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Te Whare Wānanga o Aorangi
CHRISTCHURCH • NEW ZEALAND

Waterways
Centre for Freshwater Management

2014 Postgraduate Student Conference

18 November

Lincoln University,
Christchurch, New Zealand

Abstract Booklet



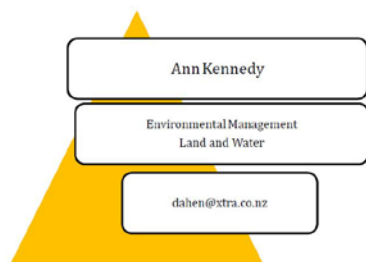
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The Waterways Centre for Freshwater Management is a teaching and research centre, jointly supported by the University of Canterbury and Lincoln University. Established in 2009, it aims to improve the knowledge-driven management of freshwater resources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

Conference Programme

Time	Presentation	
8:30	Registration	
9:00	Introduction – Jenny Webster-Brown , Director, Waterways Centre	
9:05	Welcome – Andrew West , Vice-Chancellor, Lincoln University	
9.15	Welcome – Steve Weaver , Deputy Vice-Chancellor (Research), University of Canterbury	
9.30	Characterising untreated urban runoff quality in Christchurch	Frances Charters, PhD student, University of Canterbury, pg 6
9.45	Determining the age of agricultural faecal pollution in our streams and rivers	Megan Devane, PhD student, University of Canterbury, pg 7
10.00	Post-quake recreational opportunities in Otākāro/Avon River and Ihutai/Avon-Heathcote Estuary	Palamy Xayasenh, Masters student, University of Canterbury, pg 8
10.15	Four well-being elements of Canterbury freshwater: a choice experiment application valuing environmental, social, financial and cultural attributes	Sini Miller, PhD student, Lincoln University, pg 9
10.30	Morning Tea	
11.15	The influence of pavement type on airborne pollutant wash-off	Louise Murphy, PhD student, University of Canterbury, pg 10
11.30	Earthquake and flood interactions in an urban environment: a new ‘multi-hazards’ perspective	Su Young Ko, PhD student, University of Canterbury, pg 11
11.45	The effect of windbreaks on water losses from sprinkler irrigation systems	Eric Kilaka, Masters student, University of Canterbury, pg 12
12.00	Irrigation scheduling: a soft adaptor to weather uncertainties and irrigation efficiency improvement initiatives	Birendra K.C., PhD student, Lincoln University, pg 13
12.15	Lunch; Poster Session from 12.45pm	

1.15	Glacial suspended particulate material: compositional & behavioural change through the Waitaki catchment	Phil Clunies-Ross, Masters student, University of Canterbury, pg 14
1.30	Sedimentary phosphorus release in a shallow coastal lake system in Canterbury	Sean Waters, PhD student, University of Canterbury, pg 15
1.45	An assessment of the distribution of mosquito species in the Kingdom of Tonga	Tom Swan, Masters student, University of Canterbury, pg 16
2.00	Putting galaxiid fish in the mix: assessing sensitivity of inanga to contaminants and contaminant mixtures	Nicole McRae, Masters student, University of Canterbury, pg 17
2.15	Otolith microstructure reconstructs marine development in the New Zealand whitebait <i>Galaxias maculatus</i>	Eimear Egan, PhD student, University of Canterbury, pg 18
2.30	Afternoon Tea	
3.15	Hydrologic changes in the Mekong River Floodplain as impacted by upstream hydropower and flood prevention system development	Thanh Duc Dang, PhD student, University of Canterbury, pg 19
3.30	Nitrate-nitrogen effects on benthic invertebrate communities in small lowland Canterbury Plains streams	Tom Moore, Masters student, University of Canterbury, pg 20
3.45	The application of an audited self-management system to manage nutrient leaching in the Hurunui catchment	Craig Simpson, Masters student, University of Canterbury, pg 21
4.00	Integrated sediment management for catchments with hydropower dams: opportunity, costs and uncertainty	Bikesh Shrestha, PhD student, University of Canterbury, pg 22
4.15	Drinks and Nibbles; Prize Presentation	

Presenters and student committee members can be identified by coloured name tags. Presenters are keen to hear your questions and feedback, so please feel free to approach them throughout the day. Also, please let a committee member know if you need any assistance.

Posters

Poster Title	Presenter
The effects of distribution systems on household drinking water quality in Addis Ababa, Ethiopia and Christchurch, New Zealand	Dawit Mekonnen, Masters student, University of Canterbury, pg 24
Otolith shape as a novel method to discriminate populations of the migratory Galaxiid, <i>Galaxias maculatus</i>	Eimear Egan, PhD student, University of Canterbury, pg 25
The phosphorous cycle in ponds of the McMurdo Ice Shelf, Antarctica	Hannah Christenson, PhD student, University of Canterbury, pg 26
Quantifying residual contamination from the Old Vanda Station site, as it is flooded by Lake Vanda, Wright Valley, Antarctica	Peter Taylor, Masters student, University of Canterbury, pg 27
The habitat template of <i>Stuckenia pectinata</i> in Te Waihora/Lake Ellesmere	Qian Hu, PhD student, University of Canterbury, pg 28
How effective are different lights for collecting adult aquatic insects?	Steve Pohe, PhD student, University of Canterbury, pg 29
Elevated nitrogen, low phosphorus - a recipe for <i>Phormidium</i> success?	Tara McAllister, Masters student, University of Canterbury, pg 30

Poster presenters can be identified by coloured name tags. There is a scheduled poster session in the foyer from 12.45pm – 1.15pm where all presenters will be available at their poster for questions and discussion. However, please feel free to also approach poster presenters throughout the rest of the day.

Welcome

Hello Everyone

Welcome to the Waterways Postgraduate Student Conference

We look forward to this great day every year. It is an opportunity to showcase some of the water-related research undertaken in, across and between the disciplines included within our Centre, at the University of Canterbury and at Lincoln University. There will be oral presentations and posters reflecting the diverse range of issues that currently face freshwater management in New Zealand. It is a day when those who have supported the Waterways Centre get to see the tangible results of their support, as our postgraduate students present their research on freshwater systems, on policies that affect, or could affect, water use and management, and on potential solutions to freshwater problems.

It is also an opportunity for students to interact directly with a range of stakeholders in the freshwater resources of Canterbury and New Zealand, representing community, industry, economic, regulatory, consultancy and research interests. We trust we provide such stakeholders with a great opportunity to evaluate our up-and-coming career water resource managers and scientists, and provide confidence that the future of NZ's water resources is in good hands.

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

Enjoy your day!

A handwritten signature in black ink, reading "Jenny Webster-Brown". The signature is fluid and cursive, with a long, sweeping underline.

Professor Jenny Webster-Brown
*Director - Waterways Centre for Freshwater
Management*



Dr Andrew West, Lincoln University

Dr Andrew West is Vice-Chancellor of New Zealand's specialist, land-based Lincoln University and was previously Chief Executive of AgResearch Ltd and Geological Nuclear Sciences Ltd (Crown Research Institutes), the Executive Chairman of the Tertiary Education Commission and the Chief Executive of New Zealand Qualifications Authority.

Dr West is an expert in the reform and operation of government scientific systems and tertiary education systems. In his career he has helped lead the creation of a Ministry of Science, funding agencies, regulatory agencies, limited liability research companies and tertiary education funding systems. Dr West has been a director of many firms and remains on the boards of Maori and agritech investment companies. Dr West has also overseen over \$100 million of commercialisation of public good science and technology.



Professor Steve Weaver, University of Canterbury

Professor Steve Weaver is Deputy Vice-Chancellor (Research) at the University of Canterbury and before that Dean of Postgraduate Research and a former Head of the Department of Geological Sciences.

Professor Weaver completed his BSc degree in Geology at the University of Birmingham, UK, and his PhD in Geochemistry at Bedford College, University of London. He came to New Zealand in 1978 to lead research specialising in the geological evolution of the southern Pacific Rim, in particular the relationship between New Zealand and West Antarctica.



Professor Weaver has over 120 publications and is a Fellow of the Royal Society of New Zealand. Currently he is a Director of GNS Science Ltd and has been a member of the Waterways Centre Advisory Board since its establishment in 2009.

Oral Presentation Abstracts

Characterising untreated urban runoff quality in Christchurch

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Stormwater runoff from urban impermeable surfaces during rain is a key polluter of urban waterways, contributing pollutants such as sediment and heavy metals. As is typical for many New Zealand urban areas, the majority of Christchurch's stormwater is discharged untreated directly into the nearest waterway. The quality of stormwater reaching the waterway can be improved through both pollutant source reduction measures and treatment measures, however, it is critical to understand the untreated stormwater quality to be able to develop appropriate and effective management measures. Runoff from four surface types (concrete tile, copper and galvanised roofs and asphalt road) in the Okeover catchment, western Christchurch, was collected throughout 20 rain events. The samples were analysed for total suspended solids (TSS), copper (Cu), zinc (Zn), lead (Pb) and particle size distribution (PSD). Results show that the road runoff had 10-20 times higher TSS concentration than any of the roof runoff, although TSS levels were generally lower than many other New Zealand and international studies. Conversely, copper roof runoff had Cu concentrations which exceeded those from the road runoff by a factor of 35, while galvanised roof Zn concentrations exceeded those of roads by a factor of 4. Strong correlation was observed between total and dissolved concentrations for both Cu and Zn, and first flush effects could be clearly seen for TSS and Pb, across all surface types. Particle size analysis of TSS shows variability both during and between rain events. The untreated runoff quality influences the performance of treatment systems, and the findings from this study can be used to guide selection of appropriate source reduction measures and treatment devices.

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

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Faecal pollution of waterways by agricultural sources is a recurring dilemma in our agriculturally dominated economy. The emphasis on conversion to dairy farming has highlighted the need for faecal source tracking tools (FST) that identify sources of faecal pollution. Chemical (faecal sterols) and microbial tools (genetic markers) have been developed to augment traditional microbial indicators such as *Escherichia coli*, which is identified in all animal faeces. The persistence of *E. coli* in the environment in the absence of obvious sources of contamination has highlighted the need for additional FST tools. The response of water managers to elevated microbial indicators in waterways will be dependent on factors that include the age of the faecal contamination event.

Ageing of cowpats under field conditions was carried out over two six month periods to explore changes in the microbial community of the cowpat. During the second six month period, the cowpats were subjected to simulated rainfall and the resultant run-off collected and analysed for FST markers. Results of the experiments include the effect of faecal ageing on the interpretation of faecal source specificity by the current FST markers. An exploration of markers useful for determining if an identified faecal contamination event represents fresh or historical inputs will be discussed. This study confirms that microbial indicators and FST markers can be mobilised from ageing bovine faeces under simulated rainfall for up to six months and contribute to pasture run-off into waterways.

Post-quake recreational opportunities in Otākāro/Avon River and Ihutai/Avon-Heathcote Estuary

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Otākāro/Avon River and Ihutai/Avon-Heathcote Estuary together with surrounding parks, reserves and wetlands are features of the urban environment of Christchurch City. They are popular for recreational and tourist activities, and provide educational resources, special places for people to share its rich history, plentiful wildlife, beautiful scenery, and mahinga kai (food gathering).

While there has been a considerable amount of research on the recreational activities, opportunities and resources in the Avon-Heathcote Estuary, little is known about the recreation values of the Avon River. These are needed to facilitate the restoration and enhancement of recreational uses on the river.

This research is focused on current recreational opportunities on the river and the Estuary by investigating recreational activities on the Avon River and the Avon-Heathcote Estuary before and after the major earthquakes in 2010 and 2011. The earthquake recovery envisages a huge opportunity to reshape the delivery of sport and recreation. It is therefore important to investigate the perceptions of the main factors influencing recreational users and to identify future options for promoting recreational activities. The research aims to evaluate current recreational opportunities using a questionnaire, assess levels of public participation in recreational activities and evaluate the quality of recreational resources.

The outcomes of this research will be useful for recreational planning in the Avon River and the Estuary. In addition, the river evaluation can be utilised by the Christchurch City Council to plan for recreation in the future as well as other baselines for future management.

Four well-being elements of Canterbury freshwater: a choice experiment application valuing environmental, social, financial and cultural attributes

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There are well-known issues in both the quality and quantity of Canterbury's freshwater. This complicates freshwater management which needs to consider a range of uses (from environmental, social/recreational, and financial to cultural) that contribute to society's wellbeing.



This study used the choice experiment, a non-market valuation method, to assess how people value different attributes related to Canterbury freshwater. This method was appropriate as while it allows to estimate marginal willingness-to-pay for each attribute, it also makes sure people make trade-offs between them thus improving accuracy. The study included environmental, social/recreational, financial and cultural attributes which were developed to reflect the Canterbury Water Management Strategy framework and Central Plains irrigation development. The data was collected from a survey of Canterbury residents in 2012.

Results show that, overall, people were willing-to-pay for improvement in all the attributes included in the study where the environmental attribute was valued the highest followed by the cultural, recreational and then employment attributes, subject to their level of improvement. Impacts of irrigation development on these attributes were explored for four scenarios, and found the highest welfare gains if the water quality was increased or maintained, and the lowest if water quality was reduced. However, when compared to results from a separate analysis of the revenue from irrigation, the benefits exceeded the disutility from losses.

The influence of pavement type on airborne pollutant wash-off

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Atmospheric deposition is increasingly being recognised as a significant source of total suspended solids (TSS) and heavy metals (principally Cu, Pb, and Zn) to urban runoff. However, many uncertainties and challenges remain with measuring and managing these pollutants in stormwater runoff. In particular, knowledge on the influence of pavement type on airborne pollutant wash-off dynamics is lacking. Therefore, this research aims to quantify how much of the key urban pollutants (heavy metals and TSS) are deposited and subsequently washed-off from different pavement types (i.e. asphalt or concrete; impermeable or permeable).

Experimental impermeable concrete, impermeable asphalt, permeable concrete, and permeable asphalt boards were deployed in a residential land-use area in Christchurch. Each pavement type had four replicate boards elevated 500 mm above ground at a 4° slope. Surface runoff from the impermeable boards and infiltrate from the permeable boards were collected and analysed for TSS and heavy metals throughout June 2014 to August 2014.

Results show that Cu and Zn loads were the lowest from the concrete pavements due to the hydroxides and carbonates in the concrete providing adsorption sites for Cu and Zn. Surface runoff from impervious asphalt had significantly higher loads of Zn compared to the other pavement types, which was associated with Zn leaching from the asphalt material. TSS loads were the highest in runoff from the smooth impermeable concrete, which enabled particulates to be easily dislodged. TSS loads were the lowest from the permeable boards due to the tortuous flow channels of the permeable pavements filtering out particulates.

Earthquake and flood interactions in an urban environment: a new 'multi-hazards' perspective

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Natural hazards are often considered as discrete events, with occurrences and consequences of each hazard assessed independently. Flooding after the 2010-2011 Canterbury Earthquake Sequence (CES), however, has demonstrated that certain hazards are intricately linked via “multi-hazard” processes. Following each major CES quake, ground shaking and land deformation impacts on natural waterways, engineered lifelines (transport, waste and potable water, communication, power) and flood protection infrastructures were as anticipated. However, the ensuing increased flood vulnerability was unexpected by most. Frequent media reports on enhanced flooding in Christchurch following the CES highlighted some of the chronic earthquake impacts. This direct link between earthquakes and subsequent alterations in urban flood risk is, however, an inadequately documented research topic in scientific and engineering literature worldwide.

In an initial attempt to explore interactions between earthquakes and flooding, a conceptual model was developed from a literature survey, news and engineering reports, personal and professional observations. Key effects found included changes to: topography; soil properties; land-use; flood protection infrastructure; water drainage and wastewater infrastructures; and groundwater hydrology. As a next step in this research, some key links identified will be investigated further via expert contributions from engineers and hydrologists, GIS analysis and hydrological modelling.

A significant outcome of the research to date is the finding that, given the direct consequences of earthquake-induced changes on urban floodscapes, a re-assessment of flooding hazards is necessary after all significant earthquakes.

The effect of windbreaks on water losses from sprinkler irrigation systems

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In many parts of Canterbury Plains, New Zealand, windbreaks are common features in agricultural farms. As a result of irrigation expansion, centre pivot and lateral sprays irrigation technology have replaced the old border-dyke systems. This has been due to the need to increase irrigation flexibility and efficiency to guarantee pasture growth for dairy production in the dry period. The recent conversion of large areas of the Canterbury region to dairy farming with spray irrigation has resulted in a reduction of windbreaks to 2m high or has sometimes led to 100% clearing of windbreaks. Removal of windbreaks is done to accommodate centre pivots or linear move systems which are considered more efficient in water application than old border dyke systems. However, this reduces wind sheltering effects, with a corresponding increase in evapotranspiration (ET) and spray evaporation losses (SEL). This can be more significant during the hot, dry and windy periods of summer, increasing pressure on the already over allocated ground and surface water resources in Canterbury. The major aim of this study is to determine how the removal of windbreaks will affect efficiency in water application. Experiments were conducted in field to calibrate and validate a wind speed reduction model for typical farms in Canterbury protected by windbreaks of different porosities and height. A statistical spray evaporation loss prediction model was developed using electrical conductivity method for two commonly used centre pivot sprinkler nozzles namely S3000 and R3000. Results show that for hot dry conditions in Canterbury, ET can increase by up to 1.46 mm/day and 0.97 mm/day when windbreaks are completely removed and when reduced to a height of 2m respectively. SEL losses were found to be dependent on wind speed, vapour pressure deficit and nozzle type. In a typical northwester condition, savings of over 10% of irrigated water can be achieved if windbreaks are integrated within irrigation systems. This has the potential to reduce ground and surface water resources use.

Irrigation scheduling: a soft adaptor to weather uncertainties and irrigation efficiency improvement initiatives

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Dairy farming is expanding all over the world, increasing competition for limited land and water resources and necessitating efficient use of irrigation schemes. Irrigation efficiency depends to a great extent on the selected method of irrigation scheduling that determines time and depth of the next irrigation. However, consideration of the threshold soil moisture values to start and stop irrigation taking into consideration the optimum use of rainfall is not well addressed. Additional work is also needed to specify the correct crop coefficient for pasture to determine an accurate estimate of evapotranspiration and required depth of irrigation as a function of changing canopy height.

A preliminary field study shows that pasture height in a paddock just before grazing is about 20cm which reduced to 5cm just after grazing. In addition, due to rotational grazing different paddocks have different pasture height indicating varying irrigation demand in each paddock. However, irrigation supply is uniform regardless of pasture height. Future rainfall is not taken into account during peak irrigation period suggesting possibilities of nutrient leaching. The proposed research will contribute to the development of irrigation scheduling that defines the irrigation range relative to the soil water holding capacity and takes into consideration rainfall and evapotranspiration uncertainties and correct crop coefficient based on actual plant height. The findings will contribute towards improving agricultural water management, eventually supporting the sustainable development of dairy farming industries in New Zealand and elsewhere. In addition, it will also point to ways to decrease water pollution by reducing nutrient leaching.

Glacial suspended particulate material: compositional and behavioural change through the Waitaki catchment

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Glaciers are extremely erosive environments and produce huge volumes of sediment through the crushing and abrasion of rock in alpine basins. Much of this sediment consists of fine particles that suspend in melt-waters for extended periods, scattering light and causing the turbidity and colours that are characteristic of glacial streams and lakes. To date, there have been few studies on the composition and behaviour of suspended particulate material (SPM) originating from glaciated environments, and how this changes in the transition from the upper to lower catchment. A key consideration is the rate at which glacial SPM weathers and forms secondary minerals such as clays and metal oxides. The dissolved concentrations of many toxic trace metals, nutrients and organic contaminants are strongly influenced by sorption-desorption processes on the surfaces of SPM. Because such pollutants are more bioavailable to aquatic biota in their dissolved form, the binding of trace contaminants and nutrients onto suspended particles is an important process regulating their transport and toxicity. The aim of this research is to determine the composition and adsorptive capacity of SPM in the glacial fed Waitaki catchment, and how this changes between the upper alpine catchment (Aoraki/Mt Cook National Park) and the lower, agricultural catchment. Five large hydroelectric lakes increase the residence time of SPM in this catchment to approximately 1 - 2 years, optimizing opportunities for weathering to occur. Suspended particulate matter from upper and lower catchment sites has been analysed with X-ray diffraction and scanning electron microscopy. SPM particle size distributions have also been determined with laser diffraction and dynamic light scattering methods. The capacity of upper and lower catchment SPM to adsorb phosphorus, copper and cadmium is currently being assessed through a series of experimental adsorption determinations.

Sedimentary phosphorus release in a shallow coastal lake system in Canterbury

Sean Waters

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Te Roto o Wairewa/Lake Forsyth is a small, shallow, coastal lake on the south side of Banks Peninsula. The lake has no natural outlet but is intermittently opened to the sea to control flooding. Blooms of nitrogen-fixing cyanobacteria occur regularly in summer, and it is suspected that dissolved phosphorous (P) availability may be a key factor in bloom development.



External loads of P, delivered mainly in particulate form during flood events in the lake catchment, cannot explain the observed short-term fluctuations in dissolved P concentrations in the lake. However, the release of P sequestered in lake sediments may both explain these fluctuations and, under the right conditions, trigger and sustain rapid increases in primary productivity leading to bloom formation. An understanding of the mechanisms that release dissolved P into the water column, and the factors that favour such mechanisms, is therefore critical to the formulation of good management responses to eutrophication of this lake.

Sequential extraction of lake sediments, indicate that there is a large reservoir of exchangeable and oxide-adsorbed P available for release into the water column. This data and analysis of sediment porewater confirms the mobility of P in the upper sediment profile. Release experiments, combined with in-lake monitoring data and geochemical modelling, have quantified the effect of low dissolved oxygen associated with changes in macrophyte density, salinity changes associated with lake openings, and high pH associated with increasing photosynthesis, on sedimentary P release. A combination of these factors may be important in triggering and perpetuating bloom formation.

An assessment of the distribution of mosquito species in the Kingdom of Tonga

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Mosquitoes are a significant pest and vector of arbo-viruses globally. In Tonga, both dengue fever and chikungunya virus have caused a number of deaths each year. A recent outbreak of chikungunya virus in April 2014 infected 10,000 Tongan residents, resulting in numerous fatalities. Both diseases have no cure, and contribute to high morbidity and mortality in Tonga.

We sampled larvae at 88 sites throughout the Tongatapu island group. Water chemistry parameters (temperature, pH, dissolved oxygen, conductivity), habitat type, and GPS points were also recorded. Nine species of mosquitoes were collected, including the virulent mosquito *Aedes albopictus*. This is only the second known collection of this mosquito in Tonga. *Ae. albopictus*, *Ae. aegypti* and *Culex quinquefasciatus* were the most commonly occurring species. *Ae. albopictus* was found to coexist with the introduced species *Cu. quinquefasciatus*, *Ae. aegypti* and the native *Ae. tongae* species. Mosquito larvae predominantly favoured car tyre habitats.

From this research, a pictorial key for identifying mosquito larvae will be produced to help the Tongan Ministry of Health. Increasing public awareness and the reduction of known available mosquito habitats will aid in decreasing disease incidence within the Kingdom of Tonga.

Putting galaxiid fish in the mix: assessing sensitivity of inanga to contaminants and contaminant mixtures

Nicole McRae

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Pharmaceuticals are an increasingly important environmental contaminant, but their effects on non-target aquatic biota, and their interactions with other toxicants are poorly understood. This study is investigating the effects of two ubiquitous contaminants diclofenac and zinc on the freshwater fish inanga (*Galaxias maculatus*). This fish species is widespread throughout the Southern hemisphere, is frequently an inhabitant of near-coastal streams impacted by pollution, and is of significant cultural and economic importance.



To determine mechanisms of sublethal toxicity fish were exposed to graded, environmentally-relevant concentrations of diclofenac and zinc over 96 h. Endpoints measured included those relating to ionoregulatory disturbance (sodium/potassium ATPase, whole body calcium influx), respiratory/metabolic impairment (respirometry) and oxidative stress (catalase activity). Tissue accumulation of zinc and diclofenac was also measured. Results to date indicate that zinc has a relatively minor impact on inanga physiology and biochemistry. For example, oxidative stress and ion regulation was impacted only at the highest exposure concentration (1000µg L⁻¹). Ongoing work is also examining the impact of diclofenac/zinc mixtures on sublethal toxicity in this species, while the interaction between salinity and toxicity is also under investigation. This research is the first to explore the sensitivity of galaxiid fish to emerging pharmaceutical contaminants, information that will be critical to ensuring adequate environmental protection of this important group.

Otolith microstructure reconstructs marine development in the New Zealand whitebait *Galaxias maculatus*

Eimear Egan

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Galaxias maculatus is one of five native migratory Galaxiids. The translucent juveniles comprise >90% of the whitebait fishery that has significant cultural, recreational, and commercial values. To address mechanisms behind the perceived decline of *G. maculatus* populations, a fundamental understanding of the biology and ecology of this species is needed. This species, typically amphidromous, uses the marine environment for larval development. However, little is known of this critical life phase. Uncertain larval development and the multispecies nature of the whitebait fishery, amongst other factors have confounded effective management and conservation of the species. This research aims to provide insight into the “black box” of marine larval development and will reconstruct early life using otolith microstructure techniques. *G. maculatus* were collected from key fisheries in New Zealand in 2013. Otoliths were polished to reveal the internal daily rings. Age and size at migration, pelagic larval duration, growth rate per day, amongst other characteristics were derived from the otoliths. Mean length (mm) and age at migration differ significantly between regions. Spatial and temporal differences in growth rates were observed, with two apparent growth phenotypes: fast and slow growers. This species is widely distributed throughout New Zealand coastal waters. Larvae are therefore likely to encounter spatially and temporally variable environmental and biophysical conditions during their marine development. This may be one reason to explain the observed differences between regions. It is becomingly increasingly recognised that larval history may have pronounced legacy effects on adult growth and performance, the consequences of which are discussed here.



Hydrologic changes in the Mekong River Floodplain as impacted by upstream hydropower and flood prevention system development

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Hydropower dams and flood prevention systems are being constructed rapidly within the Mekong River Basin, raising public concerns due to potential impacts on local ecosystems and agricultural productivity. While hydropower dams can regulate flows by the storage capacity of reservoirs, delta-based infrastructure directly changes water levels via the operation of sluice gates. This research assesses the impact of both upstream hydropower dams and downstream water infrastructure through historical data analysis and hydrodynamic modelling. Firstly, the changes in historical water levels of key stations in the Mekong Floodplain were analysed. Historical alterations in water level patterns (rise rate, fall rate and fluctuations) over time were then associated with the development of either dams or flood prevention systems. Flow fluctuations at the upper part of the floodplain have gradually increased by 10% between 1980 and 2013, but remained the same in the middle of the floodplain. In the lower part, rise rates and fall rates have changed significantly since 2007. This corresponds to the operation of delta based flood prevention systems. The impact of existing dams on the Vietnam Delta is currently buffered by the Tonle Sap and Cambodian Lowlands. A 3D hydrodynamic model was also applied to quantify the impact of future dam development. In a long term development scenario, if 135 dams are built upstream, the floodplain's average water levels are predicted to increase by 12% in the driest months and decrease by 3% in the wettest months compared to the period between 1980 to 1990 when there were few dams. The seasonal regulation benefits of the natural buffer zones diminish as upstream flows become increasingly regulated by artificial reservoirs.

Nitrate-nitrogen effects on benthic invertebrate communities in small lowland Canterbury Plains streams

Tom Moore

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Agricultural practices expose aquatic ecosystems to multiple stressors that threaten animal-life when critical thresholds are exceeded. For example, the increased occurrence of excessive nitrate-nitrogen concentrations in streams has raised concerns about its impacts on aquatic life.



A field survey of 41 sites was conducted to identify nitrate-nitrogen effects on benthic invertebrate communities in the Canterbury Plains. Small lowland waterways (1-3m wide) were chosen across a nitrate-nitrogen gradient ranging 0.4 - 11.3mg/L. Sites were selected to reduce possible confounding variables, however gradients of stream discharge and shade did occur.

Common biotic metrics including taxonomic richness and the Macroinvertebrate Community Index were found to not correlate with mean nitrate-nitrogen, although multivariate techniques indicated a marginally non-significant shift in community composition across the nitrate-nitrogen gradient. A comparison of the National Objective Framework nitrate-nitrogen bands suggested potential differences in benthic community composition, particularly at < 1 and > 6.9 mg/L. These findings showed nitrate-nitrogen effects are difficult to detect, and that nitrate is not a main driver of community composition in Canterbury Plains streams.

The application of an audited self-management system to manage nutrient leaching in the Hurunui catchment

Craig Simpson

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The Zone Implementation Programme (ZIP), released by the Hurunui Waiau Zone Committee in 2011, contained recommendations as to how water management issues in the zone should be addressed. In the ZIP, the Zone Committee recommends the setting of nutrient load limits and the adoption of audited self-management programmes, which have statutory backing. Load limits for nitrogen and phosphorus in the Hurunui River catchment have subsequently been set under the Hurunui and Waiau River Regional Plan, and audited self-management (ASM) programmes in the district are being developed.



Key features of ASM include the audit process, monitoring and farm environment plans. While the key features of ASM are known, there is a great amount of flexibility in applying an ASM approach in different situations. In the Hurunui River catchment what is as yet unknown are the features of an ASM approach supported by land and water users, and the arrangements required for ASM to work effectively. This research examines the stakeholder's perceptions of applying an ASM approach, by gaining an understanding of the features and arrangements stakeholders would accept in the application of an ASM approach, and comparing these to other examples of successful management of natural resources, including comparison with the design principles for the management of common pool resources outlined in Elinor Ostrom's work *Governing the Commons*. The preferences of stakeholders at different spatial scales throughout the catchment are also examined, to investigate the politics of scale in the effective management of water quality in the Hurunui River catchment.

Integrated sediment management for catchments with hydropower dams: opportunity, costs and uncertainty

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Reservoir sedimentation reduces storage capacity, which can have an impact on hydropower production, irrigation, flood control, and other benefits of dams and reservoirs. Both climate change and land use change can impact the rate of reservoir sedimentation. Reservoir storage capacity loss due to sedimentation, however, can be reduced through integrated catchment and river sediment management.

However, this requires an understanding of uncertainty in future climate, land use, and sediment predictions. Sediment predictions that are provided without addressing the associated range of potential changes could mislead the selection of sediment management strategies and associated costs. Quantifying the uncertainty in sediment predictions and its implication for the opportunity and cost of integrated sediment management for catchments with hydropower dams is especially important in regions undergoing rapid dam development such as the Mekong River Basin. Hence this research aims to quantify the uncertainty in sediment predictions and its implication for the opportunity and cost of integrated sediment management for catchments with hydropower dams, using the Lower Mekong River Basin as a case study. The implication of these uncertainties for the opportunity and cost of integrated sediment management for catchments with hydropower dams will be assessed using appropriate sediment management models and cost models. The research outcomes are expected to contribute to the understanding of the magnitude of uncertainties related to land use change, climate change and sediment modelling and their implication for the opportunity and cost of integrated sediment management for catchments with hydropower dams.

Poster Abstracts

Poster Session from 12.45pm to 1.15pm in the foyer

The effects of distribution systems on household drinking water quality in Addis Ababa, Ethiopia and Christchurch, New Zealand

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Inadequate environmental sanitation and lack of proper waste management together with poor water supply infrastructure present many problems for household drinking water quality. These issues are more severe in developing countries like Ethiopia, where treated water is supplied through old, rusted and cracked water distribution systems. This study looks at how the distribution system impacts water quality in Addis Ababa City, the capital of Ethiopia. To characterise the possible effects of distribution system on households' drinking water quality, an old settlement, Woreda-6, with cross-connected water supply distribution systems and a recent development, Woreda-8, were compared. Water samples were collected at source and at taps in households in both areas between July and September 2014 and analysed for water quality parameters. For comparison, a smaller survey was also conducted in Christchurch, New Zealand. Water samples collected in July in Addis Ababa showed increased total dissolved solids (TDS) concentrations and decreased pH levels over all sampling sites and vice versa for September, possibly due to dilution of the source water from rainfall and runoff discharge. In comparison to treatment plant and Woreda-8 samples, Woreda-6 samples show an increase in turbidity, TDS, conductivity, total iron, *E. coli* and total coliforms, and a decrease in residual chlorine, indicating possible drinking water contamination occurring in the distribution system. In comparison, the difference between source and tap water quality in Christchurch showed a non-significant increase in turbidity, TDS, conductivity, nitrate and total zinc, and decrease in pH and total iron. The increase could be due to contact reactions between the pressurised water and distribution system materials, which is generally expected. The decrease in pH and total iron could be due to oxidation and precipitation of dissolved metals mainly found in groundwater. No *E. coli* or total coliforms were found either in the source or tap water.

Otolith shape as a novel method to discriminate populations of the migratory Galaxiid, *Galaxias maculatus*

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Galaxias maculatus spends between three and six months of its life at sea as developing larvae. The translucent juveniles, (whitebait), returning to settle in coastal rivers are the target of an important multi-stakeholder fishery in New Zealand. Although mtDNA studies suggest panmixia, the degree of mixing is unclear given the dynamic oceanographic processes around New Zealand and evidence from otolith microchemistry studies suggest that at least some populations may be retained regionally. The identification and characterisation of population components is essential for effective fisheries management and conservation measures.



Otolith shape is an evolving and complementary tool to traditional stock discrimination techniques used by fisheries scientists. The shape of an otolith is a species-specific characteristic that integrates genetic and environmental components which together can be used to identify populations that are spatially or temporally discrete during some stage of their life. In this context, this study tests the hypothesis of random dispersal and that regional populations of *G. maculatus* can be differentiated by means of sagittal otolith shape analysis. *G. maculatus* were collected throughout the 2013 fishing season from multiple rivers in four regions of the country that support substantial fisheries. The left sagitta was photographed (sulcus side up) in dark field and the right sagitta used for ageing. To avoid size bias, only otoliths from 45-55mm fish (TL) were analysed. Elliptical Fourier analysis was done in SHAPE v1.3. Shape indices were derived from measurements of otolith length, width, area and perimeter. Preliminary results are illustrated here.

The phosphorous cycle in ponds of the McMurdo Ice Shelf, Antarctica

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Meltwater ponds are a common habitat for terrestrial biota on continental Antarctica. The productivity of benthic cyanobacteria (the dominant biomass) requires availability of phosphorus (P), but sources of P and factors limiting its bioavailability are poorly understood. Consequently it is difficult to predict how productivity will be affected by changes in pond size that may result from a warming climate. As part of a larger research programme to determine the P biogeochemical cycle for meltwater ponds in Victoria Land, this study has explored P distribution and speciation in ponds of the McMurdo Ice Shelf to develop a conceptual model of the P cycle in this area.

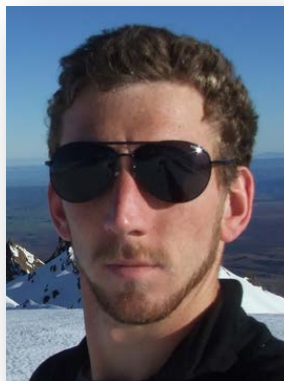
Over three visits between 2011 and 2013, soil, soil salts, sediment, water and biological material was collected from 5 ponds at the study site, as well as data on the structure of the ponds. The ponds sit above a layer of sediment 45 cm deep, which lies on an ice cement, with the water table around the ponds extending ca. 30 cm above the pond water level. The major reservoir of P in the ponds is the sediments. The speciation of water column P had variable composition, but was most often dominated by organic P species. Pond sediments contain 10-20% less total phosphorous than surrounding soils, which have up to 11 mg/kg of water soluble phosphorous, and up to 2 g/kg of total phosphorous. This suggests that recently flooded soils have a major role as an immediate source of phosphorous to newly formed ponds, and that leaching of sediments is a key process for some time thereafter. A conceptual model for a P cycle is proposed for a typical pond in this environment, identifying the sediment as the major P reservoir in the pond, and a major source of P over time.

Quantifying residual contamination from the old Vanda Station site, as it is flooded by Lake Vanda, Wright Valley, Antarctica

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Vanda Station was a New Zealand research station located in the Wright Valley on the Antarctic Continent. The station operated from 1969-1993, and throughout this period, occupation and research activities led to some anthropogenic environmental impacts. Vanda Station was decommissioned and dismantled in 1993/94 due to the risk of Lake Vanda flooding the station, during which an assessment of environmental effects was undertaken. This assessment, along with subsequent studies, identified areas of residual hydrocarbon, trace metal and phosphate contamination. An area identified where the majority of residual contaminants remained is Greywater Gully. Subsequently flooded, this is the primary location of our proposed research into residual contamination and ongoing effects on the receiving environment. We will be testing the hypothesis: *Residual contamination at the Vanda Station site continues to affect water quality and cyanobacterial growth near this site.*



For this we will analyse residual contamination in known contaminated water and soil sites, including metals, hydrocarbons and phosphates; dispersion of contaminants throughout the lake using personal care product markers as indicators of dispersed contamination; and responses of benthic cyanobacterial mats in the vicinity of contaminated sites. This research has two major aims: firstly to update the assessment of environmental effects as a result of human occupation at Lake Vanda last undertaken almost 20 years ago; and secondly to further developing the understanding of the ability of Antarctic Lake environments to assimilate contaminants.

The habitat template of *Stuckenia pectinata* in Te Waihora/Lake Ellesmere

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The primary research goal of this proposal is to develop a habitat template for *S. pectinata* within Te Waihora/Lake Ellesmere, to aid in re-establishment of the plant. The habitat template describes the set of environmental conditions under which the plant can survive and grow and will be addressed in two parts, with a focus on irradiance as a primary limiting factor. Firstly the minimum light requirement for the survival of *S. pectinata* at different growth stages will be determined, with consideration of the interactive effects of turbidity, salinity, and the presence of phytoplankton and periphyton. Secondly, how photosynthesized energy is distributed into different plant tissues when minimum light requirement is exceeded, and how this affects growth and reproduction, will be determined.

This habitat template will be used to guide selection of sites in the lake for a transplantation project. The transplantation project will be used to test the habitat template by evaluating the performance of *S. pectinata* after transplantation.



How effective are different lights for collecting adult aquatic insects?

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Light-trapping is a common method used to collect flying insects, including the adult stages of aquatic species. The lighting used ranges from low-intensity fluorescent tubes run by batteries, to very high-intensity vapour lamps run by a generator. Light in the ultraviolet spectrum is usually preferred, and an assumption of ‘the brighter the better’ is often assumed. A literature review revealed little useful information on the effectiveness of differing wavelengths or intensities of light for trapping aquatic insects. Also, in an examination of differing brands of comparable light tubes (e.g. 365 nm blacklights) we realised some had considerably different spectral signatures. We therefore decided to examine the effect of differing light configurations on capture rates of adult aquatic insects. In a field trial we tested blacklight, blacklight-blue, whitelight and a mixed-light combination, all at two intensities (16 or 32 watts). Catches were analysed for species richness and abundance of mayflies, and abundance only for caddisflies (caddis species richness still to be calculated). All light types attracted adult aquatic insects and preliminary analyses indicated blacklight-blue, closely followed by blacklight, to be most effective. Also, the high-intensity lights were more effective than the low-intensity lights. Finally, in the interest of reducing non-target taxa we investigated the abundances of terrestrial Coleoptera, Lepidoptera and Diptera. Terrestrial insect results mostly mirrored those of the aquatic taxa, however blacklight outperformed blacklight-blue. This may indicate that blacklight-blue could be more useful in aquatic studies, potentially producing larger aquatic catches and lower terrestrial ones, though more testing is needed.

Elevated nitrogen, low phosphorus - a recipe for *Phormidium* success?

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Toxic benthic cyanobacterial blooms of *Phormidium* are becoming increasingly prevalent in New Zealand's rivers. There have been approximately 100 dog deaths in the last five years. Despite the health risks, the development of effective management strategies is hampered by a limited understanding of what makes rivers vulnerable to blooms. The aim of this preliminary study was to determine when, where and why *Phormidium* blooms occur in Canterbury rivers by comparing environmental variables across 10 lowland rivers.



Phormidium was present in all rivers, but proliferated only in five. Unstable substrate and frequent flushing flows were pre-eminent factors in preventing blooms from occurring. It is less clear what factors are important in promoting *Phormidium* growth when stability criteria are met. We found no correlative relationship between *Phormidium* percentage cover and water temperature, *Phormidium* was observed in water temperatures between 4–20°C. The majority of blooms were recorded at sites with moderate to high DIN (>0.10 mg/L), but when DRP concentrations were low (<0.010 mg/L).

A tentative conclusion is that elevated DIN, low DRP waters are most vulnerable to *Phormidium* growth, though water quality is a weak predictor of blooms. The concept that *Phormidium* mats are able to access sources of P other than those supplied by river water is currently under investigation. Does the same apply to nitrogen? Planned future research will focus on evaluating the abundance of nitrogen fixers within *Phormidium* mats and as well as determining nitrogen fixing potential. We will also further explore the possibility that other water quality attributes, that have not yet been identified, influence *Phormidium* growth.

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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.

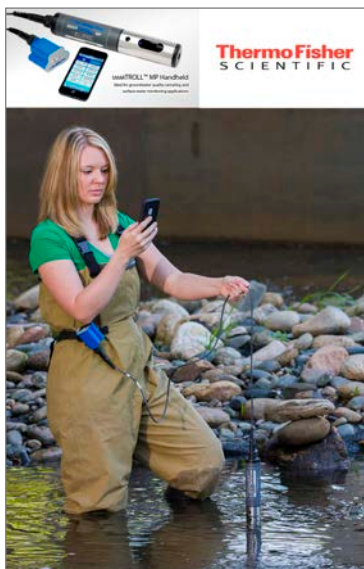
Designing projects to enhance our environmental and social sustainability, such as protecting our artesian resources and maintaining the quality of streams and rivers, are key objectives of our Water Supply and Surface Water Strategies. We aim to look after our community's health and well-being through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



The Rivers Group was formed in 2009 to provide a forum for those involved with, and with an interest in rivers, flood risk management and the operational and environmental issues of catchments and river systems. The Group incorporates a wide variety of fields, practice and interest to do with rivers, including cultural health, water quality, water quantity, flood management, energy generation and environment protection, as well as promoting a multi-disciplinary approach for river management, that reflects cultural and societal diversity in an integrated and holistic manner. Key objectives of the Rivers Group include providing a national focus for all matters relating to rivers, promoting leadership, best practice and relevant science and research, sharing of technical knowledge, facilitating cross-disciplinary discussion, promoting and sharing of technical knowledge in all aspects of catchment management, flood risk management and river engineering throughout New Zealand.

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

Check out our website - <http://www.ipenz.org.nz/riversgroup/>



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