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Te Whare Wānanga o Aoraki
CHRISTCHURCH • NEW ZEALAND

Waterways
Centre for Freshwater Management

Post Graduate Student Conference

12 November 2013

University of Canterbury,
Christchurch New Zealand

Abstract Booklet



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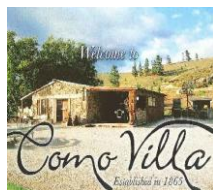
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Conference Programme

Tuesday, November 12, 2013

Time	Presentation	
8:30 am	Registration	
9:00	Introduction - Jenny Webster-Brown , Director, Waterways	
9:05	Welcome – Steve Weaver , Deputy Vice-Chancellor (Research), University of Canterbury Greg Ryan , Dean, Faculty Environment, Society and Design, Lincoln University	
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10.15	Interacting global change drivers limit the distribution of a thermally-sensitive freshwater fish	Nixie Boddy, BSc (Hons) Candidate, University of Canterbury, page 11
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11.15	Limitations of the legal framework, a limiting factor in New Zealand's freshwater reforms?	Faiz Abdul Raheem, PhD Candidate, University of Canterbury, page 13
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11.45	Determining the age of agricultural faecal pollution in our streams and rivers	Megan Devane, PhD Candidate, University of Canterbury, page 15
12.00	Political power in Canterbury's water governance: a Gramscian analysis	Nicholas Kirk. PhD Candidate, Lincoln University, page 16
12.15	Phosphorus Partitioning in Meltwater Ponds in Victoria Land, Antarctica: Insights into the P Cycle	Hannah Christenson, PhD Candidate, University of Canterbury, page 17
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1.30	Quantifying Spatial and Temporal Deposition of Atmospheric Contaminants in Runoff from Concrete Pavements	Louise Murphy, PhD Candidate, University of Canterbury, page 18
1.45	The effect of riparian management on sediment retention within a variety of different land uses and associated riparian zones	Emma Porter, Masters Candidate, University of Canterbury, page 19
2.00	A comparative study of riparian drain management and its effects on phosphate and sediment inputs to Te Waihora/Lake Ellesmere	Hannah Mitchell, Masters Candidate, University of Canterbury, page 20
2.15	Modelling of Stormwater Management Options for Enhancing Water Quality of Urban Streams	Frances Charters, Masters Candidate, University of Canterbury, page 21
2.30	Trialling passive remediation systems for treatment of severe AMD: A case study from Bellvue Mine, West Coast, New Zealand	Rae West, Masters Candidate, University of Canterbury, page 22
2.45	Gaining a better understanding of mayfly dispersal across the landscape	Matt Wallace, Masters Candidate, University of Canterbury, page 23
3.00	Afternoon Tea	
3.30	An investigation of nitrate-nitrogen toxicity effects in Canterbury stream communities	Tom Moore, Masters Candidate, University of Canterbury, page 24
3.45	Body mass-abundance relationships in streams: the importance of habitat size and flooding disturbance	Helen Warburton, PhD Candidate, University of Canterbury, page 25
4.00	Trade-offs and dispersal in unpredictable environments: generalist invertebrate persistence in ponds	Mark Galatowitsch, PhD Candidate, University of Canterbury, page 26
4.15	<i>Didymosphenia geminata</i> impacts on benthic algal and invertebrate diversity and community composition.	Jonathan Bray, PhD Candidate, University of Canterbury, page 27
4.30	Climate change impacts on future stream flows in the Hakataramea catchment	Denjam Khadka, PhD Candidate, University of Canterbury, page 28
4.45	Reproduction in a whitebait species: spawn early or spawn often?	Jessica Hill, Masters Candidate, University of Canterbury, page 29
4.45	Drinks, prize presentation	

Posters

Sophia Hunt	Climate change mediation of predator-prey interactions, page 30.
Jessica Hill	Whitebait wanderings: riverine growth and movement, page 31.
Lyndsey Kelly	Domestic Chemical Use at Scott Base: Assessment of Effects and Alternatives, page 32.
Phil Clunies-Ross	Synthetic Streams: Microplastic Pollutants in New Zealand waterways? page 33.
Craig Simpson	Groundwater Quality Change in Mosgiel, Otago, page 34.
Tom Swan	Use of biological control agents for controlling mosquito populations in the Kingdom of Tonga, page 35.
Melissa Pendley	Investigating the regional variation in rules and best management practices for forestry earthworks in New Zealand, page 36.
Gina Vetoretti	Intertidal Foraminifera of the Avon-Heathcote Estuary; Response to coseismic deformation and potential to record local historic events, page 37.

Welcome

Hello Everyone

Welcome to the Waterways Postgraduate Student Seminar!

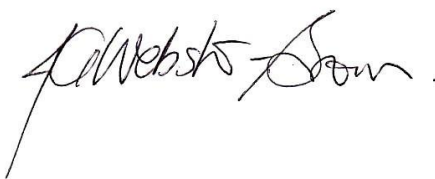
The Waterways Centre for Freshwater Management is a teaching and research centre, jointly supported by the University of Canterbury and Lincoln University. Established in 2009, it aims to improve the knowledge-driven management of freshwater resources by offering a full complement of nationally accredited tertiary courses and actively supporting postgraduate research programmes.

After the success of the inaugural Waterways Postgraduate Student Seminar Day in 2012, we have committed to staging this event every year, to provide a regular forum for our postgraduate students to showcase their research, and to interact with you - the stakeholders in the freshwater resources of Canterbury and New Zealand. We trust we can provide you with a good opportunity to evaluate our up-and-coming career water resource managers and scientists, and give you confidence that the future of NZ's water resources is in good hands.

Today we will learn about postgraduate freshwater research being undertaken at both universities, under the supervision of academic staff affiliated with the Waterways Centre. There will be talks and posters on freshwater science and on policy changes that affect, or could affect, water use and management, reflecting the diverse range of issues that currently face freshwater management in New Zealand.

This seminar day has been entirely organised by a small but dedicated committee of very capable Masters and Doctoral research students. We greatly appreciate their efforts, and they deserve all of the compliments that I am sure will come their way.

Enjoy your day!

A handwritten signature in black ink, appearing to read 'Jenny Webster-Brown', with a long, sweeping underline.

Professor Jenny Webster-Brown

Director

Waterways Centre for Freshwater Management

Keynote Speaker

Melissa Robson

Environment Canterbury

Over the last two decades, there has been increasing evidence that some of New Zealand's freshwater resources are at, or over, their capacity for use. It is also clear that the current mix of approaches being used



to deal with diffuse pollution are limited, particularly for locations where land use change and intensification is occurring. Evidently a different approach is needed. The Land and Water Forum, the National Policy Statement for Freshwater Management and most recently the proposed water reforms point to an alternative approach, with the NPS requiring quantified catchment limits to be set for water quality and quantity, and the LAWF reports and proposed water reforms recommending or recognising the use of collaboration.

Attempting to address water quality issues in this way provides both a challenge and an opportunity for those involved. Because these are not purely science processes, but community processes informed by science, the requirements of these processes have implications for the science we do, how that science is used and also for us as scientists.

In this talk Melissa will share some of the experiences of being a scientist in these processes and discuss some of those challenges and opportunities for in relation to catchment limit setting and collaboration.

Melissa Robson is an environmental scientist working in New Zealand in a joint role between an agricultural research institute (AgResearch) and Canterbury regional council. After a PhD in Plant and Soil Science and an MSc in integrated Water Management, Melissa specialised in farm to catchment scale management of diffuse pollution. In the UK she worked in a regulatory

role, testing compliance with environmental regulations particularly around nitrates and pesticides, and also in a voluntary catchment water quality programme working with farmers and other agencies delivering farm plans and a catchment water quality strategy around nitrates, phosphorus and sediment. In New Zealand Melissa has continued work from the farm up to the catchment scale and has latterly lead a multi-disciplinary team to inform collaborative community based processes for developing integrated catchment water quality and quantity plans, by assessing the impacts of land use or environmental scenarios on social, economic, environmental, cultural and on farm values.

Melissa is currently leading the technical work to inform setting of environmental limits in a couple of highly conflicted catchments in Canterbury, leading the science delivery of cultural, economic, social and environmental information to the community participants and working in the science policy interface, trying to integrate science into regional council policy. Melissa is also leading a collaborative project to develop numeric articulation of good management practice across primary sector industries, soils and climates for the Canterbury region for use in both modelling and regulation.

9.45 **Critical thresholds of population resistance to intense drought in a forest-dwelling, extremophile fish, the brown mudfish**

Richard White

School of Biological Sciences, University of Canterbury, richard.white@pg.canterbury.ac.nz



The increased intensity and frequency of extreme droughts predicted under climate change seriously threatens freshwater fish populations because of the potential for population crashes or extinctions. Identifying critical population drought resistance (survival) thresholds will be important for predicting and managing persistence through such change. Using Cormack-Jolly-Seber survival models, we investigated drought resistance thresholds in populations of brown mudfish (*Neochanna apoda*), an extremophile fish living in podocarp-swamp-forests of South Westland. The fates of over 800 mudfish from 41 sub-populations within Saltwater Forest were monitored during the “Big Dry” in March 2013, New Zealand’s worst drought in 70 years. We hypothesised that survival probability would negatively correlate with drought intensity (mean pool depth) in a threshold manner because of the interactive effects of increasing population density and physiological stress as habitat size shrinks. Sub-population mortality averaged 35 percent during the Big Dry resulting in an estimated Saltwater Forest population reduction of 2.6 million fish, down from 7.5 million. Persistence depended on pool depth, with sub-populations in pools deeper than 230 mm being the most drought resistant, but survivorship declined steeply in shallower pools. Survivorship was driven by a strong interaction between pool depth and density, supporting our threshold response hypothesis. Mudfish drought resistance was enhanced by their ability to burrow into soft peat, and their high physiological tolerances. These traits are absent in the majority of the world’s freshwater fish, which are drought intolerant and live in stony-bottomed environments. Thus brown mudfish drought resistance may represent a best-case scenario, with other, less-hardy species, potentially faring far worse under future climate change scenarios.

10.00 **Early life history of**
Galaxias maculatus
populations

Eimear Egan

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Anecdotal reports suggest that the whitebait fishery is in decline and a more thorough understanding of the dynamics of *Galaxias maculatus* populations is central to informed decision making involving managers, ecologists, policy-makers and whitebaiters. Little is known of the early life history of *Galaxias maculatus* during their marine larval phase. The environment experienced influences growth and survival. A basal condition must be achieved to enable successful recruitment to freshwater. However, small differences in condition may not manifest until later in life with important consequence for adult growth, survival and reproduction. In addition the early life history experienced, in particular growth rates at sea may influence freshwater growth. Growth capacity in populations can vary and differences in growth capacity across environmental gradients may reflect geographic variability in the benefits and costs of growth. This may have consequences for reproductive success as sufficient growth to allocate energy to reproductive organs is the primary goal for adults in freshwater. It is important to understand the differential reproductive success of adult populations throughout New Zealand which may be influenced by their early life history experiences. This is especially important in light of restoration efforts as the measure of success of such programmes is often quantified in terms of egg numbers. In the first instance this research aims to characterise the early life history and condition of whitebait populations throughout New Zealand. This will be done through a combination of otolith analysis, morphological, physiological and biochemical techniques.



10.15 Interacting global change drivers limit the distribution of a thermally-sensitive freshwater fish

Nixie Boddy

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Interacting global change drivers such as invasive species, climate warming and altered disturbance regimes are likely to have major influences, especially on aquatic ecosystems. Modified water temperature and disturbance regimes will likely cause shifts in the amount and distribution of suitable habitat, and highly competitive invasive species may decrease habitat availability, thus altering both fundamental and realized niche size. We examined how distributions of a thermally sensitive freshwater fish, alpine galaxias (*Galaxias paucispondylus*), were influenced by these global change drivers and interactions between them, with a view to extrapolate this model to predict distribution shifts in response to warming and disturbance associated with climate change. Large scale electrofishing surveys of four replicate catchments were undertaken to determine native and invasive fish distributions. Key abiotic variables were measured at whole catchment scales, including water temperature, substrate size, disturbance, macrophyte coverage, stream width, and flow characteristics. Alpine galaxias were more likely to be present at sites with flooding disturbance and large substrate. Non-native trout had stronger limiting effects on galaxiid distributions at less disturbed sites, indicating an important disturbance-invader interaction. Duration of warm temperatures were more important than maximum or average stream temperatures in determining galaxiid distributions. Moreover, because trout were also thermally sensitive there were direct and indirect effects of temperature on galaxiid distributions. Thus global change drivers will likely interact to alter the distribution of thermally-sensitive freshwater species. Moreover, species responses are likely to depend on the configuration and characteristics of local habitat networks because these constrain distribution responses.



11.00 **Virtual Water: A Useful Concept for Informing Land Use in New Zealand**

Alicia Paulson

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Virtual water is a contemporary concept, defined as the water needed to produce agricultural commodities. Separated by type – blue, green and grey – virtual water addresses the environmental problem of water scarcity and reveals a negative externality of global food trade. Virtual water flows, between and among countries, are intrinsically linked to a country's land use. This paper aims to evaluate virtual water as a policy concept and measure New Zealand's virtual water interactions nationally and internationally for a group of agricultural goods. The results of the policy evaluation framework indicate that virtual water is a useful policy concept scoring strongly in the criteria of relevance, problem framing, flexibility and scope. Quantifying New Zealand's virtual water interactions nationally showed that virtual water use for the production of agricultural goods has increased over the past five years, where green water is used predominantly. Furthermore, quantifying New Zealand's virtual water interactions internationally showed that New Zealand had a high net virtual water deficit; the majority of virtual water is exported. Although the concept of virtual water has limitations, this study illustrates that virtual water as a concept measures a product and/or nations water use which mirrors its land use. New Zealand, as a nation, is well placed to integrate the concept of virtual water into policy enabling the government to make informed decisions regarding future land use and land use policy. Through implementing a proactive policy, virtual water flows would be managed more effectively, altering industry behaviour and ensuring water (blue, green and green) is used sustainably, consequently having a direct impact on land use in New Zealand.

11.15 **Limitations of the legal framework, a limiting factor in New Zealand's freshwater reforms?**

Faiz Abdul Raheem

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New Zealand is experiencing an array of challenges in its effort to efficiently, equitably and sustainably manage its freshwater resources. The government has initiated a series of reforms to respond to these challenges. The provisions of the existing legal framework seem to be limited and not flexible to accommodate these reforms. Although a set of measures to overcome this issue is proposed by the government including a number of amendments to the existing main legislation, i.e. the Resource Management Act 1991, there still exists a doubt whether the existing legal framework could transform comprehensive and provide the flexibility required for the implementation of the ongoing freshwater reforms even after the incorporation of these measures. My presentation seeks to highlight the extent and nature of the limitations of the statutory provisions and the impacts of the 'first in first served' doctrine in the implementation of the proposed freshwater reforms that are more fundamental to be considered, with a view to draw the attention of the audience to the fact that the complexities arise out of the unique nature of water and the vital role it plays in achieving the economic, social, cultural and environmental goals of New Zealand require deeper examination of these limitations and impacts. I will also draw on the experiences of some other jurisdictions and discuss how these experiences could provide guidance to New Zealand in its freshwater reforms.

11.30 **Standards in water use: The Resource Management (Measurement and Reporting of Water Takes) Regulations 2010 and the implications for water resource management in New Zealand**

Fiona Myles

Department of Environment Management, Faculty of Environment Society and Design, Lincoln University, fiona.myles@lincolnuni.ac.nz

Freshwater is an important resource for New Zealand, but its management and allocation amongst the multiple stakeholders has always been a challenge, in part due to the high uncertainties associated with quantifying the resource. In November 2010, the Resource Management (Measurement and Reporting of Water Takes) Regulations (the Regulations) came into force within the existing framework of the Resource Management Act 1991 (RMA), requiring for the first time all those who hold consents to abstract and consume freshwater over a threshold, to measure and report their actual water usage. These requirements of the Regulations could in theory could go some way towards reducing the existing uncertainties and allow greater confidence in freshwater allocation systems.



The Regulations are a form of standard in that they provide a set of ‘rules’ to which the actors involved must adhere. Standards of this nature are ubiquitous in modern life; imbedded within social norms and technologies, and used to create order and structure in a messy and imperfect world. I have investigated the challenges that have arisen during the implementation of the Regulations, focussing on the Rakaia-Selwyn Groundwater Allocation Zone, as an example of the introduction of a standard into a previously rule free area. Using the co-production conceptual framework, I have examined the role that standards play in creating or altering the order of both natural and social systems. I have also explored potential implications, for freshwater management heading into the future.

11.45 **Determining the age of agricultural faecal pollution in our streams and rivers**

Megan Devane

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Faecal pollution of waterways from agricultural sources is a recurring dilemma in our agriculturally-dominated economy. The current emphasis on conversion to dairy farming has highlighted the need for better faecal source tracking tools (FST) to identify sources of faecal pollution. Chemical (faecal sterols) and microbial tools (molecular markers) have been developed to augment traditional microbial indicators such as *Escherichia coli*, which is present in all animal faeces. The persistence of *E. coli* in rural waterways, even in the absence of obvious sources of agricultural contamination, highlights the need for these additional FST tools.

How water managers respond to elevated *E. coli* in waterways will be dependent on a number of factors, including the age of the faecal contamination event. In this study, ageing of cowpats under field conditions was carried out over a six month period, to explore changes in the microbial community of the cowpat. The experiment also considered the effect of faecal ageing on the ability of FST markers to correctly identify the faecal source.

Metagenomic analysis of bacterial sequences from the cowpats identified significant changes in the microbial community as the cowpat aged. Bacterial species making up >20% of the microflora in fresh faeces, were reduced to <1% after 3 to 6 months. Conversely, bacterial species making up <1% of the microflora in fresh faeces, had increased to 14% over this time. These two bacterial groups are being targeted to provide a possible basis for the development of molecular markers for distinguishing an aged faecal contamination event from a fresh event.

12.00 **Political power in Canterbury's water governance: a Gramscian analysis**

Nicholas Kirk

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Contrasting values and increased demand for fresh-water resources flamed political conflict in the Canterbury region over the last two decades. Commercial actors broadly supported abstraction of fresh-water for its economic growth potential. Conservation actors were concerned this abstraction would have detrimental effects on the quality and quantity of Canterbury's fresh-water. My thesis examines the political power exercised during these conflicts.



I promote a new framework for analysing political power inspired by Italian philosopher Antonio Gramsci. The novelty of this framework is that it analyses ideological power through the exercise of cultural hegemony. The broad findings of my case study investigations will be presented alongside a discussion of the successes and drawbacks of the Gramscian inspired framework.

12.15 **Phosphorus Partitioning in Meltwater Ponds in Victoria Land, Antarctica: Insights into the P Cycle**

Hannah Christenson

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Meltwater ponds are an important habitat for terrestrial biota on continental Antarctica. The productivity of benthic cyanobacteria, the dominant biomass, appears to be limited by phosphorus (P) availability in inland areas. Sources of P and factors limiting its bioavailability are poorly understood. Consequently it is difficult to predict how productivity will be affected by potential climate change-induced increases in meltwater volume and pond size. This study has explored P concentration and speciation in key reservoirs of ponds to identify important processes involving P, to allow insight into how these systems may respond to change.

Over three years (2011 – 2013) soils, sediments, waters, biological material and snow were collected from 15 ponds in the Dry Valleys, and from 7 ponds in the McMurdo Iceshelf /Ross Is. region in Victoria Land, representing inland and coastal meltwater environments respectively. Total dissolved P concentrations were much lower in inland ponds, with Upper Wright Valley, the most inland site, having $<3 \text{ mg/m}^3$ dissolved P. In coastal areas, P concentrations were up to an order of magnitude higher in the soils adjacent to ponds (mean 2.2 g/kg), compared to inland pond soils (mean 0.32 g/kg). Sediments in ponds typically have $<25\%$ of the readily exchangeable P concentration found in adjacent soils, and generally contain less total P, indicating both immediate and long term release of soil and sediment P into pond water.

1.30 Quantifying Spatial and Temporal Deposition of Atmospheric Contaminants in Runoff from Concrete Pavements

Louise Murphy

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Total suspended solids (TSS) and heavy metals (principally Zn, Cu and Pb) in stormwater are the primary causes of water quality degradation in urban waterways in New Zealand. It is widely reported that vehicles and metal roofs are a major *direct* source of key contaminants (TSS and heavy metals) in stormwater runoff; however, the contribution of airborne-deposited contaminants, as an *indirect* source, in stormwater runoff is poorly understood. This research aims to quantify the spatial and temporal variations of atmospheric contaminant concentrations in stormwater signatures from concrete pavements.

Experimental impervious concrete boards were deployed in different land-use areas (industrial, residential and airside of an airport) throughout Christchurch. Each land-use area had four replicate boards elevated 450 mm above ground at a 4° slope. Runoff from the boards were collected and analysed for TSS and heavy metals after a rain event. Additionally, the effects of rainfall intensity, antecedent dry days, wind patterns, and total runoff volume on pollutant concentrations were quantified.

Preliminary results show that heavy metals are highest in an industrial land-use area. Metal concentrations from airside seem comparable to that of a residential land-use area. TSS displays a variation between all three sites, with TSS loadings highest in industry. Initial results indicate that the number of antecedent dry days and maximum average intensity over an hour interval are important factors in influencing metal concentrations.

1.45 The effect of riparian management on sediment retention within a variety of different land uses and associated riparian zones

Emma Porter

School of Biological Sciences (Freshwater Ecology Research Group), emma.porter@pg.canterbury.ac.nz



Riparian zones act as a buffer between land and freshwater ecosystems which attenuates contaminants and sediment prior to them entering and affecting waterways. However, continued declines in stream ecosystem health with increasing land use intensification suggest that the current implementation or design of riparian buffers is not as effective as it needs to be. My research is investigating social constraints in public knowledge and implementation of riparian management and the efficacy of existing riparian zones at capturing sediment.

The social perspective of this research has been conducted using a questionnaire to determine public knowledge of riparian management and what practices are currently being undertaken by land managers to limit the amount of sediment entering waterways. Only of 112 responses 57% knew what a riparian zone is. Results indicate that there is a lack of public knowledge regarding the primary purpose of riparian zones

In order to address the efficiency of riparian buffers I used sediment accumulation traps to investigate sediment in 50 streams including; dairy farming, plantation forestry, urbanization and native forested areas from Ashley to Waimate. Results indicate a significant influence of land use on the sediment input into waterways and the amount of groundcover has a marked effect on buffer zone efficiency. Riparian buffers with greater percentage of groundcover were more effective at attenuating sediment. My research indicates that although riparian management is a very topical subject that gains much attention from media and associated industries, limitations to the designing and implementation of riparian buffers still exists.

2.00 **A comparative study of riparian drain management and its effects on phosphate and sediment inputs to Te Waihora/Lake Ellesmere**

Hannah Mitchell

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University of Canterbury,
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There is a general consensus that lake eutrophication is one of the leading freshwater concerns of our era. It has been shown that higher rates of eutrophication coincide with economic development adding nutrients to freshwater systems. This is evident in Lake Ellesmere/Te Waihora, with excess nutrients commonly found in the lake. The major source of phosphorus and nitrogen in the lake was concluded to be from tributary flows impacted by agriculture practices.

It has been suspected by Environment Canterbury that agricultural drains and the smaller tributaries provide much of the external phosphate load entering the lake rather than the lowland streams and rivers. Little to no study has been focused in this area however. My research will calculate the annual load of suspended particulate matter (SPM) and phosphate entering the lake from the agricultural drains. It will also help determine whether or not the phosphate and SPM loads entering Lake Ellesmere/Te Waihora from agricultural drains is more or less than the loads entering from the larger natural streams and rivers.

As well as calculating these loads, my research will provide more data concerning riparian plantings and whether the planting aids in improving the quality of water entering the lake. This will be done by determining the relationship between SPM concentrations, phosphate concentrations, ecological state and the degree of riparian restoration on the drains.

2.15 **Modelling of Stormwater Management Options for Enhancing Water Quality of Urban Streams**

Frances Charters

Department of Civil and Natural Resources
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The majority of Christchurch's stormwater is discharged untreated directly into urban surface waterways. These receiving waterways are adversely affected by the contaminants carried in the stormwater, particularly sediment and heavy metals.

Understanding the magnitude and nature of the contaminant loads is crucial to implementing effective stormwater mitigation and management to restore ecological health to the waterways. This research develops a contaminant load model, MEDUSA, to assess the reduction in TSS and heavy metal loads that can be achieved by various stormwater retrofit options in Christchurch catchments.

The research aims to address the following questions: What are the effects of climate characteristics, such as rainfall intensity and duration, on contaminant generation? How much do known constraints in Christchurch affect the feasibility of implementing stormwater retrofits? How much reduction in contaminant load can be achieved with individual and combined stormwater management options? Lastly, based on the above assessments, MEDUSA will be used to assess optimal management options for catchments of different land-uses across Christchurch by implementing various scenarios of source reduction and treatment systems and comparing the reduction in contaminant load.

The scarcity of such a model for the Christchurch context, coupled with the unique opportunity for retrofitting stormwater improvements in the post-earthquake rebuild, make Christchurch a valuable case setting for this research. This approach could then be adapted for use in other urban settings outside of Christchurch.

2.30 **Trialling passive remediation systems for treatment of severe AMD: A case study from Bellvue Mine, West Coast, New Zealand**

Rae West

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Bellvue Mine is an abandoned coal mine on the West Coast of the South Island, New Zealand, that discharges acid mine drainage (AMD) into nearby Cannel Creek. At this site typically the pH of the AMD is 2.57, the Fe concentration is 110 mg/L, the Al concentration is 48 mg/L, while Ni, Zn, and Mn are enriched to between 0.02 to < 1.2 mg/L level. In the mine pool the iron is in a ferrous or reduced form but the AMD becomes aerated after discharge by a 57 m cascade and iron is oxidised into ferric form as it moves downstream. A research project is currently underway to examine the background geochemistry at the site, passive treatment of AMD in general, and how the science of AMD treatment will be applied at Bellvue. This involves monthly testing to understand the background geochemistry of AMD at the site and the chemistry of the receiving waters above and below the discharge from Bellvue. Several small-scale trial passive treatment systems are being installed, including a limestone leaching bed (LLB), two mussel shell reactors, an anoxic limestone drain (ALD), a bioreactor, and a diversion well. These systems will be designed to increase pH, precipitate the iron and aluminium oxy-hydroxide minerals, and remove trace elements from the AMD. This requires knowledge of the background chemistry as well as geochemical modelling to determine the most effective treatment systems and methods of remediation. The systems will be installed and sampled on a weekly basis for at least 8 months.



2.45 **Gaining a better understanding of mayfly dispersal across the landscape**

Matt Wallace

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Mayfly species, such as *Coloburiscus humeralis*, are an important component of freshwater ecosystems in New Zealand and around the world. As well as often being crucial intermediary links in food webs, species of mayfly larvae provide

a number of vital in stream functions that contribute to ecosystem health, such as assisting in the breakdown of coarse particulate organic matter (CPOM). The threat to viable mayfly populations from habitat destruction as well as chemical and nutrient additions from agricultural land use has had considerable attention in the New Zealand setting. However, less has been done on the potential barriers to dispersal that may negatively affect the health of stream insect populations. The goal of this study was to measure the amount of genetic structure between streams and across catchments, and in this way gain a better understanding of mayfly dispersal across the landscape. In order to identify the landscape features that either constrain or assist mayfly dispersal, I employed a resistance modelling technique based on electrical circuit theory to simulate how particular landscape factors contribute to the observed genetic structure. I found that in the study area of Cass and Arthur's Pass, populations of *C.humeralis* had high levels of genetic divergence even when the distance between streams was very low. Resistance modelling results suggest that in this species in this area, open areas provide barriers to dispersal while gene-flow is more likely to occur when streams are separated by connected native forest.

3.30 **An investigation of nitrate-nitrogen toxicity effects in Canterbury stream communities**

Tom Moore

School of Biological Sciences, University of Canterbury, tom.moore@pg.canterbury.ac.nz



The response of stream invertebrates to nitrate was investigated in Canterbury Plains streams. A field survey of 41, physically and chemically similar streams indicated invertebrate composition changed with increasing nitrate. Diversity did not change with increasing nitrate, however comparisons with proposed nitrate toxicity thresholds suggest some rare species disappear above 3.8 mg/l NO₃. A significant latent response variable incorporated in a structural equation model (SEM), showed 62% of the latent variable was explained directly by substrate size (sediment) and indirectly through algal biomass and percent dissolved oxygen (DO). Partial redundancy analysis found substrate, DO and nitrate explained 25%, 22% and 3% of the latent variable respectively. These four SEM variables, used to constrain a redundancy analysis ordination, suggest a potential threshold of 4.5 mg/l for an invertebrate community composition shift. Sites were categorized into streams representing nitrate-nitrogen values between 0-4.5mg/l and > 4.5mg/l to re-run the SEM. Relative weightings of nitrate, algae, DO and substrate size were compared between the nitrate SEM's. Nitrate and algae were not significant, whereas substrate had a significant positive effect in the 0-4.5 mg/l nitrate category and DO had a marginally non-significant negative effect in the >4.5 mg/l nitrate category. These results indicate that high nitrate does not have a direct toxic effect on stream invertebrates but has an indirect chronic effect on community composition.

3.45 **Body mass-abundance relationships in streams: the importance of habitat size and flooding disturbance**

Helen Warburton

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The relationship between body size (M) and abundance (N) is a well-documented allometric scaling relationship and links traits of individual species to the structure of whole ecological communities. In general M-N relationships are negative and linear, however despite this, M-N slopes vary within and between particular ecosystem types for reasons not fully understood. Environmental perturbations or the introduction of nonnative species, may affect M-N relationships as they often have a greater influence on larger species. Consequently, M-N relationships constructed from snapshot data may provide relatively easy-to-quantify, time-integrated, measures of community stability. To determine what conditions cause M-N relationships in streams to depart from consistent patterns, I analysed M-N data collected from a wide range of stream communities in New Zealand. M-N relationships varied across streams and departed from the null expectation in many cases. These departures were significantly related to flooding disturbance and habitat size. Flooding disturbance altered the intercept of the relationship but did not alter the scaling relationship between body size and abundance. In contrast habitat size significantly altered the scaling of the M-N relationship and therefore the structure of communities. This indicates the potential strong influence of habitat size on food web stability. These results also illustrate how body size data can increase our understanding of biotic and abiotic factors influencing the structure and dynamics of ecological communities.



4.00 Trade-offs and dispersal in unpredictable environments: generalist invertebrate persistence in ponds

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Flexible life-history traits and dispersal may allow generalist populations to persist across a range of heterogeneous habitats despite experiencing variable selection pressures. Temporary pond generalist invertebrates must develop quickly and disperse as adults, or have wide environmental tolerances. Conversely, in permanent ponds they must avoid a suite of predators (e.g., fish and dragonflies). This ‘predator-permanence gradient’ results in life-history trade-offs that influence fitness, population dynamics, and genetic structure. In addition, recruitment between habitats may be crucial to maintain generalist populations. We examined *Xanthocnemis* damselfly and *Sigara* waterboatman populations in New Zealand lakes and irregularly drying ponds through field surveys, mesocosm experiments, and microsatellite analyses to test whether: (1) generalists have flexible developmental and behavioural traits to survive different habitat conditions, and 2) terrestrially-dispersing generalists oviposit across habitat types to maximize reproductive potential.

We found generalist invertebrates used alternative life-history strategies to exploit habitats across the predator-permanence gradient. *Xanthocnemis* had longer development and consequently were exposed to more biotic and abiotic stressors. This was offset by flexible predator avoidance behaviours and drying tolerance. In contrast, *Sigara*'s rapid and inflexible life-cycle enabled them to exploit more temporary habitats, but were intolerant of drying. While generalists had different life-history flexibilities, dispersal was critical to maintain generalist populations across unpredictable disturbance regimes. Our microsatellite analyses indicate extensive genetic mixing across the predator-permanence gradient. However, irregular disturbance may be limiting genetic variation. Life-history traits that allow generalists to persist across unpredictable habitats may be crucial to their response to altered hydrology under climate change.

4.15 *Didymosphenia geminata* impacts on benthic algal and invertebrate diversity and community composition.

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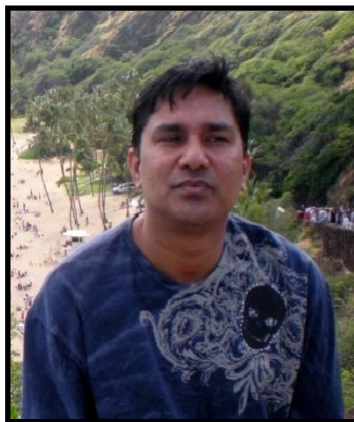
Didymosphenia geminata (Didymo) is an invasive freshwater diatom, whose effects on ecosystems and rapid global spread is of international concern. On restricted spatial scales *D. geminata* alters habitats and primary productivity, with subsequent effects throughout aquatic ecosystems. Assessing the impacts of an invasive, requires understanding of assemblage and diversity changes across broad spatial scales, whilst accounting for competing niche controls. We surveyed 55 sites across a gradient of *D. geminata* within the South Island of New Zealand to determine the effects of *D. geminata* on β diversity and algal and invertebrate assemblages. β diversity based on community turnover was strong in algal assemblages (adonis $P < 0.001$) and weaker in invertebrates (adonis $P < 0.05$). Increased community homogeneity was observed in both algal (betadisper $P < 0.005$) and invertebrates (betadisper $P < 0.05$). *D. geminata* biomass drove compositional change in both algal ($R^2 = 0.64$, $P < 0.001$) and invertebrate communities ($R^2 = 0.29$, $P < 0.001$). Variance partitioning and path analysis support the finding that across the gradient sampled *D. geminata* drives algal composition, but physicochemical niche based drivers, and space are increasingly important for invertebrates. Weakened concordance between trophic levels is an important finding suggesting resilience and a lessening of *D. geminata* impacts in invertebrates, supporting the view that fundamental differences exist between organisms dependent on organism size and the effective scale of niche based drivers.



4.30 Climate change impacts on future streamflows in the Hakataramea catchment

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Climate change impacts on streamflows and water resources in mountain catchments will differ significantly across subcatchments in terms of streamflow generation mechanisms, average and extreme flows, and impacts on water resources management needs. This study will use the TopNet hydrological model to simulate future streamflows in the very dry 900 km² Hakataramea catchment, New Zealand. Precipitation and temperature data for the baseline climate (1980-1999) were the major input data for the model and were obtained from the Virtual Climate Station Network (VCSN) database for New Zealand. The input data used to run TopNet and determine the time series of future flows were statistically downscaled future temperature and precipitation data for the 2040s (2030-2049) and 2090s (2080-2099) for the A2 Special Report on Emission Scenarios (SRES). The average of 12 different Global Circulation Models recommended by the New Zealand Ministry for the Environment was used to simulate the average monthly flows for the 2040s and 2090s. For the 2040s, the model showed 1-6% flow decrease between August to November and 5-14% increase in other months, except December when it remained approximately the same. For the 2090s, the model showed a decrease in flow of 6% and 4%, respectively, for September and October, and an increase of 2-32% for the remaining months. The predicted decrease in streamflows in spring and an increase in other months is consistent with other climate change studies which predict that there will be significant increase in rainfall coupled with decreases in snowfall that will produce the same effect.

4:45 **Reproduction in
a whitebait species:
spawn early or spawn
often?**

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Galaxias maculatus

(inanga) occurs throughout the southern hemisphere and is one of the most widely distributed fishes in the world. Juvenile inanga (whitebait) are the basis of a culturally and recreationally important fishery. The reproductive success of *G. maculatus* is closely linked to the availability and composition of dense riparian vegetation, which comprises their obligate spawning habitat. The quality of vegetation, reproductive output and egg laying interact to provide the swarms of larvae associated with whitebait, but we know little about the specifics of these critical interactions. It has previously been assumed that *G. maculatus* is an annual species with most fish dying after spawning and that the timing of reproduction does not differ throughout New Zealand. Here we present results from adult fish collections over 14 months from multiple rivers of the south island. Histological analyses indicate a slight offset in the timing of reproduction between the east and west coasts, much lower fecundity values than previously reported and clear evidence of repeated spawning by individuals. It appears that significant numbers of inanga survive post-spawning and are iteroparous, but more work is needed to confirm the age structure of adult populations. This study highlights region-specific differences in *G. maculatus* populations, which has implication for effective management.

Poster Abstracts

Poster Session from 1pm in the foyer

Climate change mediation of predator-prey interactions

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Global environmental change drivers such as climate warming and biotic invasions are altering natural ecosystems at increasing rates and can interact, generating unexpected outcomes for biological communities. Higher water temperatures and a greater potential to dry are predicted for freshwater habitats, and these altered conditions will likely mediate interactions between predators and prey, especially the effect of any invader on communities. Warmer temperatures and drier habitats will likely affect short term predator-prey interactions by increasing metabolism, activity levels and prey densities (due to decreased habitat size). To evaluate the potential for such interactions we ran two pond microcosm experiments. Firstly we tested the influence of water temperature on dragonfly predation on chironomids, and secondly, how prey density affected predation by damselflies on mosquitoes. Higher water temperatures resulted in a linear increase in prey consumption, caused by increased predator movement. There was a non-linear increase in prey consumption associated with a prey density threshold. This work suggests that drying will affect the impact of an invader on local communities due to altered predation rates associated with greater consumption rates in warmer habitats, but depending on critical thresholds. Greater consumption of invasive mosquitoes by predators may result in smaller invasive populations in the short term, but long term responses will depend on both population and evolutionary responses over time. We are now examining how aquatic warming and habitat drying will affect predator-prey interactions influencing mosquito populations, and comparing short and long-term responses by using both experimental and modelling approaches.

Whitebait wanderings: riverine growth and movement

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The diadromous fish *Galaxias maculatus* (inanga) is one of the most widely distributed freshwater fishes in the world, occurring throughout the southern hemisphere. The post-larval juveniles of this species form the basis of New Zealand's whitebait fishery as they migrate back into freshwater. This essentially annual species spawns exclusively in tidally inundated riparian vegetation in upper estuaries. The success of spawning is closely linked to the availability and composition of suitable riparian vegetation. It has been widely assumed that after entering a river as whitebait, mature fish do not migrate to other waterways before spawning. Therefore, whitebait that enter a waterway are committed to finding critical spawning habitat in that river if they are to spawn successfully when they mature. If spawning habitat is absent or degraded, their ability to contribute to future generations is compromised. Consequently, degradation or reduction of spawning habitat in individual estuaries can lead to the formation of 'sink' populations. Here we present the results of a tagging study to track adult fish across waterways during the spawning season. This study will provide a measure of stream fidelity in adult fish along with basic population characteristics and dynamics. This knowledge will allow whitebait conservation and habitat rehabilitation to be targeted at productive waterways and estuaries.

Domestic Chemical Use at Scott Base: Assessment of Effects and Alternatives

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Antarctica is considered the last pristine environment on Earth, offering a natural scientific laboratory for environmental studies. Antarctica New Zealand is the



Crown Entity responsible for the year-round management of New Zealand's permanent research facility: Scott Base. Due to the remote location of Scott Base and close living quarters, it needs to maintain healthy and hygienic living conditions. A range of cleaning chemicals and disinfectants are stored and used on base for this purpose. Active components and additives were identified in the key domestic cleaning products used on base to determine potential impacts to human health, and the wastewater treatment plant (WTP). A colour-coded "traffic light" rating scale was developed for each individual constituent as an identifier of low, slight, moderate, or high risk. Numerical codes were attached to each colour code to determine an overall risk rating value for the product as a whole for both potential human health impacts and potential eco-toxicity/WTP removal. Based on this assessment, disinfectants and floor cleaners pose the greatest risk to the WTP, while disinfectants, floor cleaners, and engineering additives pose the greatest risk to human health. Further analysis may be required to account for concentration and combination effects of specific chemicals and products. It is recommended the number and type of cleaning products be reduced on base, with low risk products replacing high risk products where possible. Additionally, products no longer of use on base should be shipped back to Christchurch for disposal.

Synthetic Streams: Microplastic Pollutants in New Zealand waterways?

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Microplastics are plastic pollutants less than 5 mm in size. Substantial quantities are derived from the degradation of plastic waste in the environment. Microplastics also include small pre-manufactured particles such as exfoliating 'micro beads' used in facial cleansers and raw plastic pellets utilised by the plastics industry. Wastewater treatment plants are often not equipped with the capabilities to remove these particles. Microplastics may therefore be entering New Zealand waterways through the mismanagement of plastic litter and treated effluent discharges. International studies have demonstrated that these particles accumulate in aquatic environments where they may have ecological impacts. To date, microplastic pollution has not yet been studied in New Zealand freshwater systems.



Groundwater Quality Change in Mosgiel, Otago

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Groundwater in the Otago Region is an important water resource; used for drinking water, irrigation, commercial and municipal purposes. In the town of Mosgiel, on the outskirts of Dunedin in the Otago Region, water quality data has been collected quarterly from nine bores over the last twenty years by the Dunedin City Council (DCC). The groundwater bores provide the potable water supply for the town of Mosgiel; a town, which has undergone considerable urban development over the last ten years. In the past the water quality data has not been interpreted beyond ensuring that the various measured parameters meet the New Zealand Drinking Water Standards (NZMoH, 2008).

The purpose of this research was to examine the water quality data collected over the last twenty years, to identify whether land use intensification in Mosgiel and in the rural lands surrounding the town, are having an effect on the water quality of the Mosgiel bores. All available monitoring data from DCC was compiled and tested for correlations between parameters, and spatial and temporal trends. Increasing trends in many of the parameters including nitrate, and chloride were evident, and these have been related to changes in land use and population increases, by using historical documents relating to city and rural planning. Finally, recommendations for improvements in the existing monitoring programme, to enable more reliable assessment of groundwater quality in the future, have been made.

Use of biological control agents for controlling mosquito populations in the Kingdom of Tonga.

Tom Swan

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Mosquitoes are one of the most important vectors for parasitic diseases and pose a major threat both to human health and diversity of biota globally. Mosquito-borne diseases are of particular concern within the South Pacific with dengue fever outbreaks most commonly reported in the Solomon Islands, Rarotonga, New Caledonia, Tonga, Samoa, Fiji, Cook Islands and Hawaii. Tonga is widely recognised as having a significant mosquito problem, with outbreaks of Dengue fever occurring in 1974, 1975, 1998, 2003 causing numerous fatalities. In recent years, a total of 8 mosquito species have been identified in Tonga, with *Aedes aegypti* (Linnaeus), a significant vector for dengue and yellow fever being the most widespread. In 2012 the discovery of the significant yellow fever and dengue fever mosquito, *Ae. albopictus* (Skuse) in Nuku'lofa, Tongatapu may exacerbate the health threat mosquitoes pose to the people of Tonga.

Mosquito larvae and pupae develop in stagnant water pools in natural (eg., ponds, tree trunks) and artificial habitats (eg., abandoned car tyres, fuel gallons). The physical attributes of habitats, including size, light-dark contrasts, and specular reflectance from water surfaces may be significant in determining oviposition sites. The use of native predators to biologically control mosquito larvae populations has been successful in many different ecosystems. Within Tonga predatory fish *Poecilia mexicana* (Steindachner), backswimmers and dragonfly larvae have all been found within aquatic habitats also inhabited by mosquito larvae. My research aims to (1) understand the current mosquito species and their distributions, (2) assess factors which influence oviposition site selection and (3) analyse the effectiveness of native predators for controlling mosquito larvae populations.

Investigating the regional variation in rules and best management practices for forestry earthworks in New Zealand

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Under the Resource Management Act 1991, the interpretation and implementation of environmental policy is the responsibility of local government, i.e., the regional councils and territorial authorities. Local government can influence the management of forestry operations through the use of two written means: statutory rules published in regional and district plans, and recommended best management practices (BMPs) published in guidelines. A primary goal is the protection of waterways and water quality from potential adverse impacts associated with forest operations.

A number of forestry companies have raised concerns that there is inconsistency in the rules between jurisdictions, and that this has a negative impact on New Zealand's forestry industry. This is both in terms of cost, but also with regard to achieving the desired environmental outcomes.

This research has investigated and quantified the variation in Permitted Activity rules and BMPs between the sixteen regional councils of New Zealand, with a particular focus on culvert installation and earthworks. Both these operations, if poorly managed, have the potential to adversely affect waterways through accelerated erosion and sedimentation.

It has been found that there is significant variation in the regional rules and BMPs governing these operations. There is considerable variation in both the level of control, i.e., the number of rules and BMPs for each council, and the nature of control, i.e., the proportion of rules and BMPs utilised by each council. Further, the rules and BMPs of one council are seldom the same as the rules and BMPs of another council. This variation is equally apparent on both a national scale and when considering only neighbouring pairs of regional councils.

Intertidal Foraminifera of the Avon-Heathcote Estuary; Response to coseismic deformation and potential to record local historic events

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The Avon-Heathcote Estuary, located in Christchurch, New Zealand, experienced coseismic deformation as a result of the February 22nd 2011 earthquake in Christchurch. This is reflected in subsidence in northern parts and uplift in the south, in addition to sand volcanoes which forced up sediment throughout the estuary floor altering estuary bed height and tidal flow.

This first part of this research project aims to quantify the change in modern foraminifera distribution caused by the coseismic deformation from the February 22nd 2011 earthquake by analysis of faunas immediately post deformation and 2 years post deformation with a comparison to earlier pre 2011 foraminifera distributions. Modern transect data show foraminiferal distributions similar to those of current New Zealand models for intertidal and salt marsh faunas. When February 2013 faunas are compared to June 2011 faunas foraminiferal zones have shifted landward or seaward as predicted according to uplift or subsidence. A distinct feature of June 2011 faunas is the occurrence of reworked prehistoric marine species in some samples that have been introduced by liquefaction processes.

The second stage of this project, yet to be initiated, will collect a sediment core and the modern distribution used to establish foraminiferal history in the Avon-Heathcote Estuary. Foraminifera are sensitive to tidal height and salinity and they may record past seismic deformation. Sampling the core for foraminifera, grain size, trace elements and carbon material (or pollen or caesium) will help to build a story of estuary development as well as past coseismic deformation events.

About the sponsors: Super Gold



Te Runanga o Kaikoura is the modern day representative of the hapu of Ngati Kuri. Te Runanga o Kaikoura is a Papatipu Runanga of Ngai Tahu whanui, recognised in the First Schedule of the Te Runanga o Ngai Tahu Act 1996.

In this role, Te Runanga o Kaikoura has a kaitiaki responsibility to protect the natural resources, mahinga kai, water and its habitats and other values of the takiwa, for the benefit of those people of Ngai Tahu descent who have customary interests in the takiwa. The takiwa of the Runanga centres on Takahanga Marae and extends from Te Parinui o Whiti to the Hurunui River, inland to the Main Divide and seaward as far as the eye can see.

Takahanga Marae is the standing place of Ngati Kuri. The marae is located on the original site of the ancient Takahanga Pa overlooking the Kaikoura township. It was developed in the 1980s and the Wharenuui (meeting house) officially opened in January 1992.

Waterways:

Waterways have a special place in our heart. They are not just collections of gravel, water and fish. They feed people but they also connect the mountains to the sea, are the lifeblood of Papatuanuki and have mana and life presence of their own. They should be treated with total respect and their health given the utmost priority. Water is key to the health of its habitats and people and is nature's environmental infrastructure.

We do not separate water from the habitats it supports and productive appropriate riparian margins and wetlands are key natural features in maintaining this health and for providing indigenous ecological corridors from mountains to the sea.

We also believe that ground water is inevitably connected to surface and should be managed as such - when you affect one you are likely to affect the other.

Mauri is used as an indicator for the health of water, it can be described as the life essence of water. Vitality, productivity, quality and quantity are all important features of Mauri; it is a key value for us.

We support any individual or organisation whose objectives are to maintain or improve the management of water and its habitats, and especially those who recognise the relationship between our people and waterbodies.



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Are you passionate about New Zealand rivers and their sustainable use and management? Do you want to make a difference in NZ river and catchment management?

Then we want you, along with your opinions, intellect and camaraderie, to join the Rivers Group and participate in discussions, collegiality and technical knowledge sharing. If you are involved with rivers, catchment management or river engineering, the Rivers Group provides the opportunity you have been waiting for - to truly integrate all the different areas of river usage and management, and to bring practitioners and community interests together.

During our four years of existence we have successfully established ourselves in the New Zealand scene, having run symposia, been part of conferences and been involved in additional learning opportunities throughout New Zealand. While doing so we have managed to keep membership fees low, and have attempted to keep members informed of interesting rivers-related topics through our quarterly newsletter, *FLOW*. We welcome you to access these previous newsletters via this website, and also encourage any feedback on these.

Whether you are an engineer, scientist, planner, academic, hydrologist, geomorphologist, climatologist, land manager or individual river enthusiast, membership is open to all.



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Department of Conservation

Te Papa Atawhai

The Department of Conservation is the leading central government agency responsible for the conservation of New Zealand's natural and historic heritage. The Department's key functions in regard to freshwater conservation are primarily to preserve as far as practicable all indigenous freshwater fisheries, protect recreational fisheries and freshwater habitats.

The Freshwater Team is part of the wider Science and Capability Unit who is tasked with providing coordinated support, technical knowledge and science across the Department in order to achieve delivery of operational priorities in the areas of visitor assets, recreation, historic, marine ecosystems and species, freshwater, monitoring, threats and terrestrial ecosystems and species. Key functions of the team are to develop innovative new tools, systems and information to deliver nationally coherent outcomes for conservation, provide advice and support, build new and maintain current scientific and technical knowledge, and broker with others to leverage better conservation outcomes.

The Department of Conservation (DOC) national Freshwater Team is made up of three Science Advisors, nine Technical Advisors, and one Project Officer. These positions are located across three service centres (Hamilton, Wellington and Christchurch), as well as two distributed positions situated in Nelson and Invercargill.



Christchurch City Council is responsible for providing public water supplies across the City and Banks Peninsula; managing surface water resources and healthy riparian zones, and maintaining wastewater systems.

Our surface water resources shape the landscape, ecology and heritage, and are a taonga to pass onto future generations. They include wetlands, two lakes, over 2650 kilometres of rivers and streams, and numerous springs. The Council's Biodiversity Strategy promotes the management and conservation of the ecosystems of which these water resources are a part.

Nearly all of the City's drinking water comes from aquifers beneath the City, providing high quality groundwater that is some of the best in the world. On Banks Peninsula most drinking water comes from streams and is treated to a high standard in the Council's treatment plants.

Our extensive wastewater network comprises eight treatment plants, 120 pump stations, over 25,000 manholes and more than 2700 kilometres of piping.

Designing projects to enhance our environmental and social sustainability, such as protecting our artesian resources and maintaining the quality of streams and rivers, are key objectives of our Water Supply and Surface Water Strategies. We aim to look after our community's health and well-being through a wastewater system that meets our people's needs now and into the future.



SKM is an award-winning leading projects firm, with global capability in strategic consulting, engineering, architecture and project delivery, deploying some 7,500 people from more than 40 offices. We are active in many markets including environmental, civil, power, mechanical, electrical, structural and transportation engineering, building and development, and minerals. The disciplines we cover include professional engineers, scientists, planners, economists and project managers and we provide extensive experience in the planning, design, construction and management of major and minor projects.

In particular:

- § We provide strategic advice that helps our clients to improve the performance of their projects and enhance return on investment, enabling more informed decision-making.
- § We engineer and design practical solutions, anticipating barriers to implementation so that our designs can be delivered to schedule and budget, and endure the test of time.
- § We manage the implementation of projects to meet or exceed clients' objectives, and those of other project stakeholders.
- § We have proprietary project delivery systems which are being used to assist in the delivery of our clients' projects.

About the sponsors: Gold



ESR, the Institute of Environmental Science and Research, is a government owned New Zealand Crown Research Institute (CRI). **Our mission is to protect people and their environments through science.**

The **Water Group** forms part of the Environmental Health aspect of ESR's research including:

- **Drinking-water quality** surveillance and reporting.
- Scientific advice and expertise to the Ministry of Health for the management of drinking water.
- ESR's **Ground water** research team addresses issues associated with land-use intensification and its effects on groundwater quality, including: modelling contaminant transport, pesticide contamination, sewage and greywater systems.
- The **Biosolids** programme aims to find practical recycling uses for carbon and nutrient-rich biowastes that are acceptable to communities, regulators and producers.
- The **Surface Water** team provides regional authorities with guidance and direction on the sources of faecal pollution in rivers and lakes, and the detection of pathogens and indicators in water, and the epidemiological investigation of outbreaks.



Aurecon provides engineering, management and specialist technical services for public and private sector clients globally. With an office network extending across 26 countries, Aurecon has been involved in projects in over 80 countries across Africa, Asia Pacific, the Middle East and the Americas and employs around 7 500 people throughout 11 industry groups. Aurecon's Christchurch office is helping to steer many key Christchurch rebuild projects, including the Canterbury Health Hub.



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WATER RESOURCES SCIENCES: Opus have a long heritage of developing New Zealand's strategic water infrastructure. New Zealand faces some unique pressures and competing demands on its water resources and environment. Our team investigates all sources of water; their various linkages and storages, their variability in time and space and their interactions with human activity. Whether it is obtaining, controlling, treating, disposing, containing or resisting it, water is a critical consideration for almost all areas of social, commercial, agricultural and industrial activity. We have a full team of expert hydraulic engineers and environment scientists providing service to power companies, local authorities and private clients. With a network of offices in New Zealand, Australia, Canada and the UK, Opus is at the forefront of award winning and innovative infrastructural design, construction and asset management.

Notes

Notes
