can develop and break down over hours to days, making physical conditions highly dynamic. Forecasting these dynamics is a critical first step towards ecological forecasting, yet whether thermal stratification remains predictable at sub-daily resolution over multi-day horizons is unknown.
In this study, we used a 2007-2026 dataset combining long-term fixed-depth water-temperature observations with high-frequency profiles collected by a profiling buoy at the deepest site of Lake Rotorua, together with historical and forecast meteorology. We developed a recursive modelling framework that issues a new seven-day forecast of Schmidt stability every three hours. Using recent water-temperature observations and weather forecasts, our hybrid machine-learning model (LSTM–XGBoost) demonstrated strong predictive performance at short lead times. Despite a gradual decline in performance as lead time increased, the model retained meaningful predictive skill throughout the seven-day forecast horizon. These results demonstrate that even the highly transient stratification dynamics of a polymictic lake can remain predictable over multi-day forecast horizons.
To assess whether this predictability can also be reproduced mechanistically, the same forecasting framework was implemented using a process-based model (GLM) to simulate future temperature profiles from which Schmidt stability is derived. Our results demonstrate that thermal stratification remains sufficiently predictable to provide the physical foundation for ecological forecasting, supporting future prediction of water-quality responses, including cyanobacterial risk.

Torrentfish decline in a Waikato stream: a local event or evidence of a broader pattern?

Prof Brendan Hicks[1,2], Dr Frank Burdon[2], Dr Mike Pingram[3]
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The torrentfish is an endemic species and the only member of the Cheimarrichthyidae, New Zealand's only endemic freshwater fish family. Its 2023 Conservation status was At Risk – Naturally Uncommon, which suggests that physical records are patchy. Around the Waikato, torrentfish have been regularly found historically but declines in abundance of torrentfish in the Rangitukia Stream are worthy of investigation. This stream is steep and bouldery and flows from the slopes of Mt Pirongia. It has been the focus of freshwater ecology field trips from the University of Waikato since 1993. These field trips have provided a unique, long-term record of the fish communities through electrofishing over 33 years. Torrentfish were a common part of the fish community in the Rangitukia Stream during the first 19 years of fishing but have not been caught since 2012 despite no change in sampling effort. Longfin eels and Cran's bully have consistently dominated the fish populations numerically and still do so, with shortfin eels, brown trout, larval lampreys and common smelt present in lower numbers. We explore Waikato Regional Council's State of the Environment fishing and reporting, New Zealand's Freshwater Fish Database, and eDNA records to establish whether the decline in torrentfish in the Rangitukia Stream is isolated event, suggesting introduction of a barrier to fish migration of some kind. Alternatively, the observed change could be evidence of a wider pattern of declining torrentfish abundance.

Fish biomass and lake ecosystem function

Prof Brendan Hicks[1]
[1]Pattle Delamore Partners

Biomass estimates for eels and NZ freshwaters are rare and increasingly precious with the expansion of eDNA for biodiversity studies and a reduction in resources applied to physical fish capture at scale. Relative catch rates with nets and electrofishing can be to estimate fish abundance with catch per unit effort and also yield size structure. Estimates of absolute abundance, however, are best made by depletion removal or mark-recapture methods and can be related to area sampled to give true biomass, which is somewhat of a holy grail of ecology.

This research combines some key studies around New Zealand to illustrate what we have learned from estimates of absolute abundance, particularly for eels, an iconic native fish species. In Waikato lakes, there is clear evidence of competition for resources, particularly between shortfin eels and brown bullhead catfish. Both are caught effectively with fyke netting, suggesting close habitat overlap, and studies of stomach contents and stable isotopes show a clear overlap between the diets of eels and catfish. Repeated removals of invasive fish from Lake Ohinewai and successive mark-recapture population estimates showed a clear response of eel and catfish biomass to removal of a large biomass of koi carp. There was a five-fold increase in both shortfin and longfin eel biomass (from 8.6 to 44.2 kg/ha, capture with replacement) but catfish increased three-fold despite capture with removal, probably also as a response to koi removal.

From these results we can conclude that koi carp and brown bullhead catfish constrain eel abundance in lakes and that therefore their spread should be avoided wherever possible. If feasible, catfish and koi biomass should be controlled to enhance eel abundance.

Effects of dynamic stream shading on stream temperature across seasons and land use settings

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Stream shading is widely recognised as one of the most effective natural mechanisms for regulating stream temperature by reducing the amount of incoming solar radiation reaching the water surface. Maintaining appropriate stream temperatures is essential for freshwater ecosystem health and water quality, influencing dissolved oxygen availability, biogeochemical processes, and the sensitivity of aquatic organisms to environmental stressors. Previous studies have relied on field-based canopy measurements or static riparian vegetation metrics that do not capture the spatial and temporal variability of stream shading. This study investigates the influence of dynamic stream shading on stream temperature across different seasons and land use settings using a physically based, high-resolution shadow-casting approach.

Stream shade factors were estimated using a LiDAR-based shadow-casting method that explicitly accounts for terrain, riparian vegetation, and built structures that intercept incoming solar radiation. High-resolution LiDAR-derived raster data were combined with solar geometry to estimate hourly stream shading across multiple spatial scales.

The Auckland region, New Zealand, provides an ideal case study owing to the availability of recent high-resolution LiDAR data and an extensive network of 38 high-frequency stream temperature monitoring sites distributed across Native Forest, Exotic Forest, Pasture, and Urban catchments. Daily maximum (Tmax), minimum (Tmin), mean temperature (Tmean), and diurnal temperature range (DTR) were used to characterise stream thermal regimes. Multivariate statistical analyses and linear regression were used to evaluate the influence of stream shading, season, and land use on stream temperature. This fed into a mixed-effects model to predict hourly stream temperature.

Stream shading was a major control on stream thermal regimes, explaining approximately 20% of thermal variation. Increasing shade was consistently associated with lower stream temperatures and reduced diurnal temperature ranges. Seasonal variation was the dominant driver, accounting for 47% of thermal variation through differences in air temperature, solar radiation, and day length. Although stream shading exerted a significant cooling influence throughout the year, its effectiveness varied seasonally, with the strongest cooling observed in spring, followed by autumn and summer, and the weakest response in winter when lower solar radiation and shorter daylight hours limited stream heating. Across all seasons, shading had the greatest influence on Tmax, followed by Tmean, while its effects on Tmin and DTR were comparatively smaller.

Land use also significantly influenced stream temperature but explained a much smaller proportion of thermal variation (7.9%) than season and stream shading. Urban catchments exhibited the strongest cooling response to increased shading, highlighting the potential of riparian restoration to mitigate elevated stream temperatures. In contrast, Native Forest streams were already highly shaded and exhibited limited variation in diurnal temperature range, resulting in no significant relationship between shading and DTR.

Finally, a linear mixed-effects model incorporating stream shading, climatic variables (air temperature, solar radiation, and season), and land use successfully predicted hourly stream temperature ($R^2 = 0.82$). The methodology enables high-resolution assessment of stream shading across spatial and temporal scales and provides a practical framework for predicting stream temperature, evaluating the thermal benefits of riparian restoration, prioritising restoration efforts, and supporting climate adaptation and freshwater management.

Do extreme storms provide a natural sediment capping mechanism improving the state of eutrophic lakes?

Prof. Jamie Howarth[1], Dr Xun Li[2], Dr Georgia Thomson-Laing[3], Dr Rose Gregersen[4], Dr Jonathan Puddick[4], Dr Sean Water[5], Ms Lizette Reyes[2], Ms Emily Carr[1], Ms Johanna von Hunerbein[1], Prof. Sean Fitzsimons[6], Dr Marcus Vandergoes[2], Prof. Susie Wood[7]
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Extreme weather events can profoundly alter the physical, chemical and biological functioning of lakes, and their impacts are likely to intensify as the frequency and magnitude of extreme rainfall increase with anthropogenic climate change. High-magnitude rainfall events can disrupt lake stratification and deliver large pulses of sediment and nutrients from catchments, with cascading effects through aquatic ecosystems. However, the same events can also trigger landsliding that mobilises relatively nutrient-poor subsurface material, producing decimetre-thick deposits across lake beds. We hypothesise that these deposits can act as a natural sediment cap, burying nutrient-enriched surface sediments and reducing the internal nutrient recycling that sustains eutrophication and harmful algal blooms. We test this hypothesis using a palaeolimnological reconstruction of ecosystem change associated with Cyclone Bola (1988) in Lakes Tūtira and Waikōpiro, two monomictic lakes in Hawke's Bay, Aotearoa New Zealand. High-resolution chronologies for the past ~70 years are constrained by Pb-210 and Cs-137 dating and correlations between sedimentary storm deposits and the instrumental rainfall record. Changes in sediment phosphorus availability before, during and after Cyclone Bola are quantified using sequential phosphorus extractions. Ecosystem responses are reconstructed using multiple complementary proxies, including sedimentary pigments, fossil diatoms, zooplankton remains, and sedimentary DNA assays targeting bacteria, macrophytes and microbial eukaryotes.

Preliminary results indicate substantial changes in community composition and reduced abundance across multiple components of the lake ecosystems following Cyclone Bola, with effects persisting for several years. Forthcoming sediment-phosphorus analyses will test whether these biological changes coincide with reduced availability and internal recycling of sediment-bound nutrients following emplacement of the storm deposit. If supported, the results would identify an overlooked mechanism by which extreme storms can produce long-term suppression of internal nutrient cycling through sediment burial. This mechanism may also provide insights for lake restoration, particularly the potential to mimic natural sediment-capping processes alongside sustained reductions in catchment nutrient inputs.

CFD Modelling of complex flows using OpenFoam and Claude AI

Kelly Hughes[1]
[1]ATS Environmental

Computational Fluid Dynamics (CFD) has become an indispensable tool for evaluating fish passage structures, enabling humans to see the world through the lens of a fish. The barrier to entry mesh generation, case setup, boundary condition specification, and results interpretation has traditionally confined this capability to specialist modellers. This presentation describes how ATS Environmental has integrated Claude AI into an OpenFOAM-based CFD workflow to accelerate the design, validation, and communication of in-stream structures, including baffled culverts and the FlexiBaffle deflector system, while preserving the rigour required for regulatory and client-facing outputs and significantly reducing costs.

Our approach uses AI assistance across three stages of the modelling pipeline. At the pre-processing stage, we built a parametric integration linking web-based FlexiBaffle Configuration Tools to OpenFOAM through a structured JSON schema. Claude was used to scaffold case templates, generate STL geometry from configuration parameters, and write results-parsing scripts, reducing the time from configuration to simulation-ready case. At the analysis stage, we use AI-assisted engineering calculations for dynamic pressure loading, with drag coefficients derived from physical test data to cross-check CFD-derived operating points for baffle deflection under hydraulic loading, closing the loop between physical testing and simulation. At the validation stage, we compared OpenFOAM outputs against the industry-standard HY-8 model for a large pipe-arch evaluating baffled and unbaffled configurations. This comparison found strong agreement between methods at high flow (approximately 2% velocity difference, matching depth predictions) but divergence of up to 20% at low flow, which we attribute to roll-wave instability and relative roughness effects becoming more significant as flow depth decreases. This finding has direct implications for practitioners relying on HY-8 alone in low-flow design conditions.

Beyond simulation itself, we present how AI tools have supported the "last mile" of CFD work: translating dense hydraulic outputs into forms usable by engineers, clients, and regulators. Visual communication tools illustrate stratified flow concepts such as a high-velocity core jet sitting above a low-velocity refuge zone behind a baffle that convey to non-specialist audiences why a given baffle configuration provides passable low-velocity zones for target fish species. We also touch on the exploration of embedded culvert design as a velocity-reduction strategy, using simplified $V = Q/A$ relationships to rapidly screen design options before committing to full CFD runs.

We conclude with lessons learned on where AI assistance adds genuine efficiency (case scaffolding, scripting, report drafting, visual explainers) versus where expert judgement remains essential (boundary condition selection, turbulence model choice, interpretation of divergent low-flow results). We argue that AI-assisted workflows do not replace CFD expertise but can meaningfully lower the cost of iteration, allowing practitioners to explore more design configurations, validate more rigorously against established methods, and communicate results more effectively to the range of stakeholders involved in fish passage remediation projects.

Trophic manipulation as an in-lake restoration tool for a shallow, dystrophic dune lake: coupled zooplankton, macrophyte and coarse fish responses at Lake Tomorata

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Lake Tomorata is a small (~15 ha), shallow, polymictic dune lake in Te Arai, Auckland, and is the region's only monitored dystrophic lake. Despite its status as a Significant Ecological Area, it has degraded to a poor, eutrophic condition (Trophic Level Index ~4.0–4.8; total nitrogen and phytoplankton in the NPS-FM C band). Submerged macrophytes cover <10% (LakeSPI 0), and the lake oscillates between vegetated clear water and turbid, algal dominated states.

Conventional catchment nutrient management is unlikely to reverse this trajectory. The catchment is small (~104 ha), the lake has no natural surface inflows or outflows, and part of the enrichment is sustained internally through sediment nutrient release and disruptions to in-lake ecosystem functions. Two illegally introduced coarse fish, rudd (Scardinius erythrophthalmus) and tench (Tinca tinca), present since 1971, are considered primary contributors to the lakes depauperate state through macrophyte herbivory, benthic disturbance, and larval planktivory. Biannual gill netting was used to remove coarse fish and act as a sustained top-down manipulation lever.

Coarse fish CPUE/biomass, zooplankton assemblage, and LakeSPI assessments were used as ecosystem function indicators that represent different trophic levels. Eight netting events (August 2022–April 2026) removed 385.6 kg of coarse fish (rudd 212.8 kg; tench 172.8 kg). Tench catches declined consistently (winter first-set CPUE ~91%, winter biomass ~78%), consistent with genuine suppression, whereas rudd continue to exhibit a boom-bust cycle where first-set CPUE fell to a programme low in August 2025 before rebounding to a programme high in April 2026.

During fish suppression, the large-bodied grazer Daphnia galeata nearly tripled in mean abundance and doubled its share of the cladoceran assemblage, while macrophytes recovered from a LakeSPI score of 0 to 46%, with no grazing damage or feeding pits. When rudd resurged, Daphnia collapsed to near-absent, the assemblage reverted to small-bodied taxa, and the lake was devegetated again by March 2026.

This bidirectional response indicates that rudd drives the zooplankton and macrophyte signals and tench the benthic disturbance, both signals directly influence in-lake state swapping. The system tracked fish pressure in both directions with a clear macrophyte response. Zooplankton responses tracked variations in planktivory but were within historic seasonal variance indicating a dynamic long-term system equilibrium.

Bottom-up manipulation using phosphorus sequestration agents and macrophyte phosphorus binding was also investigated. Top-down manipulation was prioritised due to the immediate biosecurity gain, and further data was needed before flocculants and macrophyte restoration could be justified. The newly acquired monitoring data now supports both bottom-up interventions. Flocculants are intended to supplement the current top-down approach should the desired gains not be realised. The preferred bottom-up intervention is macrophyte restoration, with active trials underway.

The evidence remains correlational at this stage of the 10 year project due to seasonal influences on complex trophic interactions. However, the coupled responses support the combination of top-down and bottom-up manipulation as a viable in-lake restoration approach for shallow lakes where catchment measures alone are insufficient. This presentation will discuss the two-way management approach being implemented at Tomorata and its transferability to other lakes.

Reframing Fish Passage from Single Metrics to Structured Complexity

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Shifting the Paradigm in Fish Passage Design: From Simplistic Metrics to Structured Complexity. Traditionally, regulations for fish passage have relied on strict, long-standing criteria based on decades-old research. While ecologists recognized the inherent complexity of aquatic systems, translating this knowledge into quantifiable, compliance-based habitat standards has proved challenging. This necessity led to an oversimplification of dynamic environments, resulting in a set of design criteria that were easy to enforce but fundamentally simplistic and misleading. Design focus narrowed primarily to three conventional cornerstones: maximum average velocity, maximum gradient, avoid turbulence. These three metrics are insufficient in isolation. Maximum average velocity is largely irrelevant for fish and is only accurately measurable in laminar type flows. Successful passage is determined by the maximum velocity encountered over a specific distance coupled with complexity. In heterogeneous (complex) flow fields, average velocity becomes ecologically inert because individual fish navigate radically different, often slower, flow paths around roughness elements. Maximum gradient is misleading without considering crucial co-factors such as flow-rate, channel roughness, and overall hydraulic complexity. Avoiding turbulence is an oversimplification. Turbulence encompasses various facets, and a thorough assessment is needed to determine if it truly constitutes a barrier to fish movement. This conventional approach, which produced homogeneous, symmetrical designs not found in nature, ignores that fish actively exploit organized, periodic vortex structures (Kármán gaiting) to reduce metabolic cost. High Turbulent Kinetic Energy (TKE) measurements alone fail to resolve this necessary temporal structure. Latest research, including Computational Fluid Dynamics (CFD) simulation, indicates that fish primarily use three distinct mechanisms moving upstream through complex flows. Reframing assessment around flow complexity means the design target is no longer hydraulic uniformity; it is structured heterogeneity. The goal is to create a flow field that simultaneously contains fast and slow water, organised and dissipated vortex zones, allowing fish of different species and life stages to select a viable path. Depth is also critical, specifically the usable, low-velocity near-bed boundary layer, which is the navigable zone for small-bodied benthic species and scales with substrate roughness. Furthermore, heterogeneous flow paths force individual water particles to travel different routes, hydraulically "lengthening" the structure and reducing the effective gradient for slower paths. For post-construction or post-remediation monitoring, a complexity-based assessment shifts the question from "did fish pass?" to "does this structure provide the hydraulic conditions within which fish passage is reasonable to expect?". This moves away from expensive, limited fish count surveys toward a structured visual assessment of flow complexity, depth, and connectivity, scored against the natural channel immediately upstream as a reference. This reference comparison is the key innovation, establishing hydraulic conditions for passage if the structure scores comparably to the natural reach. To modernise, standardise, and strengthen fish passage guidance, a new descriptive and definitional approach is emerging. The overall challenge is to embrace this new understanding of aquatic mechanisms in both practical and regulatory frameworks to ensure consistency across designs, permits, and compliance monitoring.

Observations of Juvenile Kākahi Habitat

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For decades, the early juvenile stages of Echyridella menziesii and Echyridella aucklandica (kākahi, freshwater mussels) have remained one of New Zealand freshwater ecology's enduring mysteries. Following detachment from their host fish, juveniles largely disappear from view, often thought to be within the substrate below. Conventional surveys consistently detect very few individuals, especially below 10mm. New observations from Auckland streams suggest we may have been looking in the wrong places, and that the root of the problem may be roots themselves.

As part of a collaborative monitoring programme with mana whenua and Kaipātiki Project, routine kākahi surveys across Auckland and Great Barrier Island led to the unexpected discovery of juveniles as small as 6 mm within complex root habitats not typically searched during freshwater mussel monitoring. This initial observation prompted modifications to existing survey approaches and targeted searches of similar habitats in other Auckland streams supporting broad kākahi size ranges.

Across multiple streams and catchments, juveniles were repeatedly detected within root mats and undercut banks, suggesting these habitats may provide important refugia during their earliest life stages.

These emerging observations have the potential to challenge existing assumptions about kākahi habitat and help explain why conventional surveys detect so few young individuals.

This presentation will describe the habitats in which juveniles have been recorded, examine the implications for monitoring and population assessments, and identify current limitations and future research priorities. By changing where and how we search, we may uncover a previously overlooked part of the kākahi life cycle and strengthen our ability to understand and protect these freshwater filters.

A novel refuge for kōaro (Galaxias brevipinnis): population demography, movement, and trophic structure in a lake-margin wetland periodically invaded by trout

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Wetlands are important for biodiversity and ecosystem services but are frequently impacted by human drivers including agricultural drainage and climate change. Their ecological integrity may be further imperilled where they are hydrologically connected to waterbodies supporting invasive predators. Although protected in Aotearoa New Zealand and increasingly recognised for their value in freshwater conservation, the ecological function of wetlands as refugia for native fishes other than Neochanna spp. remains poorly understood.

The spring-fed Millar Road Wetland (MRW), on the margin of Lake Ōkāreka in the Rotorua Te Arawa Lakes Region, supports a population of kōaro (Galaxias brevipinnis). Given wetlands are an atypical habitat for this species, I examined the demographic and ecological mechanisms underpinning the potential function of MRW as a refuge supporting a persistent population of kōaro. I used monthly sampling with minnow traps, mark–recapture analysis with PIT (Passive Integrated Transponder) tags, and stable isotopes to investigate population dynamics, species interactions, and trophic structure. In this presentation, I explore the ecological characteristics of the MRW kōaro population and consider the mechanisms that may enable its persistence within a wetland connected to an invaded lake.

MRW supported a resident, multi-cohort kōaro population with evidence of ongoing recruitment and high site fidelity. Although juvenile rainbow trout (Oncorhynchus mykiss) periodically entered the wetland, their occurrence was spatially restricted and appeared to be mediated by hydrological connectivity. Local environmental conditions may constrain trout while remaining within the tolerance limits of kōaro. Stable isotope analysis demonstrated trophic differentiation between kōaro and common bullies (Gobiomorphus cotidianus), indicating distinct resource-use patterns that may facilitate coexistence within the wetland.

My findings indicate that refuge function in MRW is driven by environmental filtering and trophic organisation rather than complete exclusion of invasive predators. Hydrological connectivity may facilitate predator access, while local environmental conditions favour kōaro persistence in this novel habitat. Small, groundwater-fed wetlands may therefore represent important climate-resilient refugia for taonga species and warrant greater consideration in freshwater conservation and restoration. Evaluating whether similar wetland refugia occur elsewhere in the Arawa Lakes would help determine the broader potential for wetland protection and restoration to contribute to kōaro persistence under future climatic and hydrological change.

Adopting farm practices to improve water quality: how hard can it be?

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The adoption of new practices is vital for agriculture to respond productively to community pressures improve water quality. One of the strongest influences on farmers' adoption of practices is their perception of the difficulty of changing practice as this affects the benefits and costs of change. Fine-grained differences in the characteristics of farm systems results in differences in farmers' perceptions of the difficulty of changing practice, resulting in the differential adoption of practices. The extent to which differences in the characteristics of farm systems lead to diversity in farmers' perceptions of the complexity of changing practices, and how those perceptions translate into differences in adoption, has rarely been explored.

Using survey data, we investigated farmers' perceptions of the complexity of adopting four practices that affect water quality (fencing wet areas, fencing streams, planting cover crops following winter grazing virtual and virtual fencing). We found that subtle differences in a variety of characteristics of farm systems were associated with differences in farmers' perceptions of the complexity of adopting these practices, and so the frequency of their adoption.

The results highlight how the scope promote the adoption by farmers of practices to improve water quality depends less on education and extension and more on for extent to which desirable practices can be customised to fit different farm systems. The results also suggest and that opposition of farmers to regulations intended to improve water quality may reflect concerns about the feasibility of compliance rather than opposition to policy intention.

The influence of catchment groups: peer pressure or social learning?

Dr Geoff Kaine[1], Dr Pam Booth, Dr Vic Wright
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Catchment groups have grown in popularity as a means of promoting the adoption of practices to benefit the environment in New Zealand. In principle, catchment groups may influence the adoption of desirable practices by farmers through peer pressure and/or providing opportunities for social learning as well by supporting collaboration and co-ordination. Given catchment groups are an increasingly important avenue for public investment to promote the adoption of sustainable farming practices, knowing the influence that peer pressure may have on the adoption of practices is important.

We investigated the influence of peer pressure on the intentions of farmers in New Zealand to adopt practices that improve environmental performance or productivity. Of particular interest was the extent to which the influence of peer pressure differed, if at all, between farmers who were members of catchment groups and those who were not.

We found that peer pressure from farming neighbours and catchment group members did not, but family norms did, influence farmers' intentions to improve environmental performance or productivity. This finding suggests that catchment groups primarily influence the adoption of practices through raising awareness and reducing search costs (and not through peer pressure).

One important implication of this finding is that policies seeking to promote the adoption of desirable farming practices, by encouraging farmers to join catchment groups, should also target the building of the capacity of groups to provide opportunities for social learning. Another is that differences between catchment group members and non-members in the adoption of practices to improve the environment are more likely to reflect differences in contextual constraints and the effort required to identify and implement suitable practices, and less likely to be the product of peer pressure.

Moving the Middle – Catchment groups & environmental performance on farms

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Farmers and growers play a critical role in reversing environmental decline and achieving Aotearoa New Zealand's environmental goals. Although many are willing to make changes that benefit both the environment and their businesses, they often face information overload and the complexity of interacting financial, policy and community systems.
The Moving the Middle research programme recognises that providing more information, tools or technologies alone will not deliver the scale of change required. Instead, it focuses on the human dimensions of these systems to identify interventions that reduce pressure on farmers and growers and enable meaningful action.
Using randomised controlled trials, typologies and surveys, the programme examined the influence of catchment groups and behavioural nudges on environmental outcomes, along with factors that contribute to catchment group success. A typology of catchment groups was developed based on key "hurdles" or preconditions for success. While overcoming these hurdles does not guarantee success, failing to do so makes it unlikely that groups will achieve their objectives. The typology considers a group's purpose, stakeholder relationships and member motivations, helping identify potential barriers and opportunities to improve effectiveness.
Research findings showed that some behavioural nudges increased attendance and perceived value among existing catchment group members, although they did not attract new members. The study also found that the benefits reported by catchment group members were similar to those reported by non-members. In addition, the research quantified the time, effort and financial investment farmers and growers make in land management practices that improve environmental outcomes. Together, these findings highlight the value of catchment groups and provide insights into how participation and environmental action may be strengthened.

Kākahu Peke Peke Daylighting: More Than Just a Project

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This presentation shares my experience as the rangatahi representative for Ngāi Tamarāwaho on the Kākahu Peke Peke Stream Daylighting Project, working alongside Tauranga City Council (TCC) as part of the project team. This is the first time that such an approach has been created on a TCC infrastructure project. It explains why this opportunity has been significant for both me personally and my hapū, and how it continues the legacy of those who came before us in rebuilding our relationship with council. It demonstrates how genuine partnership between our hapū and council can create positive outcomes for both the environment and the community.

I explore the history of Ngāi Tamarāwaho, the legacy of land confiscation and conflict that fractured the relationship between crown and hapū, and how the daylighting project has contributed towards restoring that relationship. I then focus on the Kākahu Peke Peke project itself, a stormwater renewals project where a 1950 mm diameter, 215 m long culvert needed to be replaced before it failed. Instead of building a new pipe, we are daylighting the stream to achieve ecological benefits and create a community asset.

Prior to this project, the stream in the culvert was unnamed on council systems, only being listed as “unnamed stormwater drain”. I explain how the name Kākahu Peke Peke was gifted, the whakapapa of the wai, and how these stories have shaped the project. It demonstrates how city waters and our hapū can work together to restore not only the health of the stream, but also our cultural connection to the wai and ensure mana whenua values are embedded throughout the project.

The role has given me the opportunity to work alongside consultants delivering ecological, engineering and design aspects of the project. From eDNA sampling and fish trapping to LiDAR mapping and hydraulic modelling I have been able to experience the different roles that contribute to successful infrastructure projects. Through this, I reflect on how western science and matauranga Maori provide complementary, rather than conflicting, world views.

This project has been a success story in how a genuine, collaborative approach to a stormwater project has meaningful results. It has strengthened project outcomes, created opportunities for rangatahi leadership, enhanced the relationship between hapū and TCC and is providing a model for how City Waters can work more constructively with hapū, showing that Maori history, culture and values will be an integral part of future TCC infrastructure.

Contrasting biological responses to human disturbance across sub-catchments in Lake Wānaka

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Since Māori and later European settlement, lakes in Aotearoa New Zealand have been subjected to multiple anthropogenic pressures. Land-use change, species introductions, pollution, and habitat modification have altered aquatic communities and driven widespread biodiversity loss. Although ecological change in smaller eutrophic lakes is well documented, the long-term responses of large micro- and oligotrophic lakes remain poorly understood.
Molecular methods such as environmental DNA (eDNA) are playing an increasingly important role in characterising biodiversity. Since all living organisms shed DNA, eDNA collected from lakes can provide information on local communities both in a lake and its surrounding catchment. Additionally, eDNA can accumulate in lake sediments, slowly and sequentially burying an archive of snapshots detailing community composition. This sedimentary ancient DNA (sedaDNA) holds records of more than 1000 years, predating human presence in Aotearoa New Zealand.
In this study we focused on Lake Wānaka, one of the largest micro-trophic lakes in Aotearoa New Zealand, and use sedaDNA to characterise biodiversity changes over 1000 years of changing human occupation. We chose two sub-catchments with different exposure to disturbance events and land-use. Roys Bay, which receives inputs from the urban settlement of Wānaka and is more exposed to open-lake conditions, and Glendhu Bay, which is surrounded by agricultural grazing land and receives substantial terrestrial sediment inputs from inflowing streams. We have investigated the biotic communities using metabarcoding across five different genes; 16S rRNA for bacterial diversity, trnL and rbcL for terrestrial plants and macrophytes, CO1 and 18S rRNA for micro-eukaryotic diversity. These data were interpreted alongside a chronology produced from Pb-210, Cs-137 and C-14, pollen abundance and independent proxies of human activity and land-use change, including charcoal abundance and cadmium flux. This presentation highlights key changes in biological communities over time, nuanced differences between the two sampling sites, and provides insights into the potential drivers of these changes.
The Roys and Glendhu Bay sub-catchments showed a strong difference in bacterial diversity in pre-human times, becoming increasingly homogenised until reaching structural equivalence in recently deposited sediments. These findings suggest that anthropogenic pressures have homogenised bacterial communities within Lake Wānaka, potentially reducing the ecological heterogeneity and unique habitats that previously existed across its sub-catchments. Analysis of both the plant genes and pollen showed a strong convergence of communities after wide-spread burning post Māori settlement and the emergence of bracken fern. However, due to many introductions and deliberate planting by Europeans, plant communities diverge again in modern times. In conclusion, our findings demonstrate that distinct biological communities can exist within different sub-catchments of a single lake and that anthropogenic pressures have altered these communities in taxon-specific ways, leading to both biotic homogenisation and divergence over time.

Modelling Potential Dispersal Pathways of the Invasive Freshwater Gold Clam (Corbicula fluminea) in Lake Karāpiro Using Three-Dimensional Hydrodynamic Particle Tracking

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The recent establishment of the invasive freshwater gold clam (Corbicula fluminea) within the Waikato River catchment presents a significant biosecurity threat to New Zealand freshwater ecosystems. Gold clams are highly invasive, capable of rapid population expansion, and have the potential to alter benthic habitats, food webs, nutrient cycling, and negatively impact water infrastructure. Understanding the mechanisms and pathways by which this species disperses within connected freshwater systems is critical for informing surveillance, containment, and management strategies.

This study investigates the passive transport and potential spread of gold clam veligers (young) within Lake Karāpiro using a three-dimensional hydrodynamic and particle tracking modelling framework. Lake Karāpiro is a key component of the Waikato River hydro-lake system and may act as a source of gold clam veligers to downstream waters. To better understand potential dispersal pathways associated with water movement, forward and backward particle tracking simulations are being undertaken using hydrodynamic outputs generated by the three-dimensional model AEM3D. Forward tracking simulations are used to assess potential transport pathways and identify locations that may be vulnerable to future colonisation. Backward tracking simulations are used to identify possible source locations and connectivity pathways associated with observed or hypothetical infestations. Together, these complementary approaches provide insight into hydrodynamic connectivity, retention zones, and regions where particles may preferentially accumulate.

The hydrodynamic model has been configured for Lake Karāpiro with a high-resolution computational grid with 25 m in horizontal resolution. The vertical water column is represented by 30 layers, with layer thicknesses of 0.5 m in the upper water column increasing progressively to a maximum of 2 m near the lake bed, resolving the lake's maximum depth of approximately 36.6 m. Meteorological forcing is provided using hourly atmospheric data from the New Zealand Convective Scale Model (NZCSM) for the period 2015–2024. Spatial variability in wind forcing is represented through 18 wind regions distributed across the lake, allowing improved simulation of circulation patterns and transport processes.

The modelling framework enables assessment of seasonal and interannual variability in dispersal conditions and provides a process-based approach for understanding how physical transport processes may influence the spread of invasive freshwater species. The work is intended to support biosecurity decision-making by identifying areas that may warrant targeted surveillance and early intervention. More broadly, the study demonstrates how high-resolution hydrodynamic modelling and particle tracking can be applied to invasive species management in large river-lake systems and provides a foundation for future risk assessments of gold clam dispersal throughout the Waikato catchment.

A shared responsibility model for looking after Lake Rotorua water quality

Mr Scott Kusabs[1]
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A shared responsibility model for looking after Lake Rotorua water quality

Lake Rotorua started experiencing water quality problems in the 1970s, due to increased loads of nutrient (nitrogen and phosphorus). In 1989 an important starting point to understanding nutrient loading to Lake Rotorua and the impact of this on the water quality of the lake was the paper, "Management of Phosphorus and Nitrogen Inputs to Lake Rotorua, NZ". This work estimated target loads of nutrient entering the lake that were associated with good water quality in the 1960's to be 435 tonne of nitrogen per year and 37 tonne of phosphorus per year. These target nutrient loads remain today, to restore the water quality of Lake Rotorua.

While there was uncertainty with the historic losses estimated, there was a clear trend of increasing nitrogen loss to the lake arising from intensification of land use in the catchment over that time, and that mimics the trend in measured stream loads.

After extensive collaboration with iwi, stakeholders and the rural community over the past twenty years, and oversight by the Rotorua Te Arawa Lakes Strategy Group, policy has been introduced and implemented by the Bay of Plenty Regional Council. This has resulted in the deployment of a range of interventions to reduce nutrient leaving the catchment for the lake. Funding comes from both the Crown and Councils to support the work to improve the lake but also requires a commitment from farmers to reduce nutrient loss from their farms over time.

A cornerstone of the policy for Lake Rotorua water quality are the provisions of the Bay of Plenty Regional Policy Statement, which requires that the sustainable nitrogen load for Lake Rotorua, of 435 Tonnes of nitrogen annually, is achieved by 2032.

The work done so far to achieve this sustainable nitrogen load has shown that no single measure will be sufficient to achieve the target or improve water quality in a lasting way. All current available tools need to be implemented to their greatest feasible extent to achieve the sustainable nitrogen load for Lake Rotorua.

The mix of tools used in this catchment involve both incentivised land use change and regulatory obligations and provides landowners with different options to consider how to meet the in-lake targets depending on individual circumstances. Some landowners have shown a commitment to continue to farm within nitrogen limits and monitored through the Lake Rotorua Nutrient Rules. Some landowners have chosen to sell their allocated nitrogen and commit to a permanent lower nitrogen leaching land use. Bay of Plenty Regional Council are concurrently working with landowners to investigate engineering solutions and restoration of wetlands on private land to enable further nitrogen and phosphorus reductions.

This presentation will touch on all aspects of the Lake Rotorua Integrated Framework of interventions and the generational change being made to improve and protect the water quality of Lake Rotorua.

Functional Fish Passage: Moving Beyond Design Guidelines to Ecological and Cultural Outcomes, Lessons from Ōtaki to North of Levin Te Pae o Tararua Project.

Duncan Law[1]
[1]Tonkin + Taylor

Ōtaki to North of Levin Te Pae o Tararua (Ō2NL) is an expressway project delivered in partnership with Muaūpoko and Ngāti Raukawa ki te Tonga to improve safety and resilience on SH1 north of Wellington. It provides a case study in delivering fish passage where ecological, engineering, regulatory, and mātauranga perspectives intersect. The project includes 21 culverts requiring fish passage and was originally consented using stream simulation, requiring box culverts up to 10 m wide. During detailed design, bankfull channel widths, flood-capacity requirements, constructability, and cost prompted reassessment of this approach.

The project team worked in partnership with Muaūpoko and Ngāti Raukawa ki te Tonga to balance fish passage objectives with project delivery requirements. Iwi perspectives broadened the design process beyond guideline compliance to focus on surface-flow continuity, and the intergenerational health of wai. Moving away from stream simulation challenged the project's guiding principles of Tread Lightly, with the Whenua, particularly Me tangata te whenua (treat the land as a person) and Kia māori te whenua (let it be its natural self). These principles instead provided a framework for prioritising the long-term fish passage as part of providing aquatic habitat. Co-developed fish passage principles translated this kaupapa into practical design and consenting commitments, including ecological connectivity, surface-flow continuity, hydraulic diversity, monitoring, adaptive management, and accountability. The resulting process integrated engineering, ecological science, and mātauranga-informed principles and outcomes to navigate uncertainty and identify solutions that were both practical and responsive to the characteristics of individual streams.

This presentation describes the evolution of the Ō2NL fish passage strategy from a single preferred design method to a more site-responsive framework. Although stream simulation remains a benchmark, site constraints, constructability, cost, low-flow conditions, and substrate characteristics required alternative solutions informed by the local hydraulic, geomorphic, and ecological processes. The final design incorporates embedded substrate systems and side-cut weir baffles.

The project highlights a broader challenge for freshwater practitioners: while fish passage guidelines provide essential design principles, they cannot fully account for the complexity of individual streams. Rather than treating guideline compliance as the sole measure of success, Ō2NL focused on maintaining functional fish passage across a range of flows, species, and life stages.

Uncertainty in fish passage performance will be addressed through a robust monitoring programme, including pre- and post-construction biological surveys, long-term assessment of hydrological and structural performance, and a defined remediation framework. The programme, driven by the iwi partnership model and developed through close working relationships with iwi as kaitiaki, reflects a shared commitment to validating fish passage outcomes in the field rather than relying solely on design assumptions.

The Ō2NL experience demonstrates how integrating engineering, ecological science, mātauranga, iwi leadership, monitoring, and adaptive management can manage uncertainty and deliver resilient freshwater outcomes for complex infrastructure projects.

Going Global, Losing Local – Are New Zealand's lake zooplankton communities converging?

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Zooplankton communities inhabiting the lakes of Aotearoa New Zealand have historically been biogeographically distinct, characterised by calanoid copepod dominance, low species diversity, and year-round breeding - patterns that contrast markedly with those in the Northern Hemisphere. Over recent decades, increasing eutrophication, the spread and establishment of invasive zooplankton (Daphnia galeata, D. pulicaria, Skistodiaptomus pallidus), and non-native fish introductions threaten to erode this distinctiveness. Whilst zooplankton community dynamics are relatively well understood within individual lakes, no national-scale assessment of zooplankton community structure and associated environmental drivers across Aotearoa New Zealand lakes, currently exists.

In this study, 170 lakes were sampled across the full trophic gradient, altitudinal range, lake size, depth, and catchment type. Filtered water samples were analysed using an environmental DNA metabarcoding assay and combined with environmental metadata and fish occurrence records to assess how environmental and biotic drivers shape our zooplankton communities.

In this presentation, we examine whether anthropogenic pressures are driving the homogenisation of zooplankton communities. Specifically, we test whether increasing trophic state and the introduction of non-native fish are reshaping community composition through the loss of native taxa, the establishment of invasive species occupying previously vacant niches, or both. Our results provide the first national-scale assessment of these interacting drivers and reveal how land-use change and fish introductions are altering the unique zooplankton communities of Aotearoa New Zealand.

Linking riparian diversity to stream food-web structure across forested stream meta-ecosystems

Mael Marguet[1], Martin Sarkezi[1], Senior Lecturer Andrew Barnes[1], Senior Lecturer Francis J. Burdon[1]
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Forested stream systems are strongly interconnected through fluxes of matter and energy, with riparian forests providing important subsidies to streams through leaf litter inputs. Biodiversity–ecosystem functioning studies suggest that diverse riparian communities produce more biomass, delivering greater and more diverse litter inputs to adjacent streams — yet how this terrestrial diversity translates into aquatic food-web structure remains poorly understood. Reconstructing food webs is a powerful tool for linking multitrophic biodiversity patterns to ecosystem processes across system boundaries, but this has been hindered at broad spatial scales, where traditional approaches such as gut-content or stable-isotope analysis are impractical across large numbers of sites. Here, we overcome this barrier by developing a metaweb-based approach using environmental DNA (eDNA) data to reconstruct theoretical aquatic macroinvertebrate food webs across Aotearoa New Zealand. This approach takes community occupancy data recorded using eDNA and infers interactions via a metaweb of known trophic links across nearly 100 sites — at a spatial scale not previously achievable for whole-food-web comparisons.

We used stream catchments dominated by native forests and exotic pine (Pinus radiata) monoculture plantations as proxies for contrasting levels of riparian biodiversity and tested whether riparian diversity influences aquatic food-web structure and architecture. We hypothesised that greater diversity and quantity of terrestrial resources in native forest streams would promote aquatic consumers, and this bottom-up effect would propagate through the food webs, resulting in differences in food-web architecture and trophic structure across landscapes. We found that key food-web properties responded in a manner consistent with theory: the more disturbed, resource-poor pine stream food webs showed decreased chain length, maximum trophic level, and overall complexity relative to native forest streams.

By resolving aquatic food-web structure at a national scale, this work demonstrates that eDNA-based metawebs offer a scalable route to studying cross-ecosystem biodiversity effects — one readily transferable to other landscapes and land-use contrasts. Our findings show that riparian biodiversity loss, such as that driven by conversion to plantation forestry, can restructure aquatic communities and food-web architecture, with implications for catchment management and riparian restoration.

Evaluation of the likely ecological impacts of aluminium, copper and zinc in Southland rivers

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This literature review was part of an Envirolink Medium Advice Grant that focused on the likely ecological impacts of metal pollution in Southland rivers. In 2023 and 2024, Environment Southland conducted two surveys of metal concentrations in 20-22 Southland rivers. Metal concentration ranges under wet and dry weather conditions exceeded one or more of the guidelines considered for aluminium, copper and zinc, but not for lead, nickel, arsenic and cadmium. Consequently, our literature review focused on aluminium, copper and zinc.

The review provides an overview of the known, published ecotoxicological effects on freshwater organisms for aluminium, copper and zinc, focusing on these metals' effects on ecologically relevant responses of freshwater fish, invertebrates and algae or (in a few cases) other plants. Most of the studies included were from overseas; where possible, these were complemented by studies performed in New Zealand. For each metal, the key effects on the tested organisms were evaluated in the context of the river surveys conducted by Environment Southland in 2023 and 2024. In brief, the combined available evidence indicates that the aluminium, copper and zinc concentrations detected in the two river surveys are all high enough to raise concerns regarding potential detrimental effects on the freshwater biota in these rivers – with a few cautionary notes regarding this overall assessment.

For aluminium, no relevant ecotoxicological studies exist from New Zealand. For seven freshwater species investigated in overseas studies, clear detrimental effects of aluminium exposure were found at experimental concentrations within the range detected in Southland rivers during the 2023 dry weather survey. For another five overseas species, clear negative effects of aluminium exposure were reported during acute 96-h experiments at concentrations within the range detected during the 2024 wet weather survey (when aluminium concentrations were generally higher than during the dry weather survey).

For copper, a 48-h exposure study on the NZ freshwater mussel Echyridella menziesii (kākahi or kāeo), a taonga species for Māori, reported that survival of mussel glochidia was reduced at dissolved Cu concentrations well within the range detected in Southland rivers during the 2024 wet weather survey. For seven further freshwater taxa investigated in overseas experiments, clear detrimental effects of copper exposure were found at concentrations within the range during the 2023 dry weather survey. For another six overseas species, clear negative effects of copper exposure were found in acute-exposure studies at concentrations within the range detected during the 2024 wet weather survey (when copper concentrations were generally higher than during the dry weather survey).

For zinc, one of three relevant studies from NZ reported that two freshwater species were affected by zinc exposure at concentrations within the range detected in Southland rivers (which was near-identical in the dry and wet weather surveys). For an additional nine overseas taxa (and in one community-level, overseas mesocosm experiment), detrimental effects of zinc exposure were found at experimental concentrations within the range detected in Southland.

From Framework to Implementation: Co-designing Catchment Management and Master Plans for Seven Land Drainage Catchments in Selwyn District

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Lowland drainage networks are among the most modified freshwater ecosystems in Aotearoa New Zealand. Traditionally managed for land drainage and flood protection, these waterways are increasingly expected to support ecological, cultural, recreational, and community values. Responding to this challenge, EOS Ecology and Aqualinc Research partnered with Selwyn District Council, Te Taumutu Rūnanga, drainage committees, landowners, agency representatives, and catchment working parties to develop and implement a new approach to catchment planning across the seven rated drainage catchments that cover 24,500 ha and all discharge to Te Waihora/Lake Ellesmere.

The programme began with the development of a catchment planning framework that provided a structured pathway from understanding catchment values, condition, and challenges through to identifying management responses and implementation priorities. Developed through a co-design process involving catchment working parties, Te Taumutu Rūnanga, Selwyn District Council, and other stakeholders, the framework integrated four value baskets encompassing mauri and ecosystem health, thriving communities, healthy people, and a prosperous land and water-based economy. These provided a shared foundation for balancing multiple objectives, identifying desired outcomes, and developing a collective vision for each catchment.

The framework was then applied across seven catchments. Ecological assessments, freshwater surveys, spatial analyses, and catchment investigations were used to establish past and present state, identify key issues and challenges, and classify waterways according to their physical and ecological characteristics. From this evidence base, catchment-scale approaches and a toolbox of reach-scale interventions were developed, with interventions tailored to specific waterway types and management objectives.

A major component of the programme was the creation of a new spatial framework based on LiDAR-derived digital elevation models. This generated approximately 8,456 km of waterways and flow paths across the seven catchments, substantially improving understanding of network extent and connectivity compared with existing datasets.

The subsequent Master Planning phase translated the strategic intent of the Catchment Management Plans into implementation-ready outputs. More than 4,300 interventions were spatially located, attributed, and prioritised using catchment context, waterway characteristics, and site-specific opportunities and constraints. These were incorporated into an ArcGIS Online decision-support platform, enabling interventions to be visualised, queried, tracked, and updated over time.

This presentation will describe the framework, process, and lessons learned from delivering a six-year programme spanning seven catchments. We demonstrate how collaboration between consultants, council, tangata whenua, drainage stakeholders, and local communities can move catchment management beyond planning and into implementation. The programme highlights the value of co-design founded on genuine, enduring relationships, creating catchment plans that all parties stand behind, not just sign off on. Coupled with robust science and spatial decision-support tools, this approach provides a scalable model for managing drainage-dominated freshwater systems across Aotearoa New Zealand.

25 years of macroinvertebrate monitoring: What changes have we captured across Waitaha – Canterbury?

Chris Meijer[1], Lucy Rust[1]
[1]Canterbury Regional Council (Environment Canterbury)

Environment Canterbury (Canterbury Regional Council) has maintained a network of river sites across Waitaha - Canterbury that are surveyed each year for freshwater macroinvertebrates. Alongside macroinvertebrate samples, we collect a range of environmental data. Together, these data help us assess aquatic ecosystem health across the region, identify potential drivers of change, and inform national reporting and local planning decisions. As we review our protocols in the context of the National Environmental Monitoring Standards, it is timely to look back at what our long-term dataset has captured to date, particularly changes occurring at broad spatial scales. For example, consistent declines in macroinvertebrate communities, or in local environmental conditions across river types, may indicate large-scale risks to ecosystem integrity. Conversely, broad-scale improvements in either would suggest that collective efforts to protect and enhance riverine ecosystems are having a positive effect. In this presentation, we explore what our long-term dataset can tell us about regional-scale changes in riverine ecosystems and how those data can guide future monitoring and management decisions.

Balancing coverage and data quality: using summer students in state-of-the-environment monitoring

Chris Meijer[1], Lucy Rust[1]
[1]Environment Canterbury

Environment Canterbury (Canterbury Regional Council) has used summer students to support state-of-the-environment (SOE) monitoring for over 25 years. This approach has helped us establish and maintain our extensive monitoring networks. National discussions and updated guidance on monitoring protocols have prompted us to review our SOE monitoring approach from time to time. Summer students remain a cost-effective way to maintain our current spatial coverage, but this approach involves trade-offs. For example, each field season requires training to bring new recruits up to speed. More demanding protocols also require more targeted training; without it, there is a risk that the data collected will be of lower quality. In this presentation, we use our macroinvertebrate SOE programme to highlight the refinements we have made to balance summer students' capabilities with the collection of high-quality, meaningful environmental data.

From dose to decision: a process-based model for continuous alum treatment in lakes

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[1]University Of Waikato, [2]Limnotrack

Excess phosphorus loading continues to drive eutrophication in lakes worldwide, promoting widespread use of alum (aluminium sulfate) to reduce phosphorus availability. While the chemistry of alum–phosphorus interactions is well understood, quantitative tools that link treatment dose to in-lake phosphorus trajectories remain largely empirical because existing modelling tools cannot explicitly link alum dosing strategies to lake-scale phosphorus dynamics and long-term water quality outcomes.

We present a new process-based module developed for the General Lake Model coupled with the Aquatic EcoDynamics (GLM-AED) framework applied to Lake Rotorua (Bay of Plenty). The module simulates key processes governing alum effectiveness, including delivery of alum from treated inflows, kinetic uptake of phosphorus in the water column, gravitational settling of alum floc to the lake bed, continued phosphorus binding at the sediment–water interface, and gradual loss of reactivity through alum floc ageing. A pH modifier captures the sensitivity of binding efficiency to lake water chemistry, is particularly relevant in lakes where pH can vary substantially.

The model is applied to Lake Rotorua, where more than two decades of continuous alum dosing provide a rare opportunity to develop, calibrate and evaluate a mechanistic representation of alum treatment. The resulting framework provides a mechanistic tool for evaluating treatment scheduling (frequency and timing of doses), trade-offs between water-column and sediment-based removal, and the influence of inflow conditions on treatment outcomes. Further work will include scenario modelling under different management scenarios to assess whether alum treatment alone is sufficient to meet water quality targets, or whether it needs to be combined with catchment-scale load reductions.

The GLM-AED alum module is designed to be transferable beyond Lake Rotorua to any system where alum or similar coagulant treatment is being considered as a management intervention. By embedding treatment dynamics within a full lake process model, it bridges the gap between operational dosing decisions and long-term water quality outcomes.

The influence of river flowrates on E. coli concentrations and contact recreation gradings in NZ rivers

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Swimming is a valued activity in NZ society and yet the safe swimming guidelines are often exceeded across the country. In pastoral catchments runoff is a major source of Escherichia coli to rivers. This has led to the assumption that high concentrations of E. coli in water quality monitoring datasets are associated with high flow rates at the time of sampling. Most swimming activity occurs during low or base-flow conditions in rivers. There have been discussions on targeting the swimming guidelines on the times and flow conditions on when people are swimming. To explore this topic, we collated data from across NZ and identified 283 sites nationwide where E. coli concentrations and flowrates were recorded in proximity (mean of 184 matched data points per site). From this data we conducted regression analyses (using multiple statistical techniques) and found R2 values were typically low. Furthermore, the sites with a high R2 value were often strongly influenced by a single datapoint. We then investigated the effects of flow on long-term gradings at these sites. We calculated the individual E. coli metrics (median, % >260 MPN 100mL-1, %>540 MPN 100mL-1 and 95th percentile) and the overall grading at each site using samples collected at all flows. At each site we then removed any samples collected at >90th percentile of flows and recalculated the E. coli metrics. This process was repeated for samples collected at >80th, 70th, 60th and 50th percentiles of flows. The removal of samples collected during high flowrates had little effect on the calculated median concentrations and % >260. The removal of high flow samples had a larger effect on the % >540 and 95th %ile metrics. For the overall site grades, removing the top 10% of high flows decreased the percentage of sites in the D grade from 34 to 32%, E grades from 24 to 21%, and increased the A grades from 23 to 29%. Removing the top 50 percentile of flows decreased the percentage of sites in the D grade from 34 to 28%, the E grades from 24 to 18% and increased the A grades from 23 to 36%. For the % >540 metric (utilised in surveillance and grading), removing the top 10% of flows decreased the percentage of sites in the D grade from 19 to 12%, the E grades from 17 to 14% and increased the A grades from 23 to 31%. For the %>540 metric alone, removing the top 50th percentiles of flows decreased the percentage of sites in the D grade from 19 to 8%, the E grades from 17 to 12% and increased the A grades from 23 to 38%. This analysis indicates that there may be value in exploring alternative swimming guidelines based on when people are most likely to swim. However, the application of any alternative approaches is likely to be site specific and will need to be linked to known sources of E. coli contamination.

From Records to Monitoring: Developing a Monitoring Framework for Lamprey and Shortjaw Kōkopu under the NPS-FM

Dr Bram Mulling[1], Mr Shyam Morar[1]
[1]Greater Wellington Regional Council

The National Policy Statement for Freshwater Management 2020 (NPS-FM) introduced new requirements for the monitoring and management of threatened freshwater species. For Greater Wellington Regional Council, implementation of these requirements highlighted a fundamental challenge: for some species of interest, including lamprey (Geotria australis) and shortjaw kōkopu (Galaxias postvectis), existing information on distribution and population status was limited, fragmented, or based on records that were often decades old.

This presentation reflects on Greater Wellington's threatened species monitoring journey to date and shares lessons learned as we developed and implemented a regional monitoring programme for these nationally significant species. Rather than presenting a completed research project, this presentation provides a practitioner-focused progress report on establishing monitoring frameworks in the face of significant information gaps.
To address the lack of distribution data, a two-phase approach was adopted. Phase 1 focused on improving understanding of species occurrence and distribution across the Wellington Region through targeted, species-specific investigations. Survey locations were prioritised using multiple lines of evidence, including historical records, modelled distributions, observations and knowledge shared by communities and partner organisations such as mana whenua and the Department of Conservation, incidental eDNA detections from unrelated investigations, and catchments identified as spatial knowledge gaps but containing potentially suitable habitat.

A range of survey methods have been trialled and refined throughout the programme. The presentation will discuss the effectiveness and limitations of different approaches, including where methods performed well, where expectations were not met, and how monitoring designs were adapted in response. Findings to date have highlighted both the challenges of detecting rare and cryptic species and the value of combining traditional survey techniques with emerging tools and local knowledge.
The programme has also generated new insights into the variety of habitats occupied by both lamprey and shortjaw kōkopu within the region. Several discoveries have challenged assumptions about species distribution and habitat use, resulting in practical implications for monitoring design, prioritisation of future survey effort, and freshwater management activities.

Building on these outcomes, Greater Wellington RC is planning a transition to Phase 2 of the programme at the end of this financial year/season. This next stage aims to establish long-term population monitoring at selected sites to better understand trends over time, while retaining capacity for ongoing distribution investigations and exploration of remaining knowledge gaps.
By sharing successes, setbacks, and lessons learned, this presentation aims to contribute to a wider discussion on threatened freshwater fish monitoring under the NPS-FM. The experiences presented may assist other organisations facing similar challenges as they move from limited baseline knowledge toward robust, long-term monitoring programmes capable of supporting effective conservation and management of threatened freshwater species.

Simulating Streamflow: GloFAS-ERA5 Performance and Implications for Catchment-scale Forecasting in New Zealand.

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River management relies on high-quality flow-rate datasets for successful kaitiakitanga / guardianship. Climate change threatens to complicate our understanding of streamflow and its relationship to precipitation, snowmelt, and subsurface water. By 2100, warming trajectories suggest 36.7% of rivers globally will experience increased streamflow extremes. Consequently, comprehensive streamflow observations are vital for analysing emerging trends under climate change, informing localised water management and environmental stewardship.
Traditionally, streamflow has been measured through at-site monitoring. However, creating long-term flow series poses a challenge in regions with limited resources, dynamic geomorphology, and poor site access. To address these limitations, hydrological 'reanalysis' models have evolved. This includes the Global Flood Awareness System (GloFAS). Built from the LISFLOOD discharge model and ERA5 runoff model, GloFAS-ERA5 v.4.0 generates daily catchment streamflow from 1979 to near present, at a 25km2 resolution. Literature has established GloFAS-ERA5, version 2.1, as skilful at streamflow simulation in 86% of global catchments. However, the river gauges used for calibrating and validating this data are not equally distributed. Spatial gaps exist across Asia, South America, Africa, and Oceania, where diversity in climate zones, topography,
and catchment management may have affected GloFAS-ERA5 performance. For New Zealand, the inclusion of two validation sites proves a significant limitation.
We present findings exploring the predictive power of GloFAS-ERA5 v.4.0 across several calibration-poor region, by analysing the differences between observational streamflow and simulated streamflow time series. We seek to answer:
1)
How well does GloFAS-ERA5 v.4.0 perform across poorly calibrated regions, including Eastern Canada, New Zealand, India, and Chile, where hydroclimates vary in aridity, snowmelt contribution, and catchment behaviour?
2)
Which catchment and climatic characteristics affect streamflow modelling and drive differential performance?
3)
Where is GloFAS-ERA5 v.4.0 appropriate for streamflow simulation in ungauged catchments, and where should model improvement be focused for successive GloFAS-ERA5 versions?
Addressing these questions will determine whether initial assessments of GloFAS-ERA5 v.4.0 were globally representative, which catchment and climatic variables require better model accuracy, where streamflow simulation is appropriate for localised water management, and how the match between simulated and observational flow may evolve under changing climate conditions.

Otolith diaries: reconstructing early lives of glass eels

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New Zealand longfin (Anguilla dieffenbachii) and shortfin eels (A. australis) have complex catadromous life cycles, yet important aspects of their early marine life history remain poorly understood. In particular, the timing of larval development, migration pathways, and transition from oceanic to freshwater environments are difficult to observe directly. This study used otolith microstructure and Sr:Ca microchemistry to investigate the early life history of longfin and shortfin glass eels recruiting to the Rangitāiki River, an east coast river in the North Island. By examining daily growth increments and elemental profiles in glass eel otoliths, we reconstructed aspects of hatch timing, larval duration, metamorphosis, and recruitment. The findings showed species-specific differences in early life history traits and suggested that larval dispersal to New Zealand may be more variable than previously recognised. Variation in otolith microchemistry also provided insights into possible differences in oceanic environments, migration behaviour, or dispersal pathways experienced before arrival. Together, these results contribute to a growing understanding of the marine phase of New Zealand glass eels and highlight the value of otolith-based approaches for investigating cryptic life stages that are otherwise difficult to study.

Kanakana/Piharau - the little living fossil

Pascale Otis[1], Riki Parata[2], Kristie Parata[3], Mohi Edwin[3], Courtney Bennett[4]
[1]Media Elves, [2]Hokonui Runanga, [3]Te Ati Awa ki Whakarongotai, [4]Kete Planning Consultancy

This 22 minute short film follows Mohi Edwin and Kristie Parata's emotional journey to restore kanakana (piharau) to their Waikanae waters. Beginning with a powerful karanga at the estuary with their children, Mohi and Kristie travel south to meet Kristie's cousin Riki Parata at Hokonui Rūnanga, where New Zealand's first kanakana breeding programme offers hope for nationwide restoration. Together, they witness the ancient survivors in breeding tanks before embarking on a dramatic nighttime expedition through an old paper mill to the Mataura River falls. Under torchlight, they carefully catch migrating kanakana blocked by century-old industrial barriers, then relocate them upstream to complete their 360-million-year-old lifecycle. The next morning, surrounded by young kapa haka performers whose passion embodies future hope, Mohi and Kristie reflect on what they've learned. Returning home to Waikanae, Kristie performs karanga along the water with her children present, calling the kanakana back to their ancestral waters—a powerful act of faith in restoration and cultural continuity, demonstrating how whakapapa connections between regions and generations can help bring back species thought lost.

New Zealand lakes are warming, but annual trends hide contrasting seasonal climate responses

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Climate change is altering lake thermal regimes worldwide, yet our understanding of long-term lake surface water temperature (LSWT) trends remains limited by strong geographic and temporal biases. Our review of 75 published studies showed that 88% were conducted in the Northern Hemisphere, while 76% reported only annual trends and only two examined all four temperate seasons. To address these biases, we quantified annual and seasonal LSWT trends for 312 New Zealand lakes between 2000 and 2023 using Landsat-derived satellite observations.

New Zealand lakes exhibited a modest mean annual warming trend (0.015 ± 0.07 °C yr^{-1}), although responses varied markedly among lakes, with 61% warming and 39% cooling. Summer warming (0.053 ± 0.11 °C yr^{-1}) was more than three times greater than the annual trend, whereas autumn and winter showed little overall change. Annual trends masked substantial seasonal heterogeneity: only 16% of lakes exhibited consistent warming or cooling across all four seasons, while 84% showed contrasting seasonal responses. Spring trends most closely reflected annual warming, whereas summer trends consistently overestimated annual warming rates. We identified lake volume, elevation, and summer precipitation trends as the primary drivers of seasonal warming behaviour, highlighting the interaction between lake morphometry and regional climate.

Annual trends alone provide an incomplete picture of climate change impacts on lakes. Future assessments should routinely quantify seasonal warming patterns to better understand the drivers and ecological consequences of climate change in freshwater ecosystems.

Stressed Lakes: A Shiny dashboard to investigate multiple stressors of lake ecosystems.

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Human activity is leaving an indelible mark on the environment with freshwater lakes among the most sensitive sentinels to these pressures. Lakes respond not only to environmental factors directly affecting the lake but are also impacted by disturbances in the catchments of lakes. This makes lakes early warning systems for anthropogenically induced change at local to regional scales.

Efficient monitoring methods are required to promote proactive protection and management. Traditional monitoring is time consuming and expensive, which limits the number of lakes monitored. Also, traditional methods of understanding the health of a lake have generally focussed on assessing the level of eutrophication and little consideration has been made to understanding the biological dynamics of freshwater systems. Microbial communities are vital in lake ecosystems where they drive nutrient cycling. However, microbes are profoundly altered by human disturbance with their diversity, composition and metabolic functioning rapidly changing to adapt to changes in environmental variables. By investigating the ecological responses of microbes to a variety of environmental stressors (e.g., eutrophication, heavy metals) a better understanding of how lakes respond to multiple stressors and the effect on ecosystems services is possible.

In this study we sampled surface sediment from over 150 lakes across Aotearoa-New Zealand and undertook metagenomic sequencing of environmental DNA to investigate how the genes for metabolic processes change across stressor gradients. We constructed a comprehensive gene catalogue from these surface sediment samples and showed that the distribution of functional genes varied across environmental gradients including eutrophication. Using the national scale dataset, we identified indicative genes for various stressor gradients including markers for eutrophication, organic matter, heavy metals and cyanotoxin production.

To distill the distribution patterns of the stressor genes derived from the metagenomic data into a clear and accessible format we developed, in partnership with iwi and regional councils, a shiny app dashboard. This dashboard is publicly available at https://cawthron.shinyapps.io/BST18597_FunEA/. The dashboard provides an indication of which stressors are impacting a lake and enables comparisons across lakes. By understanding how multiple stressors affect lake ecosystems, more informed management decisions can be made to improve the status of lake ecosystems and maintain and improve ecosystem services.

Lake productivity and non-native fish influence native fish communities in shallow, lowland lakes

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Fish communities in shallow, lowland lakes can be impacted by a wide range of factors including eutrophication and introductions of non-native species. Identifying the key drivers of fish abundance is important to inform evidence-based management, conservation and restoration for these ecosystems. To investigate the relative roles of eutrophication and introduced fish on native fish communities, we analysed species- and community-level responses using two freshwater fish datasets from shallow, lowland lakes in New Zealand. The first was a national dataset with lakes spread across the country and the second dataset was restricted to lakes with a regional distribution. We found that lake productivity (indicated by trophic state as quantified in the Trophic Level Index or TLI) and non-native fish presence were both important drivers of community composition. However, the relative importance of lake productivity and non-native fish varied with the native species and dataset examined. Our analyses also indicated that other forms of habitat state not captured by the TLI (e.g., catchment land cover and in-lake habitat modification) need consideration alongside natural landscape factors (e.g., connection to the sea) that influence diadromous native fish access to freshwater ecosystems. Our results further suggest that effective lake management requires approaches that address multiple factors including eutrophication and the introduction of non-native fish. An integrated management approach will help better protect and restore native freshwater fish populations in sensitive shallow, lowland lakes prone to these impacts.

Assessment of potential global river periphyton growth risk and uncertainty in nutrient concentrations under high flows in a changing climate

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High nutrient (nitrogen (N) and phosphorus (P)) concentrations in freshwater facilitate algal growth, resulting in increased periphyton biomass and the impairment of drinking water, recreational appeal and aquatic biodiversity. Periphyton growth in rivers is most common during low, stable flows, whereas annual nutrient loading is usually dominated by delivery during high flows, particularly in smaller streams. Flow regimes are expected to change substantially around the world under climate change, creating uncertainty in potential freshwater nutrient availability and risk of periphyton growth. To assess this risk, we utilised global discharge simulations along with observed nutrient concentration and discharge data to derive estimates of N and P concentrations under median and the 90th percentile of flows both in the present and in 50-years' time. These estimates were used to (1) classify areas based on their potential periphyton biomass under normal conditions and (2) determine which areas express the most variability in nutrient loading during high flows. We then made comparisons between geographic regions, across two distinct potential climate scenarios, and for both the present and 50 years in the future. These results have potential uses in determining proportions of the population affected by undesirable levels of periphyton biomass as well as advising freshwater management on areas which may be vulnerable to variability in high flows in a changing climate.

Te Huringa Āhuarangi He Waimanawa: Kaupapa Māori Approaches to Groundwater Governance Under a Changing Climate

Dr. Ruby Pitiroi[1], Professor Ocean Mercier
[1]Te Herenga Waka - Victoria University Of Wellington

Groundwater sustains freshwater ecosystems, drinking water, agriculture, and communities across Aotearoa New Zealand. Yet groundwater systems are increasingly affected by climate change, including changing rainfall patterns, drought, sea-level rise and the increasing risk of saltwater intrusion in coastal aquifers, alongside land-use intensification, and nitrate contamination. These pressures create new uncertainties about the resilience of freshwater systems and how they can be sustained into the future.

Responding to such change requires more than technical solutions; it requires approaches to freshwater management that recognise Indigenous authority, draw respectfully on those bodies of knowledge, and are grounded in the values, relationships, responsibilities and aspirations of the communities who care for and rely on these waters.

This presentation introduces Te Huringa Āhuarangi He Waimanawa, an ongoing kaupapa Māori research project (2025–2028) that works alongside iwi partners to explore how iwi and hapū perspectives can strengthen groundwater governance and resilience across the Te Aupōuri and Heretaunga aquifers. Drawing on community hui, wānanga, qualitative interviews, co-design workshops, and field-based research, the project brings together mātauranga Māori and hydrogeological science to develop responses shaped by iwi-identified priorities. These include approaches to exploring groundwater governance options and provisions that support iwi data sovereignty and authority over groundwater information.

The research explores how mātauranga-ā-iwi can inform groundwater governance under conditions of climatic change. It considers tensions between environmental stewardship, commercial interests, and Indigenous rights, identifying opportunities for more adaptive and resilient approaches to groundwater governance. In doing so, the project examines how different knowledge systems can be brought into dialogue to support decision-making amid environmental and climatic uncertainty, while supporting iwi priorities and authority.

The presentation shares emerging insights from kanohi-ki-te-kanohi engagement and co-design processes, highlighting the potential of Indigenous perspectives to reshape freshwater management from a focus on responding to environmental change toward strengthening the resilience of freshwater ecosystems and the relationships that sustain them. Te Huringa Āhuarangi He Waimanawa demonstrates how working across knowledge systems and centring iwi authority can contribute to more adaptive, culturally grounded, and climate-resilient approaches to groundwater management in Aotearoa.

Historical warming and deoxygenation of Lake Taupō revealed by observations and three-dimensional modelling

Dr Aidin Jabbari[1], Dr. Piet Verburg[2], Dr. David Plew[1], Dr Simon D. Stewart[3], Dr Mat Allan[4], Dr Christian Zammit[1]
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Climate warming is altering deep lakes by changing thermal structure, oxygen availability, and ecosystem processes, yet long-term evidence from large Southern Hemisphere lakes remains scarce. We combined observations from Lake Taupō's long-term monitoring programme with a three-dimensional hydrodynamic-water-quality model (AEM3D-iWQ) to examine historical changes in temperature, dissolved oxygen (DO), stratification, and water quality from 1992 to 2022. We also quantified river influences and evaluated associations with the El Niño-Southern Oscillation (ENSO).

Annual air temperature increased by 0.037 ± 0.008 °C yr^{-1}. Both surface and bottom waters warmed significantly. Observed summer surface temperature increased fastest, at 0.065 ± 0.025 °C yr^{-1}—nearly twice the global mean summer lake-surface warming rate of approximately 0.034 °C yr^{-1} reported for 1985–2009. Modelled annual temperatures increased by 0.028 ± 0.009 °C yr^{-1} at the surface and 0.020 ± 0.005 °C yr^{-1} in bottom waters. Lake heat content and stratification strength also increased, although stratification duration showed no significant trend. A separate modelling study for Lake Taupō projects that, over 2019–2098, annual surface and bottom temperatures will increase by 0.004–0.037 and 0.004–0.030 °C yr^{-1}, respectively, across low- to high-emissions scenarios.

Summer surface DO declined by 0.008 ± 0.003 mg L^{-1} yr^{-1}, consistent with reduced oxygen solubility as water warms. Mean bottom-water DO showed no significant long-term trend, but values were lowest during years of high heat content and strong stratification, occasionally falling below 7 mg L^{-1} from 60 m depth to the lakebed. Such conditions may constrain habitat for cold-water fish and other aerobic organisms. Elevated chlorophyll-a, total nitrogen, and particulate nitrogen sometimes coincided with warmer summers, although this relationship was not consistent across the record. Summer total and particulate nitrogen increased over 1995–2021 but have declined since about 2014, potentially reflecting catchment management alongside climate variability.

Surface heat exchange, rather than river inflows, was the dominant control on lake heat content. Inflows altered lake temperature by no more than approximately 0.3 °C and bottom-water DO by up to 0.20 mg L^{-1}. This maximum increase in bottom-water DO is comparable in magnitude to approximately 25 years of the modelled decline in summer surface DO. Inflows also had little effect on stratification. ENSO contributed to interannual variability: elevated air and surface-water temperatures occurred during five of seven strong La Niña periods, and lake-surface temperature responded to Niño indices with an approximately six-month lag.

These findings show that even a large oligotrophic lake with relatively high water quality is already responding to climate warming. Continued warming and deoxygenation may reduce deep-water habitat, alter nutrient cycling, and increase the risk of phytoplankton and cyanobacterial growth, highlighting the need to integrate climate change into Lake Taupō monitoring and management.

Modelling weed washup events in Lake Rotorua

Dr David Plew[1], Dr Anika Kuczynski[1]
[1]Earth Sciences New Zealand

Lake Rotorua experiences significant weed wash-up events when storms dislodge lake weeds and transport them to shore. Wash-ups along the Rotorua City waterfront are of particular concern to the community because decaying weed can generate strong odours and contribute to fish kills by reducing oxygen levels in the lake.
Removing washed-up weed is also costly for Rotorua Lakes Council and Bay of Plenty Regional Council. For example, approximately 780 tonnes of material were reportedly cleared from the waterfront after a severe weather event on 12 November 2025, at a cost of about $130,000.

Lake Rotorua supports extensive invasive aquatic weed growth across the lake bed, largely because of its shallow profile. Invasive aquatic weed species, including hornwort, Lagarosiphon, Egeria and elodea, have been present in the lake since at least the 1950s. The main areas of pest plants are thought to occur along shores sheltered from the prevailing south-westerly winds, but the lake's extensive shallow areas provide suitable habitat for invasive weeds more broadly. Because no recent lake-wide aquatic plant survey has been completed, the current extent and severity of the problem are not well documented.

With current resources, eradication is considered unlikely, so control efforts need to be carefully targeted to achieve the greatest benefit. To help target weed beds that contribute most to wash-ups at Rotorua City, we coupled a hydrodynamic model with a particle-tracking model to simulate the transport of weed fragments during storm conditions.

We recreated storm events associated with significant weed wash-ups in 2020, 2022, 2024 and 2025. Using both forward and backward particle tracking, we identified the weed beds, or parts of weed beds, that are likely to contribute the greatest proportion of material washing up along the city waterfront. Results indicate that the large weed bed in front of the Rotorua City is the most likely source. However, differences in wind directions and wind speeds, which drive the currents that transport weed fragments through the lake, suggest that targeting only a small part of the weed bed would have limited benefit.

Forecasting Lake Ecosystem Responses to Extreme Weather Events: A Novel Integrated Modelling Approach

Dr Matthew Prentice[1], Professor Jamie Howarth[2], Professor Sean Fitzsimons[3], Dr Xun Li[4], Mr Christopher McBride[1,5], Dr Jonathan Puddick[6], Dr Georgia Thomson-Laing[6], Dr Marcus Vandergoes[4], Professor Susie Wood[7], Professor Deniz Özkundakci[1]
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Climate change is projected to drive an increased incidence and intensity of extreme weather events, including storms and droughts. These events will profoundly impact future lake ecosystem functioning by disrupting thermal regimes, causing pulsed sediment and nutrient loading, initiating spikes in sediment resuspension, and driving unpredictable shifts in biological communities. Despite these looming events—and their complex interactions with existing stressors, including eutrophication, catchment land use, and hydrological regulation—their cumulative ecosystem impacts remain poorly understood. Because traditional monitoring data cannot capture the unprecedented convergence of these extreme frequencies and magnitudes, traditional empirical observation alone is insufficient. Therefore, the aim of this study was to develop and apply a novel framework for hindcasting and forecasting lake ecosystem responses to extreme weather events. To achieve this, we coupled the GLM-AED lake ecosystem model with the GR4J catchment model in an integrated approach leveraging diverse temporal datasets that span contemporary monitoring, historical reconstructions, and future climate projections. First, we utilized high-frequency monitoring buoy and discrete routine monitoring data to achieve initial short-term calibration and validation. Second, we leveraged historical land use imagery, meteorological reanalysis data (i.e., ERA5), and paleolimnological proxies (including mass accumulation, pigments, Cladocera and diatom fossils, sedaDNA, hyperspectral scanning, trace metals, and pollen and charcoal) to hindcast the coupled model to 1950. Third, we combined our long-term model, calibrated using paleolimnological proxies, with future climate projections (i.e., CMIP6), employing an ensemble approach that incorporates multiple global climate models and shared socioeconomic pathways, to simulate the ecosystem's response to extreme weather events through the year 2100. In this presentation, we demonstrate the validation and application of this framework in Lake Tūtira, a warm-monomictic lake situated in the Hawke's Bay region of New Zealand's North Island, whose sensitivity to extreme weather events—including cyclones Giselle in 1969, Bola in 1988, and Gabrielle in 2023—makes it an ideal test bed. We show that the framework reproduces short-term changes in temperature, dissolved oxygen, turbidity, and chlorophyll-a measured by the high-frequency monitoring buoy during Cyclone Gabrielle and the subsequent 12 months. Additionally, we show the framework successfully hindcasts multi-decadal ecosystem trajectories and impacts of cyclones Giselle, Bola, and Gabrielle reflected by paleolimnological proxies from 1950 to the present. Finally, we present projections through 2100 that reveal critical insights into how lake ecosystems will respond to the increasing incidence and intensity of extreme weather events under future climates. Ultimately, our novel integrated framework provides a robust tool for projecting lake ecosystem vulnerability to extreme weather events through the year 2100.

When did ‘best practice’ become ‘negligible effect’?

Justine Quinn[1]
[1]Tonkin + Taylor

Erosion and sediment control (ESC) guidance provides an important framework for managing sediment discharges from land disturbance activities. However, ecological assessments often place considerable weight on the implementation of recognised ‘good’ or ‘best’ practice measures, despite limited consideration of how those measures translate to ecological outcomes in freshwater receiving environments. ESC guidance typically provides a toolbox of management options, with the effectiveness of those options dependent on site-specific factors, sensitivity of the receiving environment, and broader catchment context.

While ESC measures are designed to reduce the risk and magnitude of sediment discharges, they do not prevent sediment discharges occurring nor do they directly quantify ecological effects. Nevertheless, assumptions of negligible, low, or acceptable ecological effects are frequently inferred from the proposed implementation of best-practice controls, despite limited consideration of the residual sediment discharges and ecological responses that may still occur.

Drawing on experiences from large and small projects across New Zealand, this presentation explores the relationship between sediment management measures, predicted effects, and observed ecological responses. We examine how sediment-related effects are assessed during consenting processes, and challenge the common assumption that implementing good-practice ESC measures is sufficient to demonstrate acceptable ecological outcomes. We distinguish between two complementary but fundamentally different processes: implementing good-practice ESC measures to minimise sediment discharges and manage unforeseen events, and assessing the ecological effects that may occur despite those measures. This presentation highlights the importance of effects-based assessment frameworks that explicitly quantify expected changes, document key assumptions, and use monitoring to evaluate whether predictions are supported by observed ecological responses. It argues that ESC measures should be viewed as risk-management tools rather than evidence of ecological outcomes in themselves.

As freshwater management and consenting frameworks continue to evolve, including an increasing focus on limits and measurable environmental outcomes, there is growing value in ensuring that sediment management approaches are linked to robust predictions of ecological effects. The lessons presented provide practical insights for practitioners, regulators, and project teams seeking to strengthen the link between sediment management measures, predictions of effects and outcomes for freshwater ecosystems.

Closing the Gap: Improving Surveillance of Non-Naturalised Freshwater Pests

Yanika Reed[1], Rachel Hooks[1]
[1]Biosecurity New Zealand

Biosecurity New Zealand / Tiakitanga Pūtaiao Aotearoa has undertaken work to address an identified gap in the biosecurity system – a surveillance programme for freshwater pests not naturalised in Aotearoa New Zealand. Work undertaken so far has been committed to embedding Māori worldviews and recognising the significance of te wai māori (freshwater) as a taonga. It has also sought to raise awareness of high-risk species – encouraging all New Zealanders to keep watch on freshwater and report any suspected pests.

Research projects in the programme have so far;

Identified high-risk freshwater pest species (across plants, fish and invertebrates) with the potential to establish and cause harm to freshwater ecosystems through integration of risk assessments with climate suitability analyses.

Developed and published the Freshwater Pest Watchlist, a field guide highlighting identifying features and typical habitat preferences for the identified high-risk freshwater pests.

Proposed potential high-risk sites for initial incursions of identified species and surveillance methods most appropriate for sampling locations and species.

Development of a useful tool to visualize the locations identified as high-risk for incursion potential, allowing for species specific scenarios showcasing likelihood of incursions at a spatial scale. This tool helps to inform site prioritisation.

This talk seeks to share the work done to date and important messaging to enhance the detection of new freshwater pests, should they arrive.

Warmth, wind, and wanderers: a millennium of climate from Aotearoa's lakes

Andrew Rees[1], Sebastian Naeher[2], Valerie van den Bos[3], Emily Carr[1], Samantha McAulay[4], Jamie Howarth[1], Marcus Vandergoes[3], Susie Wood[2]
[1]Te Herenga Waka – Victoria University Of Wellington, [2]Te Whare Wānaka o Aoraki – Lincoln University, [3]Earth Sciences New Zealand, [4]Te Papa

The southern westerly winds (SWW) are among the most important drivers of Aotearoa's climate, shaping rainfall, temperature, and the water resources on which our communities depend. Unsurprisingly, the position of the westerlies has profoundly shaped human-landscape interactions during our time on the Land of the Long White Cloud, from Polynesian voyaging in the 13th century to flooding in the 21st. Yet instrumental records capture only a few decades of SWW behaviour, offering the briefest glimpse of what "normal" looks like. Lake sediments can dramatically extend that glimpse, preserving hydroclimate records throughout human history in Aotearoa.

A compelling archaeological narrative recounts Polynesians arriving in a land with a warm, settled climate that fostered rapid expansion. Later generations weathered a colder, stormier environment, and pā began to dot the landscape. The narrative deploys terms such as "Medieval Climate Anomaly" preceding a "Little Ice Age", nomenclature derived from the North Atlantic. We set out to test the global relevance of these terms using evidence archived in freshwater systems.

Using molecular markers, we reconstructed temperature and westerly wind variability over the last millennium from four lakes spanning a latitudinal gradient from 39.2°S to 44.7°S. Mean annual temperatures were derived from bacterial membrane lipids (brGDGTs), while the hydrogen isotope composition of leaf-wax n-alkanes (δ^2Hwax) tracked the balance between subtropical and Southern Ocean moisture sources, a fingerprint of SWW position. Chironomid assemblages, summarised using topic models trained on a new ~150-lake national calibration set, captured the lakes' ecological responses, helping to separate climate signals from within-lake productivity and catchment change.

The reconstructions indicate that people arrived during relatively warm conditions, before sustained cooling reshaped the climate that pre-European Māori society navigated. Critically, the westerlies did not shift as a rigid belt. Southern sites remained under persistent westerly influence throughout, while northern sites recorded a progressive increase in Southern Ocean moisture, indicating that the northern margin of the westerlies migrated across the country. Our multi-proxy approach also exposes traps that single proxies would miss. For instance, an apparent warming at Nganoke during strong westerly phases reflects föhn winds in the lee of the axial ranges.

These results carry a message beyond prehistory. The SWW's behaviour under a changing Southern Annular Mode is a central uncertainty for New Zealand's water security. Paleolimnology offers the only physical baseline for their natural variability before industrial-era forcing, providing a reference state for gauging how far today's freshwater systems have drifted. Our transect provides some of the highest-resolution hydroclimate records of the last millennium in the Southern Hemisphere, helping to fill critical gaps in paleoclimate reconstructions and data-assimilation products. The same records also ground a dialogue with mana whenua in the Wairarapa, comparing points of convergence and difference between scientific reconstructions and mātauranga held by Ngāti Kahungunu ki Wairarapa and Rangitāne o Wairarapa. As we make decisions about freshwater futures under an uncertain climate, our lakes remind us that they have been keeping watch all along.

Beyond nutrients: exploring the role of trace metal bioavailability in algal bloom dynamics in Lake Karāpiro

Linda Robb[1], Professor Susie Wood[1], Associate Professor Niki Lehto[1], Associate Professor Adam Hartland[2]
[1]Lincoln University, [2]Lincoln Agritech

Beyond nutrients: exploring the role of trace metal bioavailability in algal bloom dynamics in Lake Karāpiro

Linda Robb1, Susie Wood1, Nik Lehto 1, Adam Hartland 2

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Lake Karāpiro is the last of eight hydroelectric reservoirs situated along the Waikato River. This riverine reservoir lake effectively sets the water quality for Hamilton City, 50 km downstream, making biogeochemical dynamics therein decisive for water treatment and supply to rapidly growing population (190,000 residents 2025 census). The lake has experienced recurrent cyanobacterial and algal blooms—a prominent driver of water security risk over recent decades. While nutrient enrichment and changing environmental conditions are widely recognised as key drivers of bloom development, the role of trace metals in regulating algal and cyanobacterial dynamics remains poorly understood. Recent research has highlighted the importance of trace metals as micronutrients that can influence primary productivity, species composition, and bloom formation. However, the factors controlling trace metal bioavailability in freshwater systems are often complex and highly dynamic. In Lake Karāpiro, trace metal bioavailability may be influenced by both internal lake processes and external catchment inputs. Internal processes, including thermal stratification, redox-driven cycling, and sediment-water interactions, can alter metal speciation and regulate the fraction available for biological uptake. Conversely, runoff from the surrounding catchment can introduce nutrients, dissolved organic carbon (DOC), and trace metals that may modify metal speciation and transport, thereby affecting their bioavailability within the lake. The aim of this research is to determine whether trace element bioavailability is controlled by in-lake processes or external catchment inputs, and how these factors influence algal abundance and composition.

To investigate these controls, fortnightly monitoring has been conducted since October 2024 at three locations spanning the lake: an upper-lake site near the inflow, a mid-lake site co-located with a continuous depth profiler monitoring buoy, and a site downstream of the dam outlet. Water samples are analysed for dissolved and bioavailable trace metals, nutrients, major anions, and DOC. Continuous profiling data collected at the buoy includes pCO_2, dissolved oxygen, temperature, chlorophyll-a, phycocyanin, pH, turbidity, and meteorological variables such as wind speed, air temperature, and atmospheric pressure.

Early results indicate that trace metal bioavailability has been predominantly influenced by external catchment processes, with elevated concentrations of several metals coinciding with high-flow events. However, evidence of internal cycling has also been observed, including episodic increases in dissolved iron concentrations within bottom waters following short periods of hypoxia or anoxia. Redundancy analysis (RDA) indicates that iron (Fe) has been the primary significant environmental driver, of the metals analysed, at the inlet site (model $p = 0.012$; Fe $p = 0.005$) so far. Variations in Fe concentrations may be an important factor regulating algal blooms at this site. In contrast, relationships at the mid-lake site were less clear, with pH identified as the most significant environmental variable ($p = 0.001$). Results at the downstream site are still inconclusive.

Looking beyond the usual suspects: Non-conventional agents of change of positive environmental action on land

Dr Melissa Robson-Williams[1], Dr Flo van Noppen[1], Dr Nick Kirk[1], Mr Justin Connolly, Dr Sam McLachlan, Mrs Angela McFettridge, Dr Erena Le Heron, Dr Suzanne Vallance[1], Dr Bruce Small
[1]Maiangi Taiao Bioeconomy Science Institute

Achieving sustainable land management in Aotearoa New Zealand (ANZ) is likely to require significant to transformative change. Often efforts to encourage positive environmental action on land have focused on trying to change land-manager behaviour directly, and less on enablers in the wider system who can influence system change. As a part of the larger Moving the Middle programme, this research examined where and how non-conventional agents of change intervene in systems, how interventions at different levels of leverage generate change, and the capabilities associated with working at different leverage depths.

The research combined a survey of approximately 200 people from organisations involved in agricultural and environmental change with five case studies encompassing 20 examples of agents of change in, or relevant to, Aotearoa New Zealand. We interviewed agents to understand their intentions and interventions, and target audiences to examine perceived impacts. Data were analysed using the four classes of system leverage—parameters, feedbacks, design and intent—drawing on Meadows' leverage-points framework. Causal mapping was used to identify indirect and longer-term pathways through which interventions could influence system behaviour, while social practice theory provided an additional lens for examining how agents sought to change practice.

Survey respondents considered significant to transformative change necessary for sustainable land management. However, the agents and approaches most widely recognised and supported predominantly operated at shallower leverage levels. Case studies of a broader range of agents revealed distinct patterns of intervention across leverage depths. Agents working with feedbacks strengthened processes supporting desired change or weakened those maintaining undesirable behaviours. At system design, agents altered rules, social norms, decision-making processes and information flows, including whose knowledge and perspectives were represented. At system intent, interventions engaged with underlying goals, values, relationships and worldviews—for example, by strengthening relationships with place, highlighting interconnections between human and environmental wellbeing, extending time horizons, and engaging with alternative ways of understanding human–nature relationships.

Leverage depth was also associated with the elements of practice targeted. While shallower interventions more commonly engaged with materials and competences, deeper interventions increasingly engaged with meanings, including values, identities, perceptions and worldviews. Agents also frequently influenced multiple leverage levels, intentionally or otherwise, creating potentially reinforcing pathways of change.

These findings suggest that sustainability transitions require attention not simply to who agents of change are, but to how and where they intervene. Broadening support for agents working at deeper leverage points, while aligning interventions synergistically across multiple levels, may increase the potential for transformative change. Causal mapping can help make visible these potentially powerful but indirect, longer-term pathways of influence and support more deliberate intervention in complex systems.

Streams as Infrastructure: doing better for freshwater in a time of change

Mr Andrew Rossaak[1]
[1]Morphum Environmental

New Zealand's freshwater regulatory management is entering a period of rapid change. The Resource Management Act is being replaced, fast-track consenting is reshaping how major projects proceed, urban intensification is accelerating, and the Water Services framework is redrawing responsibility for the pipes and waterways our cities depend on. Across these shifts, freshwater assessments are increasingly expected to be proportionate and timely, while still being ecologically defensible.

This presentation acknowledges that the pressure is real, but the conclusion often drawn from it is wrong. Freshwater ecology, especially when considered late in projects, can be perceived as a constraint rather than an asset to integrate into design. In practice, the ecological condition of our streams is the infrastructure that protects communities: healthy, functioning waterways can buffer floods, stabilise banks, filter contaminants, moderate temperature, and underpin the wellbeing of the people who live alongside them, when functioning well. When stream ecology is degraded, we are not removing a cost — we are deferring a larger one onto councils, ratepayers and future generations.

Building on our call last year for freshwater ecologists to do better in the regulatory space, this talk turns that challenge into a constructive agenda. As the regulatory system changes, we have an opportunity to clarify what good practice looks like beyond minimum compliance. Doing better means assessments that are sharper, more defensible, and grounded in field reality rather than over-reliance on desktop information; reporting that is sound, evidence based, balanced and addresses ecological infrastructure resilience and community wellbeing, not only ecological compliance. Engagement that is early, solutions-focused, and framed around shared outcomes rather than adversarial positions.

The presentation sets out what “doing better” looks like in a shifting regulatory landscape: how freshwater ecologists can express the value of ecological services in terms engineers, decision-makers and communities recognise; how we can hold the line on ecological integrity even where statutory protections soften; and how we can reposition freshwater ecology from a late-stage hurdle to an early, central input into resilient design. Drawing on recent New Zealand examples such as erosion and sediment management through soft engineering on Awaruku and Papawai streams; Auckland Council’s blue-green network projects under their making space for water programme; Te Kukuwai o toa wetland in Porirua;]and others. These show that protecting stream ecology and building liveable, resilient communities are not competing goals.

My message is optimistic and practical. A time of regulatory change is also a chance to reset how our discipline works, communicates and earns its place at the table. The streams we protect are the same streams that protect us — and making that case, clearly and credibly, is the most important work freshwater ecologists can do in the years ahead.

Cross-ecosystem effects of leaf litter diversity on stream invertebrates and decomposition

Martin Sarkezi[1], Jasmine Brown[1], Mael Marguet[1], Dr. Stephen Pohe[2], Dr. Andrew Barnes[1], Dr. Francis Burdon[1]
[1]University Of Waikato, [2]Pohe Environmental

The biodiversity and ecosystem (BEF) paradigm stipulates that changes to the biodiversity of systems affect ecosystem functioning such as a system's ability to process organic matter. In recent years, there has emerged an understanding that such effects can propagate across ecosystem boundaries. Coupled stream-forest meta-ecosystems offer an excellent model system to test the cross-boundary effects of biodiversity. Several major aquatic insect groups spend most of their lives in freshwater habitats where they contribute to ecosystem functioning in the form of nutrient cycling and decomposition. Since forested streams are frequently nutrient limited, freshwater invertebrates are highly dependent on allochthonous inputs of leaf litter. The focus of this study was to investigate how diversity of leaf litter resources affects freshwater invertebrate community structure and contributions to ecosystem functioning. Leaf litter bags containing single species- or multiple species of leaf were exposed in two Waikato streams for a period of two weeks. One of the streams flows through diverse native forest while the other is situated inside a pine plantation. The invertebrates recovered from the leaf bags were measured and identified to the highest practicable level. Diversity metrics, biomass, and community-weighted mean trait abundances were calculated for their communities. The diversity of leaves in leaf bags did not greatly affect invertebrate community composition, but stream identity did as well as individual leaf species. The native stream showed higher abundances of macroinvertebrates with greater diversity and evenness. Varying decomposition rates of leaf bags could not be explained by invertebrate abundance or consumption alone and hint at microbial decomposers. This study suggest that leaf identify effects may outweigh diversity effects when shaping freshwater invertebrate communities. The consequence of this result will be discussed in the context of reciprocal linkages to riparian food webs.

Patterns and potential drivers of fungal diversity across Aotearoa New Zealand lakes

Dr Lena Schallenberg[1], Dr Eva Biggs[2], Dr Emilie Gios[1], Dr Georgia Thomson-Laing[3], Dr John Pearman[3], Dr Susie Wood[1]
[1]Lincoln University, [2]Bioeconomy Science Institute, [3]Cawthron Institute

Freshwater fungi are increasingly recognised as diverse and important components of aquatic ecosystems, contributing to organic matter decomposition, nutrient cycling, and food web dynamics. However, they remain poorly understood relative to other freshwater microorganisms, partly because many taxa are microscopic, difficult to culture, and challenging to identify using traditional methods. Advances in environmental DNA (eDNA) sequencing now provide new opportunities to characterise fungal communities and investigate their ecological roles in aquatic environments. Here, we present a nationwide assessment of freshwater fungal diversity across 300 lakes in Aotearoa New Zealand spanning broad gradients in latitude, lake area, depth, trophic state, catchment land use, and other environmental characteristics. Surface sediment samples were collected and analysed using sedimentary DNA (sedDNA) metabarcoding targeting the internal transcribed spacer (ITS) region to characterise fungal communities. We investigate how fungal community composition and functional diversity vary across environmental gradients and lake types. Fungi can interact with phytoplankton through processes such as parasitism, potentially influencing nutrient cycling, organic matter processing, and aquatic food webs. We therefore examine potential associations between fungal and phytoplankton communities, including whether particular fungal groups are consistently associated with specific phytoplankton taxa. These results provide new insights into the diversity, distribution, and ecological significance of freshwater fungi, addressing a major knowledge gap in Aotearoa New Zealand lake ecosystems.

Funding the future - Longevity and efficacy of environmental grants in Northland NZ

Megha Sethi[1], Rowan Scott[1]
[1]Northland Regional Council

Over the past two decades, Regional Councils in New Zealand have invested significantly in fencing, planting, and land retirement grants to improve freshwater outcomes. The benefits of fencing and planting have been studied but there has not been the same research into the longevity of these projects or if they lead to further environmental actions by the landowner. The study examines the longevity of interventions and social behaviour changes to assess the long-term efficacy of regional grant funding models.

Moving the Middle - towards greater environmental performance

Graham Sevicke-jones[1], Dr. Suzie Greenhalgh[2]
[1]Land and Water Solutions Ltd, [2]Bioeconomy Science Institute

Moving the Middle programme is a 5-year Endeavour research programme (2021–2026) aims to give rural land managers greater confidence to improve their environmental performance voluntarily. In July this year the programme was given a further year to enable additional research and uptake of the knowledge generated over the course of the programme. The programme has been working in two case study catchment areas (Waikato and Southland).

While many farmers are willing to make the changes needed to protect the environment and sustain their businesses, others are overwhelmed by information overload and the complexity of the multiple systems and pressures they face.

Providing more information, tools or technologies will not bring about the scale of change required. To empower real change, our research looks at the often-ignored human dimension of the systems affecting farmers and growers (e.g. financial, market, policy, societal/community) to identify places to intervene (leverage points) and thereby reduce pressures coming from these interacting systems.

Moving the Middle has five key areas of research:

1. complex systems that influence farmer decision-making
2. effective voluntary initiatives to improve environmental performance
3. alternative financial lending options and Māori agribusiness transition
4. non-traditional stakeholders who influence land management decisions
5. narratives related to environmental decision-making and policy formation.

Whilst the knowledge generated in this programme is relevant to many problem areas it is particularly pertinent to catchment management to effect improved environmental performance and water quality/ecology outcomes. This research is crucial for sustainable land management and the broader environmental goals of New Zealand

An AI-assisted metaweb approach to inferring trophic structure from eDNA in New Zealand lakes

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[1]Cawthron Institute, [2]Earth Sciences New Zealand, [3]Lincoln University, [4]Te Pūnaha Matatini, Complexity Centre of Research Excellence

Understanding food web structure provides ecological insight beyond what community composition alone can offer, but the rapid uptake of environmental DNA (eDNA) for characterising freshwater communities has outpaced our ability to assess the trophic structure underlying those communities - particularly in under-represented regions and for small-bodied consumers that are often overlooked. A metaweb, a regional inventory of trophic interactions used to infer local, realised food web structure, offers a promising way to close this gap. We present an AI-assisted workflow for inferring predator–prey interactions, applied to develop a regional metaweb for New Zealand lakes from eDNA data. Using a regional pool of 312 freshwater taxa, we generated two metawebs - a high-confidence link (HCL) network and a broader all-consumers (AC) network - and validated the approach against expert assessment, testing it further by comparing local realised networks for 15 lakes against null models to detect non-random structure. Networks assembled from observed communities showed significantly higher connectance and mean trophic level than expected by chance, indicating that trophic interactions constrain community assembly; these effects were more pronounced in the HCL than the AC networks. Food web metrics, particularly modularity, proved more sensitive to environmental gradients than species richness alone, demonstrating ecological insight beyond traditional biodiversity measures. This framework offers a scalable, cost-effective route to inferring trophic structure from eDNA, with practical value for freshwater ecosystem monitoring, management, and the prioritisation of lakes for targeted investigation.

Ka mua, ka muri. Looking Back on 500 Consents: Recurring Lessons for Freshwater Decision-Making in a Time of Change

Mr. Jason Smith[1]
[1]Morphum Environmental

Ka mua, ka muri. Looking Back on 500 Consents: Recurring Lessons for Freshwater Decision-Making in a Time of Change

Every resource consent is unique, yet many of the issues encountered during consenting are consistent. Drawing on experience in preparing and reviewing more than 500 freshwater-related resource consent applications across Aotearoa New Zealand, this paper identifies the recurring ecological themes that lead to project delays, cost over-runs as well as potentially compromising ecological outcomes.

Despite advances in professional practice, resourcing and the increasing recognition of Te Mana o te Wai, and a changing policy framework many consenting challenges remain stubbornly predictable. Rather than focusing on individual cases, this paper synthesizes patterns observed across a wide range of activities and projects.

In many cases, the limiting factor is not the absence of ecological knowledge, but how ecological knowledge is communicated and incorporated into project decisions. Ecological knowledge needs to be communicated to stakeholders from our clients, project managers and wider project teams/partners. That communication is not a one and done exercise and needs to be maintained as a project advance from investigations, through to design, construction and post-construction monitoring phases.

The common issues can be grouped into themes. These include:
1. Project scope and design direction are often set before ecological considerations
2. Failure to include key stakeholders
3. Assessments that focus on satisfying minimum information requirements rather than understanding ecological processes
4. Inconsistent recognition, interpretation, and significance, of effects
5. Misunderstanding of regulatory requirements
6. Effects management proposals that lack supporting evidence
7. Measures that are technically compliant but unlikely to deliver enduring ecological outcomes

Ecologists, planners, engineers, applicants and regulators all operate within a system that often rewards certainty, standardisation and efficiency, while ecological systems remain inherently variable, complex and uncertain.

As a result, the same discussions, requests for further information, consent conditions and avoidable redesigns are repeated across projects, across the country.

These observations that arise in this paper arise from substantial professional experience (as a consultant to regulatory authorities and consent applicants). The observations span diverse catchments, regions, councils and consenting pathways.

The paper highlights components that distinguish consent applications that meet project objectives, regulatory requirements and deliver on environmental outcomes. These include:
1. Integrating ecology into project design from inception
2. Adopting process-based approaches to restoration
3. Improving communication within a project team

4. Framing effects management around ecological outcomes

We are in a time of change, particularly in the policy and regulatory landscape, but also in climate impacts, new technologies, and evolving community/stakeholder expectations. Freshwater outcomes are the product of hundreds of small decisions. By sharing practical lessons, this presentation aims to stimulate discussion about how the profession can improve ecological outcomes and deliver more effective freshwater management across Aotearoa in a time of change and help prepare freshwater science for the challenges ahead.

The lessons are broadly applicable to consent applicants, consultants, regulators and decision-makers seeking to improve both the efficiency of the consenting process and the quality of freshwater management.

Toi Taiao ~ the confluence of Art, Ecology & Mātauranga Māori

Vicki Smith, Mel McColgan
[1]ToiTaiao / artecology

Vicki Smith and Mel McColgan use the kupu ToiTaiao to describe their way of working together and will share insight into where their research has lead them so far. This paper will provide an overview of the confluence of knowledge systems and practice for ToiTaiao; outlining individual mahi and projects and looking forward to explore how a creative research grant has enabled an opportunity to explore processes that may prove useful to their future communities.

Mel McColgan is from Arowhenua, she has a background in environmental science, iwi monitoring, ecology and working with Tangata Whenua in Te Tauihu. Mel brings her passion for all things water and a strong sense of responsibility in working towards the safeguarding of our natural freshwater resources for future generations. Mel was recently awarded Freshwater Champion for her work in Waimāori.

Vicki Smith is an artist who works to create connections for community across the marine, terrestrial and freshwater ecological spaces. She has worked in the Forest Service, with Ministry of Fisheries, for the Science & Environment teams in local government, as well as across Education and Community Arts.

Being from Harihari has formed both Vicki's connection to Te Taiao and drives many of her projects. Through art and ecology she seeks to engage community in understanding the science and co-creating works that help populate this information across a broad public, and to then work with them to seek creative ways to assist these communities in future.

Mel and Vicki have been working on projects together for approaching a decade. Their collective mahi includes monitoring, marine and freshwater science engagement and art making. An early collaboration Breathe (combining art, ecology and open source technology) was included in the 2018 FSS Conference in Whakatū, where Vicki also presented within the arts strand.

Tī Kouka – Place Stories and Ecosystem Services is the title of the Creative New Zealand research grant. It aims to create 'communities of practice', to collaborate and investigate fibre processes, materiality and their potential for use for remediation of ecological pressures. The grant provides a platform for engaging in the historic and cultural importance of Tī Kouka (cabbage tree) and more broadly in the pairs' combined practice, through exploring material and fibre practices.

With this rakau (Tī Kouka) forming the backdrop, they look to explore, expand and expedite community connectivity and biodiversity corridors all with an underpinning of freshwater as part of an important system rather than a standalone discreet entity.

Linking Changes in Agriculture to Water Quality Trends in New Zealand Rivers

Ton Snelder[1], Dr Caroline Fraser[1], Dr Jason Augspurger[2], Dr Ross Monaghan[3], Dr Richard Muirhead[3], Dr Elaine Moriarty[4], Marie Patterson[5]
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Long term changes in agricultural land use have influenced river water quality in New Zealand, yet few studies have examined the strength and consistency of these effects over time. Using Weighted Regressions on Time, Discharge, and Season (WRTDS), we evaluated trends at 127 water quality monitoring sites across time-windows of 5 , 10 , and 20 years duration over the 20-year period ending in 2024 for six water quality variables (total nitrogen, total phosphorus, dissolved inorganic nitrogen, dissolved reactive phosphorous, Escherichia coli. turbidity). Unlike traditional trend assessments based on Mann-Kendall correlation, the WRTDS model incorporates river flow. This enables the removal of the component of water quality variability associated with climatically driven flow variation and the evaluation of flow normalised trends, which represent the anthropogenic component of water quality change. We derived land use indicators describing agricultural land use pressure and changes in these pressures in the catchments of the water quality monitoring sites for each time-window. Land use pressure indicators were derived by combining spatio-temporal data derived from the Statistics NZ agricultural production census describing the numbers of animals on pastoral farms, with land use described by the LUCAS land use database. For each water quality variable and time-window, we then used multiple linear regression models to quantify the effect of the land use pressure indicators on the observed trends. Degrading trends for nitrate and total nitrogen were strongly associated with increasing catchment pastoral land use pressure and shifts from sheep to dairy farming. However, improving trends for nitrogen and phosphorus were strongly associated with dairy dominated catchments, consistent with implementation of mitigations on existing dairy farms. Plantation forestry had contrasting effects: high levels of established plantation forest within catchments was linked to degrading nitrogen trends, while increasing area of plantation forest was associated with improving trends for Escherichia coli. Although individual regression models explained modest amounts of between-site variation in trend rates, meta regression revealed highly consistent signals across windows and durations, indicating the analysis identified robust relationships between agricultural land use pressure and water quality trends. The results demonstrate that WRTDS flow normalisation and available water quality and land use data enable robust attribution of agricultural drivers of water quality change and reveal how evolving catchment land use affects water quality over time.

Transmission Gully Fish Passage Remediations

Mr Brett Stansfield[1]
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This presentation provides a summary of techniques used to improve fish passage for over 40 stormwater structures that were undertaken in Transmission Gully on behalf of Waka Kotahi in 2025. The presentation also outlines the methods and criteria that were used to determine fish passage compliance.

Because we were dealing with 'as built' structures the Fish Passage Action Team Principles and Outcomes document was our go to guidance to tailor the designs to ensure best fish passage outcomes.

As a result of the remediations over 65% of the stormwater structures demonstrated compliance within the first year of post remediation monitoring. Two stream diversions were also subject to remediation to return surface water flow and to enhance habitat with stream bank woody debris.

A key feature of the remediation designs was to reduce outlet perch height and provide rest pools and complex flows to ensure good fish passage was achieved. Another feature was to ensure that the remediations provided a range of options for climbing structures including wetted margins and splash zones to cater for fish with a climbing ability.

Retaining bed material within each culvert was achieved using flexi baffles which have the added advantage of having minimal effect on culvert flow capacity during storms.

Providing vegetation cover with planter pods and riparian planting for migrating fish was also a consideration to avoid predation throughout the migration journey. The planter pods have an added value of providing flow dissipation of a flume.

A big challenge with this project was to provide solutions that were robust enough to withstand the extreme flow dynamics characteristic of a piped stormwater network.

An important follow up of the program includes annual inspections of remediation measures to ensure the overall success for fish passage continues.

Assessing wetland restoration for enhancing īnanga production

Dr Simon Stewart[1], Dr Robin Holmes[1], Dr Jess Lueders-Dumont[2], Dr Andrew Watson[3], Ms Ariana Manukau[4], Prof Jeff Shima[4]
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New Zealand's longfin eels (Anguilla dieffenbachii) are endangered, and conservation action is needed. Recent work has shown that one major limitation to their population recovery, slow growth rate, is in fact driven by reduced availability of high-quality food resources. Specifically, declines in īnanga (Galaxias maculatus), associated with lowland wetland habitat loss has resulted on reduced longfin eel growth rates.

This finding opens up an exciting new opportunity freshwater fish restoration in Aotearoa; restoring wetlands to propagate food across landscapes for large predators such as eels and birds. However, while there is widespread enthusiasm and action for wetland restoration, the value of current wetland restoration practices for enhancing fish production is not well understood.

Here we investigate how wetland restoration enhances īnanga production. Using three sets of paired small (4th order) urban streams, one with and one without in-channel wetland construction, we examine the biomass, growth and diet of īnanga. The presence of wetlands appeared to increase the carrying capacity of streams for īnanga.

In streams with wetlands, īnanga biomass was higher, their diet incorporated wetland resources and growth rates remained comparable to non-wetland streams with much lower biomass. Daily growth analysis along the otolith chronologies suggested that wetlands reduce the negative impacts of high flow events on juvenile īnanga and may in fact convert high flow events from a stressor in streams without wetlands onto a resource boom for adult īnanga in the presence of constructed wetlands.

We will also discuss future avenues for enhancing the value of wetland restoration for native galaxiids.

Permanent, intermittent and ephemeral streams: what are they, why does it matter and how do you know what you've got?

Dr. Richard Storey[1]
[1]Wildland Consultants

Auckland, like most regions in New Zealand, recognises permanent, intermittent and ephemeral streams as distinct stream types for management purposes. Intermittent streams are provided the same level of protection as permanent streams, while ephemeral streams have less protections. Determining whether a particular stream reach is intermittent or ephemeral therefore has major implications for developers and freshwater ecosystems. Management decisions require a clear definition of each stream type, and a method to classify individual stream reaches.

Since there is rarely time to directly measure streamflow duration (which would require repeat visits over two years), a method for classifying streams based on visible indicators of streamflow duration is required. The method must be scientifically robust, practical, unambiguous, able to be completed on a single site visit and applicable in all situations including modified catchments and channels. Since 2013 the Auckland Unitary Plan has included definitions of the three stream types and a set of six criteria for distinguishing between ephemeral and intermittent streams. Thirteen years later, as Auckland Council considers improvements to freshwater management of freshwater, it is an appropriate time to review the definitions, the criteria and the related Practice and Guidance Note, based on the experience of consent applicants and Council reviewers, and a survey of equivalent systems overseas and in other regions of New Zealand.

Wildland Consultants led the review, which culminated in a workshop with environmental consultants and Auckland Council ecologists and resource managers. Considering situations where the current criteria are difficult to apply, common points of contention between applicants and Council and differences with methods used elsewhere, changes to the definitions, criteria and practice note were discussed. It was agreed that the current definitions are robust, and the six criteria are clear and practical. However, the criteria are not sufficient in themselves to produce a robust classification in all situations, rather, professional judgment and supporting information are typically required. Next steps include determining how to incorporate supporting information more formally into regulations and how to support good professional judgment. In-person training and standardised data forms were recommended to improve quality and consistency among assessments.

The method for defining and classifying permanent, intermittent and ephemeral streams has significant consequences for developers and the natural environment. Providing a scientifically-robust, clear and practical method is important to ensure freshwater ecosystems are adequately protected and stream protection regulations are applied fairly.

The mystery of the deep: Uncovering the diversity of the South Islands deep lakes

Dr Roe Stuart[1]
[1]University Of Otago

Deep lakes contain a variety of freshwater habitats and often support unique assemblages of species, with high rates of endemism common in large deep lake systems. Due to their significant depth, deep lakes contain areas that are isolated from the surface influences such as light and wind, resulting in distinct benthic habitats requiring adaptions by the fauna present. New Zealand has several deep lakes in the southern South Island, four of which exceed 400 m in depth, but few studies have explored beyond the littoral margins. This poster presents initial findings from pilot work exploring the habitat at depth in the South Island's deep lakes. Preliminary sampling indicates that several species of invertebrate are present even at the deepest parts of the lake and suggests that allochthonous input of terrestrial vegetation is reaching these deep points. We hope that as this project continues, it will reveal the fish and invertebrate communities occupying the deepest parts of our deep lakes, as well as the connectivity this habitat holds with the surface, and how human impacts may influence the depths.

Dry times in wet countries: the effects of past, present and future drought on biodiversity in UK river ecosystems

Prof. Rachel Stubbington[1], Dr Romain Sarremejane, Dr Judy England, Prof. Ross Thompson
[1]Nottingham Trent University

Drought is natural, but climate change and water resources pressures are interacting to exacerbate its effects on river ecosystems and their biodiversity—even in supposedly cool, wet places such as New Zealand and the UK. In particular, as drought unfolds in such temperate river systems, the abundance and diversity of freshwater species including fish, insects and plants declines. River ecosystems have long been considered resilient to drought, with biodiverse communities apparently recovering quickly after it ends—but our recent research using long-term, large-scale data characterizing aquatic invertebrate communities and environmental conditions across England's chalk streams questions this paradigm. We find that, in fact, drought-associated shifts in taxonomic composition are common… and follow surprising trajectories. Moreover, our research demonstrates how human pressures such as water pollution and abstraction can slow recovery after drought ends, whereas flow augmentation can promote ecosystem resilience. This talk will also draw from emerging insights from NZ–UK research exploring parallels and contrasts in ecological responses to drought in cool, wet countries. As drought events become more frequent and intense across multiple global regions, we highlight how research-informed actions and strategies could support the health of river ecosystems as they adapt to our changing world.

Mixing-regime shifts in phytoplankton–pCO2 causal relationships revealed by convergent cross mapping in Lake Karāpiro

Farzaneh Taheri[1], Associate Professor Adam Hartland[2], Dr Matthew Prentice[1], Associate Professor Julia Mullarney[1], Professor Deniz Özkundakci[1]
[1]University of Waikato, [2]Lincoln Agritech LTD

Freshwater carbon cycling emerges from complex interactions between physical mixing and biological production, yet these interactions are often nonlinear and difficult to distinguish from shared environmental forcing. We investigated how water-column mixing alters causal relationships between phytoplankton dynamics and the partial pressure of carbon dioxide (pCO_2) in Lake Karāpiro, New Zealand, using convergent cross mapping (CCM), a nonlinear causal inference approach. Analyses used high-frequency time-series data from a fixed monitoring buoy equipped with an automated vertical profiler and weather station.

Based on the CCM analysis, chlorophyll-a (Chl-a) showed a significant causal influence on pCO_2 during stratified conditions. Cross-map skill (ρ) increased and approached convergence with increasing library size ($\rho = 0.42$, $p = 0.03$), whereas this relationship largely disappeared during mixed conditions ($\rho = 0.06$), indicating that physical mixing weakens the coupling between phytoplankton biomass and carbon dynamics. In contrast, the phycocyanin: Chl-a ratio, used as a proxy for cyanobacterial dominance, exhibited strong causal coupling with pCO_2 during mixing periods ($\rho = 0.74$; $p = 0.005$) but not during stratified periods ($\rho = 0.03$). Additional analyses showed that no single physical driver fully explained this shift, suggesting that turbulence and rapidly changing environmental conditions alter the biological regulation of carbon cycling through multiple interacting processes.

These findings reveal a fundamental mixing-regime shift in the biological controls on pCO_2: total phytoplankton biomass dominates during stratification, whereas community composition becomes increasingly important during mixing. More broadly, this study demonstrates the value of nonlinear causal inference for identifying changing ecosystem controls that conventional correlation-based approaches may overlook.

Mechanisms Enabling Coexistence Between a Nationally Endangered Alpine Galaxiid and Introduced Salmonids in the Upper Manuherikia River

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In Aotearoa, coexistence between river-resident galaxiids and introduced salmonids is a complex and context-dependent process. Vulnerability to displacement or predation varies among galaxiid species, driven by differences in their biological traits. Understanding the mechanisms enabling coexistence is essential for developing effective management. This research investigates how habitat preferences and life history traits allow a highly disjunct population of nationally endangered alpine galaxias (Galaxias affinis paucispondylus “Manuherikia”) to coexist with three piscivorous salmonid species (brown trout (Salmo trutta), rainbow trout (Oncorhynchus mykiss) and brook char (Salvelinus fontinalis)) in the upper Manuherikia River.

Twenty stream reaches across the upper Manuherikia River were sampled from February to August 2026. At each site, fish were collected via electrofishing, identified, measured, and released, and instream habitat variables were measured to characterise the physical conditions associated with galaxiid presence and abundance. Sites with high galaxiid abundance were revisited, and a sample of gravid females was collected for life history analysis. Ovaries were dissected and weighed to calculate gonado-somatic index as an indicator of reproductive effort and spawning timing. Sagittal otoliths were extracted, and growth rings counted to determine age structure and construct length-at-age growth curves.

Data collection is complete, and analysis is currently underway. Electrofishing surveys found galaxiids were the numerically dominant species, dominating most mainstem reaches, with their entire surveyed distribution overlapping with at least one salmonid species. Further analysis will characterise the instream habitat variables associated with galaxiid presence relative to salmonids, and describe age structure, growth rates, and reproductive investment across the sampled population.

This is the first study of any kind to examine the life history traits of the Manuherikia alpine galaxiid and provide a comprehensive analysis of their habitat preferences and how these enable them to coexist with introduced salmonids. By filling key knowledge gaps in the species' life history and coexistence dynamics, these findings will help determine their vulnerability to invasive salmonids and enable prioritisation for the effective management and conservation of this threatened taxon.

Gorge-ous attributes, ecological sampling trial to inform parameters for monitoring gorge environments

Dr Channell Thoms[1]
[1]Environment Canterbury

Te Kākaho/Kakahu River is a culturally significant waterway, valued by mana whenua as an historic source of mahinga kai. The Kakahu River mid-catchment contains regionally rare, volcanically derived gorge sections, creating the potential for distinctive freshwater ecosystems. However, the Kakahu has experienced substantial environmental and management change, and these gorge features present challenges for conventional ecological monitoring. In this presentation, I summarise the known environmental stressors and ecological values of the Kakahu, largely based on assessment above and below the gorges. I also introduce a trial survey design developed to assess aquatic ecosystem health within these gorges, supported by preliminary ecological data.

Assessing passive environmental DNA sampling for lake biodiversity monitoring

Dr Georgia Thomson-laing[1], Lena Schallenberg[3], Samantha Massett[2], Diane Orihel[2], Susanna Wood[3]
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Environmental DNA (eDNA) has become an increasingly valuable tool for monitoring aquatic biodiversity, with active water filtration currently the standard sampling approach. However, active sampling provides only a snapshot of eDNA at a single point in time and may fail to capture temporal variation in species presence. Passive eDNA samplers offer a promising alternative by integrating DNA accumulation over time, potentially increasing biodiversity detection and reducing the influence of short-term spatial heterogeneity. Despite this potential, their performance relative to conventional active sampling remains poorly understood in low-flow lake ecosystems. This study evaluated passive eDNA sampling across a range of lake environments by investigating the effects of deployment duration, filter type, and comparisons with conventional active water filtration. In Lake Chalice (Marlborough) and Lake Moawhitu (D'Urville Island), passive samplers were compared with active filtration for the detection of koaro (Galaxias brevipinnis) and tuna (freshwater eels; Anguilla), respectively. A deployment time trial (2–120 hours) was conducted in Lake Hayes to determine the optimal filter type and deployment duration for passive samplers. In addition, weekly sampling was undertaken at three sites in Lake Opinicon (Canada) to compare active filtration with passive GF/C and nylon filters while assessing the effects of filter type, within-lake spatial variability, and temporal consistency. DNA recovered from all sampling approaches was extracted and analysed using species-specific droplet digital PCR assays, fish metabarcoding, or broad eukaryotic metabarcoding, depending on the study objectives. Together, these complementary studies provide a comprehensive evaluation of passive eDNA sampling across multiple lake types and applications. The findings demonstrate the potential of passive eDNA sampling in lakes and support the development of robust, cost-effective methods for freshwater biodiversity monitoring.

Drifting through an urban world: macroinvertebrate diversity and drift along the Pūharakekenui | Styx River in Christchurch

Kayla Valentine[1], Adrian Paterson[1], Issie Barrett[1], Elysia Harcombe[1]
[1]Lincoln University

Urbanisation drives urban stream syndrome, a well-documented condition that is characterised by negative factors such as increased fine sediment, pollution and changes in stream morphology. These changes to freshwater habitats can disrupt the entire ecosystem: a degraded habitat has decreased available shelter, food sources and can lead to habitat fragmentation, which decreases overall biodiversity of the ecosystem.

Macroinvertebrates are useful indicators for water quality and are widely used in research and monitoring to determine ecosystem health. An important part of most macroinvertebrates' life cycles is dispersal, however, typical assessment methods do not directly measure this. There are several factors that can influence dispersal, including habitat quality and fragmentation. These factors can affect the rate of macroinvertebrate drift, which influences overall diversity. Therefore, it is crucial to understand downstream drift patterns and identify the environmental factors affecting dispersal.

We investigated the drift and diversity of macroinvertebrates to better understand community dynamics within the Styx catchment in Christchurch, New Zealand. This included the Styx River, Smacks Creek and Kā Pūtahi Creek, with 13 sites across a broad gradient of urban impact. Driftnets and kicknets were used to investigate macroinvertebrate dispersal and benthic macroinvertebrate communities, respectively. Environmental data were collected and sites characterised according to factors including fine sediment composition, flow, and levels of vegetation. Overall, sites with a higher level of urbanisation were associated with high fine sediment, slower flow and less vegetation, and sites with lower levels of urbanisation were associated with less fine sediment, faster flow and ample levels of native vegetation.

These physically degraded sites typically had lower abundances of sensitive taxa, and a higher abundance of more tolerant taxa resistant to factors such as pollution and high fine sediment. At degraded sites, more tolerant taxa were typically found in the drift nets.

Restoration of freshwater ecosystems can involve large-scale projects addressing both riparian and in-stream habitat. Yet even where significant restoration is implemented, successful recolonisation is not guaranteed, particularly if catchment-scale issues remain unaddressed. Understanding how macroinvertebrates disperse, and what factors limit their dispersal, is essential for designing appropriate and effective restoration interventions.

Iconic clear-water lakes are changing: evidence from Lakes Wānaka and Wakatipu

Dr Marcus Vandergoes[1], Dr Susie Wood, Dr Jamie Howarth, Dr Xun Li, Aaron Kolder, Dr Georgia Thomson-Laing, Dr John Pearman, Dr Sean Fitzsimons, Dr Rose Gregersen, Lizette Reyes, Te Aomania Te Koha
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Large oligotrophic glacially formed lakes in Aotearoa New Zealand are of high value and recognised for their exceptional water clarity and ecological condition. However, concerns have increased in recent decades about rising chlorophyll-a concentrations, the appearance of lake snow caused by the invasive diatom Lindavia intermedia, urban growth, land-use intensification, and other pressures within their catchments. Because routine monitoring spans only a small fraction of the period over which environmental change occurs, we can use lake sediment records to reconstruct ecological and water-quality change over the past several centuries and provide insights into the timing and likely drivers of change.

In this study, we investigate the ecological changes over the last 200 years in Lakes Wānaka and Wakatipu using sediment cores. A suite of multi-proxy palaeolimnological techniques, including biological, chemical, and physical indicators preserved within the sediments were used to reconstruct past catchment conditions, water quality, and ecological communities. These included pollen charcoal, trace metals, diatoms, hyperspectral scanning and sedimentary ancient DNA analysis.

Our results indicate that distinct changes occurred in these systems after the late twentieth and early twenty-first centuries. Marked changes were detected across bacterial, eukaryotic, and diatom communities indicating widespread ecosystem change. We explore the timing and likely drivers of these recent changes with a goal to provide information to guide future management decisions and better understand the pressures influencing these high value lake systems.

Genetic structure of Neochanna rekohua across island lakes.

Ms Anusha Verma[1], Dr William Pearman[1], Ms Grace Fortune-Kelly[1], Professor Ceridwen Fraser[1]
[1]University Of Otago

Neochanna rekohua, the Chatham mudfish, is one of the five endemic mudfish species from New Zealand, all of which are at risk or threatened. On Rēkohu (Chatham Island, Wharekauri), which remains free of non-native fish, N. rekohua has ventured out of wetlands and swamps to occupy lakes throughout the island. Very little is known about the evolutionary history, migration patterns, or population structure of N. rekohua. We therefore conducted a genotyping-by-sequencing analysis of populations from thirteen lakes to better understand the genetic diversity and structure of Chatham mudfish.

Our findings reveal distinct northern and southern genetic clusters. This latitudinal separation explained most genetic variation, with some remaining isolation by distance among southern populations. In contrast, the northern lakes, especially those near sea level, showed greater genetic differentiation and fragmentation from each other. Northern lakes may therefore be under particular risk due to low connectivity as well as threats from land use and potential saline intrusions. A better knowledge of the genetic structure of this unique fish is a key step toward understanding its conservation and management requirements.

From barriers to better outcomes: Outcomes and lessons learnt from Greater Wellington's five-year fish passage project

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[1]Greater Wellington Regional Council

Greater Wellington Regional Council has recently completed a five-year fish passage programme, delivered in partnership with Ngāti Toa Rangatira and jointly funded by the Ministry for the Environment (MfE). The programme improved freshwater connectivity across the Wellington Region through barrier assessments, remediation projects and capital investment in council-owned assets. Over the lifetime of the programme, more than 2,000 barriers were assessed, and 350 remediation projects were completed.

This presentation shares lessons from experiences delivering fish passage at a regional scale. While identifying barriers is relatively straightforward, prioritising which barriers to address and determining how they can be remediated is often more complex. Land and asset ownership, access constraints, competing uses of structures and available funding can all influence whether and how a barrier can be addressed. The programme delivered a range of solutions, from low-cost, simple fixes through to higher-quality, nature-based approaches, with engineering constraints, site conditions and project objectives also shaping the solutions ultimately delivered. Case studies illustrate the practical challenges of prioritisation and remediation and the trade-offs involved in delivering fish passage across the region.

Delivery required collaboration with Ngāti Toa Rangatira, territorial authorities, infrastructure owners, landowners, consultants, contractors and internal council teams. Key challenges included securing support, integrating fish passage into asset management, and balancing ecological outcomes with competing priorities. Resource consenting was also a common requirement and, in many cases, a significant time and delivery constraint, adding complexity and delays to remediation projects.

A key component of the programme was developing a regional “global consent” approach to streamline fish passage remediation across multiple sites. While still progressing through the regulatory process, the approach provides insights into the challenges and opportunities of regional consenting, alongside experience gained through consenting nature-like rock ramp fishways.

Towards the end of the programme, Greater Wellington partnered with Tim Marsden of Australasian Fish Passage Services and Cindy Baker of Earth Sciences New Zealand to design and construct three nature-like rock ramp fishways, with at least two more planned for summer 2027. These projects provide practical examples of nature-based fish passage solutions and are intended to form a key remediation approach for future fish passage works across the region.

This presentation will provide practical lessons from five years of delivering fish passage at scale, including the realities of prioritisation, remediation quality, consenting and collaboration, and how these experiences are shaping the future direction of fish passage delivery in the region.

Global Lake Health in the Anthropocene: Lessons for Freshwater Futures

Professor Gesa A. Weyhenmeyer[1], Professor Susie A. Wood[2]
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Lakes provide essential ecosystem services that support human well-being, including drinking water, food production, recreation, cultural values, and climate regulation. However, increasing anthropogenic pressures are compromising the health of lake ecosystems worldwide. Drawing on a global synthesis of lake observations, assessments, and environmental datasets, major threats to lake health and their implications for freshwater futures are here examined. Using a framework inspired by human health, lake health issues are classified into thermal, circulatory, respiratory, nutritional and metabolic disorders, infections, and poisoning. These health issues arise from multiple interacting stressors, including climate change, eutrophication, water abstraction, pollution, invasive species, hydromorphological modification, and the release of emerging contaminants. Globally, many lakes exhibit symptoms of deteriorating health, including heat accumulation, ice-cover loss, drying, flooding, harmful algal blooms, oxygen depletion, salinization, and declining water quality. These pressures rarely occur in isolation; instead, they increasingly interact, creating compound risks that can reduce ecosystem resilience and compromise the services on which societies depend. Of particular concern is the growing disconnect between the scale of emerging threats and the capacity of current monitoring and management approaches to detect and address them early. To maintain freshwater futures a shift from reactive responses to preventative lake healthcare is required, including regular monitoring, early diagnosis of emerging problems, evidence-based interventions, and ongoing evaluation of management outcomes. Adopting a lake health perspective can help integrate ecological, social, and management objectives, improve communication among scientists, managers, policymakers, and communities, and support more effective stewardship of freshwater resources. As environmental pressures intensify and societal expectations evolve, healthy lakes should be recognised as critical infrastructure for sustainable and resilient futures. Lessons from global lake health assessments highlight both the urgency of action and the opportunities for protecting and restoring freshwater ecosystems for future generations.

Prioritising management action in multi-stressor catchments

Dr Richard White[1], Mrs. Maree Paterson[2], Dr Rick Stoffels[1]
[1]Earth Sciences New Zealand, [2]Horizons Regional Council

Environmental managers recognise the need to account for multi-stressor interactions in management strategies. This requires tools that accommodate the complexity of real-world multi-stressor problems, but in a way that simplifies that complexity, and transparently presents the information necessary to advance decision-making. We present a decision-support model for identifying which stressors, when remediated, are most likely to improve macroinvertebrate communities in catchments of New Zealand's Manawatū–Whanganui region. The model was co-developed with end-users to ensure model design was fit-for-purpose. The model accommodates any form of n-way interaction among five freshwater stressors: low-flow duration, dissolved inorganic nitrogen (DIN), dissolved reactive phosphorus (DRP), and suspended (SFS) and deposited fine sediment (DFS). At numerous sites spanning a gradient of multi-stressor impact we predicted how the community would respond to changing each stressor from its current state, to a 'management target', while holding other stressors at their current state. These 'one-at-a-time' stressor improvements showed that remediating DFS, SFS and DIN may yield the largest gains in macroinvertebrate abundance, biomass, and richness, particularly at sites most impacted by multiple stressors. Responses differed among taxonomic groups: pollution-sensitive taxa showed consistently strong positive responses to stressor reductions, whereas pollution-tolerant taxa generally responded weakly and inconsistently across sites. We discuss limitations of our approach, some of which may be overcome through more careful design of monitoring programmes. We also outline some design features of the approach that improve its usefulness to managers, and touch on some challenges in strengthening the bridge between theory and application for multi-stressor science.

Kōura, Culture and Lake Health: Implementing Te Mana o te Wai through Māori-led Cultural Valuation in the Rotorua Te Arawa Lakes.

Ms Mereana Wilson-Rooy[1]
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As Aotearoa navigates changing freshwater challenges, implementing Te Mana o te Wai requires governance approaches that recognise the confluence of communities, catchments, and knowledge systems shaping our freshwater futures. While freshwater management continues to rely heavily on biophysical indicators, important cultural dimensions of lake health often remain underrepresented in assessment and decision-making processes. Strengthening freshwater governance therefore requires Indigenous-led approaches that make Māori values, aspirations, and decision-making authority visible and actionable.

Drawing on research undertaken with the Rotorua Te Arawa Lakes, this presentation demonstrates how cultural valuation can support holistic freshwater assessment by weaving together mātauranga Māori, ecological science, and community wellbeing objectives. Two culturally designed tools are presented: the CHIEF decision-making framework and the Eco-Cultural Lake Systems (ECLS) model. Together, these tools provide practical mechanisms for understanding lake systems through interconnected ecological, cultural, and social dimensions.

This presentation highlights culturally relevant indicators, including the abundance of kōura, the presence of key taonga species, and Catch-Per-Unit-Effort (CPUE) measures that reflect mahinga kai and cultural wellbeing values. Within the Rotorua Te Arawa Lakes context, CHIEF and ECLS identify kōura abundance as a key indicator of cultural wellbeing and lake health. Through modelling and knowledge weaving, these measures can be considered alongside the Trophic Lake Index (TLI), providing complementary ecological and cultural perspectives on freshwater condition.

This research demonstrates how Indigenous-led cultural valuation can operationalise Te Mana o te Wai by integrating cultural, ecological, and community indicators within freshwater governance. The Rotorua Te Arawa Lakes case study offers a practical pathway for supporting more equitable, resilient, and future-focused freshwater management while strengthening relationships between people, place, and freshwater ecosystems.

Keywords: Freshwater; Te Mana o te Wai; Te Arawa; kōura; cultural valuation; lake systems; mahinga kai; modelling; knowledge weaving; Catch-Per-Unit-Effort (CPUE); Trophic Lake Index (TLI).

Did perch eradication reduce cyanobacterial blooms in Roto Kawau (Lower Karori Reservoir)?

Prof Susie Wood[1], Ian Duggan, Alton Perrie, Andrew Rees, John and Beth Wood, Kari Beaven, Jo Ledington, Danielle Shanahan, Amber McEwan
[1]Lincoln University

Roto Kawau (Lower Karori Reservoir) is a small, monomictic lake located within Zealandia Te Māra a Tāne, Wellington, New Zealand. Despite its largely protected catchment and low external nutrient inputs, the lake has historically experienced supertrophic conditions and recurrent cyanobacterial blooms. A large population of introduced European perch (Perca fluviatilis), present for over a century, was identified as a potential driver of these conditions through strong predation pressure on zooplankton grazers. To support ecological restoration goals, a progressive perch eradication programme was undertaken between 2007 and 2021, culminating in whole-lake eradication.

We analysed approximately 20 years of monitoring data (2005-2026) to evaluate ecosystem responses to changing fish population structure and eventual perch removal, focusing on plankton communities, nutrient dynamics, and water quality. The most consistent response was a substantial decline in phytoplankton. Chlorophyll a concentrations and total phytoplankton abundance decreased markedly over time, accompanied by declines across several major phytoplankton groups, including cyanobacteria. These changes represent a shift from supertrophic conditions during the early monitoring period toward eutrophic conditions in recent years. Dissolved reactive phosphorus concentrations also declined significantly, indicating reduced bioavailable phosphorus availability. Zooplankton responses were more complex. Total zooplankton abundance declined significantly and became less variable through time, with no clear recovery of large-bodied grazers such as Daphnia. This pattern may reflect long-term legacy effects of size-selective predation by perchor complicating influences such as any trophic impact from the concurrent removal of over 200 short and longfin eels during the perch eradication project.

In contrast to biological indicators, total nitrogen and total phosphorus concentrations showed no significant long-term decline, indicating that substantial nutrient reservoirs remain within the system. The persistence of relatively low phytoplankton biomass despite nutrient concentrations consistent with eutrophic lakes suggests a partial decoupling between nutrient availability and algal production. Strong thermal stratification, periodic hypoxia, and evidence of internal nutrient loading appear to play important roles in regulating this response.

Our findings indicate that perch eradication has contributed to improved water quality and reduced phytoplankton biomass, but that legacy nutrient stores and lake physical processes continue to influence ecosystem dynamics. Roto Kawau provides a valuable case study demonstrating both the benefits and limitations of biomanipulation as a lake restoration tool.

Finding Gold: How Freshwater Ecologists Discovered Gold Clam in New Zealand and What Have We Learned Three Years On

Mark Yungnickel[1], Alex Reid
[1]WSP

On the 19th April 2023, what initially appeared to be an unfamiliar shell on the edge of the Waikato River led to the discovery of the invasive freshwater gold clam (Corbicula fluminea) in New Zealand. The discovery was made during routine ecological fieldwork and ultimately triggered a major biosecurity response involving Biosecurity New Zealand, NIWA, Mana Whenua, Councils, the Department of Conservation and other stakeholders.

Three years on, gold clam remains one of New Zealand's most significant freshwater biosecurity challenges. This presentation reflects on the journey from Mark and Alex's initial discovery through to the ongoing response and examines how our understanding of the species, its distribution, risks and management has evolved over time.

The presentation will consider what the incursion has taught us about early detection, surveillance, collaboration and practical biosecurity management in freshwater environments. It will also reflect on how gold clam has influenced ecological practice, project delivery and the way freshwater practitioners respond to emerging biosecurity threats.

You Can't Treat a Frog Like a Fish: What Freshwater Ecologists Should Know About Hochstetter's Frogs

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Freshwater practitioners routinely assess fish, macroinvertebrates and water quality, yet threatened freshwater-dependent species often require different approaches. Hochstetter's frog (Leiopelma hochstetteri) is one such species, being closely associated with forest streams while exhibiting ecological requirements that differ markedly from those of native fish.

Drawing on recent experience undertaking comprehensive frog surveys, ecological assessments and salvage programmes across northern New Zealand, this presentation aims to introduce freshwater practitioners to Hochstetter's frogs and the challenges associated with detecting and managing them in freshwater environments. The presentation will discuss habitat characteristics, survey methodologies, frog detectability, interpreting survey results, and the relationship between survey findings and the numbers of frogs ultimately encountered during salvage.

The presentation will discuss practical challenges encountered in the field, including identifying suitable habitat, interpreting absence data, estimating population abundance, and integrating frog surveys alongside more traditional freshwater investigations. It will also reflect on how the presence of frogs can influence field methods, project planning and ecological decision-making.

By sharing field observations and lessons learned, this presentation aims to provide freshwater practitioners with greater confidence when assessing and managing freshwater habitats that support New Zealand's only native frog regularly associated with streams.

A mending approach to urban freshwater

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Aotearoa is facing significant infrastructure resilience and affordability challenges. Could modest, incremental interventions, inspired by the craft of mending, support better outcomes for urban waterbodies, biodiversity and communities?

Much of our infrastructure requires urgent renewals and upgrades to support growing urban populations, adapt to the effects of climate change and address legacy issues such as cross-connections. Our National Infrastructure Plan asks us to prioritise maintaining our existing infrastructure and think carefully about what we can afford and how we invest going forward.

We also know that increased imperviousness in urban areas is driving more frequent, flashy and variable flows into waterbodies receiving stormwater discharges; adversely affecting bank stability, flows, water quality and aquatic habitat. Significant investment is required to manage flood risks and improve urban freshwater outcomes, yet stormwater design solutions addressing cumulative effects on urban hydrology and water quality can be prohibitively costly and complex to retrofit and maintain.

So how do we navigate complex environmental issues alongside increasing financial constraints? This presentation proposes a mending approach to urban freshwater.

Urban places are inherently diverse and unpredictable; shaped by their history, the people and creatures living there, and the environmental processes occurring or unable to occur. Mending presents an alternative to notions of control, certainty and perfection. A mending approach responds to issues with observation, humility and iteration. It means listening to, accepting and caring for what we already have through a sometimes messy, adaptive process of improvement.

Incentivising reductions in impervious surface and urban greening is a simple, comparatively cheap way to improve urban freshwater outcomes and invest in our stormwater networks – an example of what could sit in our mending toolkit. What would it look like to enable this to be delivered and maintained collectively by communities in affordable and low-tech ways? What might the cumulative benefits of small-scale land use change be?

Identifying seasonal and spatial variation in biodiversity in the littoral communities of Lake Rotoiti, Nelson Lakes National Park

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Lake littoral zones are important biodiversity hotspots which contribute substantially to regional beta diversity, with this contribution shifting throughout the annual cycle as community composition turns over. Yet, there is a marked lack of spatiotemporal studies assessing the changes in the diversity and structure of littoral biological communities, particularly in Aotearoa New Zealand, where endemic invertebrate and fish assemblages, combined with limited long-term monitoring infrastructure, make seasonal biodiversity dynamics especially poorly resolved. Lakes are strongly seasonally forced ecosystems, driving shifts in biodiversity and food web structure. These variations can occur at local or ecosystems-wide scales and carry implications for the overall stability of communities and food chains, as species respond to changes in food and energy availability. Identifying these patterns of change is essential in understanding lacustrine contributions to the landscape and informing impactful conservation and restoration actions. This study evaluates eDNA approaches alongside traditional biotic monitoring approaches to capture spatial and seasonal variations of lake biota. We described the spatial and temporal variation in the diversity of littoral communities in Lake Rotoiti, Nelson Lakes using traditional invertebrate and fish sampling, and environmental DNA (eDNA) focusing on two gene regions: small subunit ribosomal RNA (18S) and cytochrome c oxidase I (COI). To account for the multiple trophic levels and functional feeding groups within littoral food webs, we partitioned diversity by trophic and functional group (hereafter 'multi-trophic diversity') to test whether seasonal and spatial patterns differ across the food web. We tested two hypotheses (1a) eDNA-based sampling resolves alpha diversity and community composition with greater sensitivity than traditional sampling; (1b) traditional sampling captures taxa density fluctuations and detects taxa that eDNA methods missed; and jointly, (1c) the two approaches are complementary rather than interchangeable; (2) multi-trophic diversity varies significantly across seasons and spatial distribution. Alpha diversity, multi-trophic diversity, and community composition were evaluated across six spatially distinct locations around Lake Rotoiti, sampled at six time-points (at two-monthly intervals) over one year. Firstly, although eDNA identified a greater seasonal turnover of community composition and diversity, traditional sampling detected larger invertebrate larvae (orders Ephemeroptera, Odonata and Plecoptera), which had been entirely missed by eDNA. Secondly, dividing diversity and community composition by functional feeding group revealed complementary temporal fluctuations which were not defined when diversity was assessed in aggregate. However, spatial differences had limited effects on alpha diversity and community composition, changes in which were predominantly dictated by temporal variation. This study showcases the complementarity of biodiversity assessment methods and the importance of a multi-trophic biodiversity perspective in understanding the drivers of biological shifts within lake communities at a seasonal scale.