Living Lake, Changing Catchment:

2011

Te Waihora/Lake Ellesmere integrated catchment symposium

waihora ellesmere trust

Living Lake 2011 is hosted by Waihora Ellesmere Trust with support from:

Environment Canterbury Regional Council Kaunihera Taiao ki Waitaha · Te Rūnanga o NGĀI TAHU · Lincoln University · Department of Conservation Te Papa Atawhai · NIWA · Fish & Game New Zealand · Selwyn District Council · The Canterbury Community Trust · meridian · Fonterra

Lincoln University, November 15th & 16th, 2011

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"Waihora Ellesmere Trust (WET) is a community organisation dedicated to the improvement of the health and biodiversity of Te Waihora/Lake Ellesmere and its catchment."

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Living Lake 2011 is hosted by Waihora Ellesmere Trust with support from Environment Canterbury, Ngai Tahu, Lincoln University, Department of Conservation, NIWA, Fish & Game NZ, Selwyn District Council, Canterbury Community Trust, Meridian and Fonterra.

The Waihora Ellesmere Trust is delighted to welcome you to the third Living Lake symposium.

Te Waihora/Lake Ellesmere, one of New Zealand's most important wetland systems, is a brackish, shallow lagoon with an average depth of 1.4m. Covering around 20,000 hectares, Te Waihora/Lake Ellesmere is New Zealand's fifth largest lake and is internationally significant for its wildlife abundance and diversity.

Although often referred to as one of New Zealand's most polluted lakes, Te Waihora/Lake Ellesmere is highly valued by many sectors of the community.

The timing of this symposium is opportune for a number of reasons as it ties in with several initiatives to help address the plight of the Lake: the recent changes to the Water Conservation Order, the Land Use and Water Quality project, the release of the draft Selwyn-Waihora Zone Implementation Programme, and the work that is underway on Whakaora Te Waihora.

These two days will bring together information on science and research, projects that are underway, and comment from experts on numerous topics, linking them to discussions on managing the long term future of the lake and its catchment.

This is a perfect opportunity to talk about how we can tie the various work-streams together to ensure we look after one of New Zealand's most precious lakes.

Many thanks to all our sponsors and to all the people who have contributed to the planning and organising of this symposium.

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Living Lake, Changing Catchment - Symposium Programme

Day 1 - Tuesday November 15th, chaired by Jenny Webster-Brown, Director of the Waterways Centre for Freshwater Research

9.00am	***Mihi whakatau***, Te Taumutu Rūnanga Mark Solomon, Kaiwhakahaere (Chair) Te Rūnanga o Ngāi Tahu
9.40am	***"Setting the Scene"*** – Clive Howard-Williams and Ned Norton, NIWA
9.55am	***Land Use Change in Selwyn District*** – Andrew Mactier, Selwyn District Council
10.15am	Morning tea
10.45am	***Updates :*** ***Ngāi Tahu Customary Fisheries Protection Areas Project*** – Nigel Scott, Te Rūnanga o Ngāi Tahu ***Freshwater fish of Te Waihora – recruitment, important habitats, and changes in fish communities –*** Don Jellyman, NIWA ***Update of surface water hydrology in the Te Waihora /Lake Ellesmere Catchment –*** Dan Clark, Environment Canterbury ***Groundwater resource update and managed aquifer recharge –*** Howard Williams, Golder Associates **Lake water quality trends and identifying opportunities to make significant improvements** Adrian Meredith, Environment Canterbury **Ecological flows for rivers in the Te Waihora/Lake Ellesmere catchment** Greg Burrell, Golder Associates
12.15pm	Lunch *sponsored by Meridian*
1.15pm	***Restoration project updates:*** Stephen Brailsford, Waihora Ellesmere Trust Brooke Turner, Te Ara Kākāriki Andrew Spanton, Te Rūnanga o Ngāi Tahu ***Monitoring and enhancing ecosystem services at Te Waihora/Lake Ellesmere –*** Steve Wratten, Lincoln University
2.00pm	***Whakaora Te Waihora*** – Donna Woodley, Environment Canterbury and Jason Arnold, Te Rūnanga o Ngāi Tahu
2.20pm	***University research updates*** Jenny Webster-Brown, Director, Waterways Centre for Freshwater Management
3.00pm	Afternoon tea
3.30pm	***NIWA updates:*** ***Modelling the water balance of Te Waihora for the National Water Conservation Order amendments*** - Graeme Horrell, NIWA ***Canterbury Lysimeter Network Project*** – MS Srinivasan, Maurice Duncan, NIWA ***The Selwyn River/Waikirikiri*** – Scott Larned, NIWA
4.30pm	***The future of dairying in Selwyn-Waihora*** – Todd Muller, Fonterra
5.00pm	Drinks, nibbles & networking – *sponsored by Fonterra*

Day 2 – Wednesday November 16th, chaired by David Caygill, Environment Canterbury Commissioner

9.00am	***Recap of Day 1*** – Ken Hughey, Lincoln University & Ken Taylor, Environment Canterbury
9.15am	***Keynote address*** ***Lake restoration: Is there a successful model?*** David Hamilton, Bay of Plenty Regional Council Chair in Lake Restoration, University of Waikato
10.15am	Morning tea
10.45am	***The Canterbury Water Management Strategy regulatory framework*** – Peter Skelton, Environment Canterbury Commissioner
11.10am	**Water Conservation Order** - Craig Pauling and Jason Arnold, Te Rūnanga o Ngāi Tahu
11.20am	***Land Use and Water Quality*** – Ian Brown, Environment Canterbury
12.00pm	Lunch
1.00pm	***Future proofing through the CWMS*** – Brett Painter, Environment Canterbury ***CWMS Implementation Programmes (ZIPS & RIP): What have we learned so far?*** – Miria Goodwin and Peter Ramsden, Environment Canterbury
2.00pm	***Have your say on Water Management*** **-** Selwyn-Waihora Zone Committee present their draft Zone Implementation Programme.
4.00pm	***Summary of main themes emerging from both days*** – Bryan Jenkins, Waterways Centre for Freshwater Management
4.30pm	***Closing remarks, poroporoaki***

Please note, times may be subject to change

"Setting the Scene"

Clive Howard-Williams and Ned Norton

National Institute of Water and Atmospheric Research Ltd., Christchurch

Clive.Howard-Williams@niwa.co.nz and Ned.Norton@niwa.co.nz

The community will face some challenging decisions around Te Waihora/Lake Ellesmere in the very near future. With formation of the Selwyn Waihora Zone and associated Committee, preparation is under way for catchment and regional level plans that, over the next 12 months, set objectives for the Te Waihora catchment and associated limits to land and water resource use in the catchment. These plans will need to reflect the multiple targets of the Canterbury Water Management Strategy (CWMS), but identify where the attainable balance of these targets lies for the catchment.

Key outcomes from Living Lake 2 (2009) revisited:

1. The lake's complex catchment physiography, land use and issues with emphasis on the multiple values of the lake and the multiple factors that affect these values.
2. The 2010 water conservation order on timings of openings related to desired outcomes.
3. The lake's future being tied to more than just the lake level management regime. Riparian management, lake edge wetlands, and nutrient and sediment management are clearly necessary issues for attention.
4. Time lags in restoration and appreciation of the time-scales for restoration and change.

Key knowledge gaps for 2011 that we hope will be at least partly addressed here.

For improved predictions (models) of lake ecosystem state we need:

- Flow related nutrient loads (lake nutrient balance). How important are nutrients in the total picture of the healthy lake?
- Detailed water balance that improves salinity models and addresses spatial issues for nutrients and salinity.
- Influence of the lake opening regime on the lake's phytoplankton.
- Linked groundwater-surface water systems: Groundwater-fed tributaries: Values and what do we manage these for? Community decision making will be important.
- Macrophyte restoration techniques for a large lake.

Key management challenges for the next 12 months:

1. for scientists and other technical people will be to describe the possible future states, the multiple influences on state (e.g., water allocation and lake level regimes, land use, restoration initiatives and climate change), the way these interact, and the costs and trade-offs involved.
2. for planners will be to integrate the technical knowledge, inform and engage the community to help make informed choices, and to reflect decisions in measurable terms within planning documents.
3. for the community as a whole will be to make the tough choices, to accept decisions made and to work together to implement plans for the catchment once made. The uncertainties involved

mean that we are unlikely to get plans absolutely right first time, but we need to get it near to right, and then be prepared to monitor, review and adapt accordingly.

Land Use Change in Selwyn District

Andrew Mactier, Planner, Selwyn District Council, Andrew.Mactier@selwyn.govt.nz

Selwyn District is approximately 656,000 hectares in area and is bounded north and south by the mountain-fed Waimakariri and Rakaia rivers. The District comprises a diverse range of environments, from coastal beaches, alluvial plains, river terraces, rolling hill country to steeper high country and alpine areas. The District has a population of nearly 39,000 in 2011, which is anticipated to increase to over 63,000 by 2041. Most people live on the plains within a short drive of Christchurch. Only five percent live in the hills and mountains.

The Te Waihora/Lake Ellesmere catchment comprises some 275,000 hectares of the District. The population of the five main towns within the catchment in 2011 is approximately 16,000 and is expected to more than double to over 35,000 by 2041. Future urban development is being managed within a comprehensive strategic growth management framework which is designed to limit the further expansion of urban areas within clearly defined Metropolitan Urban Limits.

Most of Selwyn District's farmland is used for animal production, with the remainder being utilised for arable and grain crops, horticulture and production forestry. According to the Parliamentary Commissioner for the Environment (PCE, 2004, pp 42), the overall size of the arable sector (nationally) is shrinking and is becoming increasingly focused on providing silage for the dairy sector. The dominant trend nationally is away from traditional pasture based farming systems, instead moving towards farming systems that rely on inputs from outside the farm, utilising increased feed supplements from off farm (maize and cereal silage), irrigation and fertiliser (PCE, 2004, pp36). This national trend is also apparent within the wider Selwyn District and the Te Waihora/Lake Ellesmere catchment, although no data on rural land uses specific to the catchment is currently collected.

Since 1995, there has been an additional 31,000 hectares of productive agricultural land available within the District (from 394,580ha to 425,581ha). As a proportion of productive agricultural land, there has been a decrease in land used for pastoral uses since 1995 to 2007 from 78% to 70%, while land used for dairying in the same period has increased from 3% to 10%. Other than land used for Lifestyle purposes (increased from 5% to 8%) other land uses have remained relatively stable.

Since the mid-1990s through to 2007, there has been a fall in sheep numbers (from 1,466,769 to 954,373) and a rise in, beef cattle, deer, pigs and perhaps most significantly, dairy cows. Between 1990 and 2007 there was an increase in dairy cow numbers from 28,942 to 148,181.

Statistics New Zealand figures show that in 2002 there was over 60,000 hectares of land developed for irrigation within the District, with over 51,000 hectares of that land actually irrigated. Figures from 2007 show that the total area of the District equipped for irrigation stands at 84,450 hectares. The Central Plains Water Project proposes the operation of a large scale irrigation scheme for 60,000 hectares, with a net gain of 30,000 new irrigated hectares.

The Ngāi Tahu Customary Fisheries Protection Areas Project: Restoring Rangatiratanga (chieftainship/leadership)

Nigel Scott, Te Rūnanga o Ngāi Tahu, Nigel.Scott@ngaitahu.iwi.nz

Ngāi Tahu Whānui are a native tribe who reside in the South Island of New Zealand. This presentation will provide detail on a project that is being conducted by Toitū Te Whenua (the tribe's environmental policy and planning unit) to facilitate the establishment of a co-ordinated network of customary fishing protection areas ("CPA"), spread throughout their tribal domain. This project will ensure Ngāi Tahu maximise the effectiveness of CPA both individually and collectively, whilst minimising the impact on the commercial fishing sector.

The presentation will also outline how Ngāi Tahu have used this spatial planning to assist with the conservation and management of Te Waihora (Lake Ellesmere) with Tangata Tiaki/Kaitiaki (Customary Fisheries Managers) and the Management Board for Te Waihora.

Freshwater fish of Te Waihora – recruitment, important habitats, and changes in fish communities

Don Jellyman, National Institute of Water and Atmospheric Research Ltd, Christchurch, D.Jellyman@niwa.co.nz

The fish species of customary and commercial importance (eels, flatfish, mullet) are all migratory (diadromous) and recruits arrive from the sea during spring. The timing and duration of the opening is important to ensure adequate recruitment – recruitment failure in any one year is reflected in a very poor flatfish fishery two years afterwards, although the impact on eels is less dramatic. Important smaller fish (smelt, inanga and bullies), are normally diadromous, but lake-dwelling stocks have developed in Te Waihora, meaning recruitment of these species from the sea is beneficial but not essential.

Most species have an association with shallow water, especially adjacent to vegetated margins of the lake, although adult eels and flatfish are more widespread. Tributaries provide particularly important refuge areas for longfin eels. The fish community in the lake is dynamic – over the past few decades, brown trout have almost disappeared, bullies have flourished, while the abundance and species composition of flatfish is highly variable; commercial catches of shortfin eels have shown an increase in catch-per-unit-effort over recent years and growth rates are relatively rapid, indicative of a healthy eel stock. Despite periodic concerns about the wellbeing of the lake, fisheries production remains high.

Update of surface water hydrology in the Te Waihora/Lake Ellesmere Catchment

Dan Clark, Environment Canterbury, Daniel.Clark@ecan.govt.nz

The Te Waihora/Lake Ellesmere Catchment has recently been the focus of surface water modelling by Environment Canterbury. This has covered the lowland streams, hill slope catchments and the drying reaches of the Selwyn River/ Waikirikiri. The modelling of the lowland streams was focused on the Selwyn River, Harts Creek, L-2 River, Halswell River and the Irwell River. These five streams are distributed around the lake and contribute approximately three quarters of the mean surface flow to the lake.

The lowland streams that flow into Te Waihora/ Lake Ellesmere are spring fed and cumulative groundwater takes further up the catchment are having an effect on their baseflows. This cumulative baseflow reduction cannot be measured and has been modelled using the Williams (2011) Eigen model. This lumped model gives an indication of what the flows in the five indicator streams would be like if no abstraction was occurring within the catchment. The model gives a relative flow compared to the measured flow and not an absolute flow value due to the lumped nature of the model.

Eigen modelling "natural" flow statistics have been derived from Williams (2011) and when compared to recorded flows there is a reduction in flows in lowland streams due to groundwater abstraction in the Te Waihora/ Lake Ellesmere catchment.

As part of this work we modelled what the expected flows on lowland streams would be if all abstractors in the catchment used all of their allocated water, as it is estimated that on average only 40-50% of consented water is abstracted. This showed what the lowland streams and therefore lake inflow could look like with intensification of current practices.

From this work it is clear that cumulative groundwater takes have a large effect on lowland streams and these must be managed effectively to protect the flows in these and into the lake.

References

Clark, D., (2011) The surface water resource of the Lake Ellesmere/ Te Waihora catchment. Environment Canterbury technical report R11/26.

Williams, H.R., (2011) Modelling of groundwater levels and stream discharge in the Te Waihora/Lake Ellesmere Catchment. Elemental Geoconsulting Report No: ECMP-1.

Groundwater resource update and managed aquifer recharge

Howard Williams, Golder Associates (NZ) Ltd, hwilliams@golder.co.nz

Summary

The state of the groundwater resource quantity and quality, and how these have changed since 2009 is presented along with a critical assessment of the possibilities and issues associated with managed aquifer recharge.

Most of the water that enters the lake has at one time been travelling through the Central

Plains groundwater system. The health of the lake is a function of the health of the groundwater system that feeds water into it. The water resource within the lake catchment is a highly connected system of both groundwater and surface water. The resilience of the lake is expected to be largely dependent upon effective management of climatic and land use stresses (maintaining or increasing recharge in the face of over-allocation of the water resource; managing nitrogen). Managed aquifer recharge (MAR) is a tool to help achieve an effective response to both these two stresses.

Resource update:

- That groundwater levels are generally at average to above average levels, despite the dryish winter.
- Nitrogen concentrations have risen since 2009.
- Likely a long response time between cause and effect in the large aquifer system. Unclear as to how much of the monitored rise in nitrogen reflects recent, rather than historical land use change.

Managed aquifer recharge (MAR):

- Effective and economic in some countries since the 1960s;
- Potentially increase recharge over that naturally occurring by rainfall and alpine and Selwyn river seepage;
- Could be used to bolster groundwater levels and flows in groundwater-dependent streams;
- Providing 'clean' water is used, the nitrogen concentration in the groundwater system can be lowered, thereby lowering concentrations in the discharge;
- Modelling has shown that 10 m^3/s of water infiltrated in the upper parts of the catchment over five winter months can provide a measurable increase in flow in the spring-fed streams such that current breaches of the statutory minimum flows are avoided or mitigated.
- Infiltration ponds deliver the water to the groundwater system during the winter period providing water is available.

Conclusions

- That continued and more effective management of nitrogen use in the catchment is required if the observed rise in nitrogen levels towards the NZDWS MAV is to be halted.
- MAR has the potential to address both nitrogen and low stream flow issues.

Recommendations:

That MAR be investigated further, especially in light of the Lake Coleridge proposal.

Lake water quality trends and identifying opportunities to make significant improvements

Dr Adrian Meredith, Principal Water Quality Scientist, Environment Canterbury

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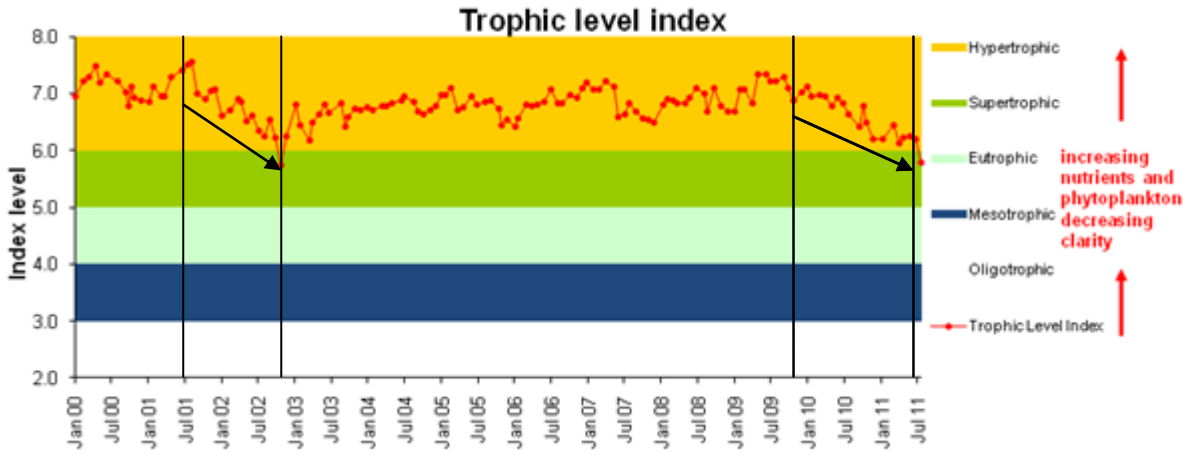
Te Waihora/Lake Ellesmere has been regularly monitored for almost 20 years and remains in a fairly stable though degraded state. The Trophic Level Index (TLI) combines a number of measurements to describe an overall lake nutrient enrichment state. This has remained in the HYPERTROPHIC (highest category) state, while plans strive to reduce this initially to the SUPERTROPHIC state, primarily through efforts to reduce nutrient inputs to the lake.

While there is no distinct change in state, over the past 11 years, there are two periods (2001/02 and 2010/11) when TLI consistently dropped over a year or more to plan target levels (Figure 1). These periods offer opportunities to examine conditions where lake processes were generating changes in the right direction. This paper examines inputs and processes over these times, and whether they offer clues that might assist smarter opportunities to achieve a better environmental outcome for Te Waihora/Lake Ellesmere.



Ecological flows for rivers in the Te Waihora/Lake Ellesmere catchment

Greg Burrell, Golder Associates (NZ) Limited

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The Canterbury Regional Council (CRC) is in the process of reviewing minimum flows set via consents at over 40 sites in the Te Waihora/Lake Ellesmere catchment. The flow review process involves looking at the flow regime and minimum flow requirements for a wide variety of values, including aquatic ecosystems, landscape/riverscape, aquatic plants, and cultural (Maori) values. Management of the entire water resource also includes balancing instream values (e.g., fish habitat) with out of stream water use requirements (e.g., for irrigation). This presentation focuses on work undertaken over the last two years assessing flow requirements for aquatic ecological values in the Te Waihora/Lake Ellesmere catchment.

In the upper catchment, key ecological values include a nationally significant and acutely threatened Canterbury mudfish population and a locally significant brown trout fishery in the Selwyn River catchment. Key ecological values in the lower catchment include a brown trout fishery, spawning and rearing habitat in a number of rivers, and significant eel fisheries in many rivers. Flow intermittency is a characteristic of the mid-reaches of the Selwyn River and the headwaters of lowland rivers. Intermittency is associated with poor water quality (especially higher temperatures and lower dissolved oxygen concentrations) and lower abundance and diversity of fish and invertebrate populations, but is also a feature of Canterbury mudfish habitats.

I reviewed the results of a number of previous minimum flow studies at individual sites to evaluate minimum flow requirements for rivers throughout the catchment. Minimum flow recommendations derived using both expert panel and habitat modelling approaches showed a close relationship with estimates of seven day mean annual low flow (MALF). Therefore, catchment-wide minimum flow recommendations were indexed to MALF. I recommended a higher proportion of MALF (at least 90 %) as a minimum flow for smaller streams (MALF <300 L/s) and hill-fed streams (e.g., Selwyn and Hawkins Rivers), that are ecologically-sensitive to reduced flow. Similarly, I recommended at least 90 % of MALF for the Hororata River minimum flow site, to protect nationally significant Canterbury mudfish populations. Minimum flows of at least 70 % of MALF were recommended for other lowland streams with higher flows (MALF>300L/s).

My review indicated that existing minimum flows are lower than those derived using three different methods; an expert panel approach, instream habitat modelling, and the interim National Environmental Standards (NES) for ecological flows. Furthermore, hydrological modelling indicates that current rates of water abstraction from the catchment are responsible for lower flows overall and increased frequency of river drying compared to historic, pre-abstraction levels. Models developed as part of the Selwyn River research programme indicate that water abstraction and increased river drying is associated with reduced abundance and diversity of fish and invertebrate communities. Modelling indicates that increasing flows in the Selwyn River catchment and in lowland streams would improve overall fish abundance and aquatic biodiversity values, provided flow increases occur alongside initiatives to improve habitat and water quality.

Waihora Ellesmere Catchment Riparian Restoration Programme

Stephen Brailsford, WET Restoration Consultant, s.brailsford@xtra.co.nz

Key facts:

- 50,000 seedlings were installed into over 20 riparian sites throughout the catchment during 2009 and 2010.
- Wherever possible we used public land with good visibility and access.
- 4 different contractors, using different restoration techniques, were employed.

This has enabled WET to identify the components of an effective and efficient restoration system.

Our riparian landscape is dominated by practices that satisfy the need for land drainage but little else. As these installations further develop they are becoming part of the visual landscape and add to people's perception of what is possible - effectively they are working billboards within the productive landscape. These sites have considerable demonstration and educational value for encouraging and accelerating good management practices.

Building on this experience, WET and partners are now focusing on the drainage network with a new project, Sustainable Drain Management in Selwyn-Waihora - *healthy waterways within productive land.*

Creating a green pathway across the Canterbury Plains

Brooke Turner, Coordinator Te Ara Kākāriki – Greenway Canterbury Trust
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The amount of remaining native vegetation in Canterbury is one of the lowest in New Zealand. Less than 1% of the original vegetation remains and the majority of the region is classified as either 'acutely threatened' and 'at risk' or 'critically under-protected' (Walker, et al., 2006). In the Selwyn District the situation is even more critical where less than 0.5% of the native vegetation remains (Meurk, pers. comm.). Te Ara Kākāriki - Greenway Canterbury Trust's focus is enhancing and creating native plant communities in dryland areas, to create a greenway of native habitat, also referred to as Greendots.

The Greendot Project is a landscape scale project. The vision is to build stepping stones across the Canterbury Plains from the mountains to the sea linking the foothills and mountains to the coast and Banks Peninsula. This is to create refugia for native organisms and restore or enhance ecosystem processes, such as bird disperser migration, seed dispersal and spontaneous establishment of habitat patches linking the stepping stones.

A major objective of the Trust is to work with custodians of both public and private land, to encourage and provide assistance for both the protection of existing indigenous vegetation, as well as the establishment of new areas of biodiversity plantings.

In 2011 TAK initiated a 'Canterbury Plantout weekend' in collaboration with key partners WET, Selwyn District Council, Ngai Tahu, Environment Canterbury, Conservation Volunteers and Department of Conservation. Our first weekend in September 2010 saw 380 people attend and plant 4000 trees. The collaborative 'Plantout' weekend enables a united approach to enhancing and restoring the Canterbury Plains, while enabling partners to work together to provide knowledge, experience, and a social event to attendees.

Te Ara Kākāriki has captured people's imagination and the requests to be part of the network have been growing. TAK planted out five Greendots in September 2009, nine Greendots in September 2010, and ten greendots in 2011. More and more people have been enquiring about how they can contribute to the aims of the Trust and add their Greendot to the landscape.

Ngāi Tahu Te Waihora restoration activities

Andrew Spanton, Ngāi Tahu, Andrew.Spanton@ngaitahu.iwi.nz

Te Waihora is a tribally significant taonga to Ngāi Tahu. Over the last four years Ngāi Tahu has undertaken a number of restoration actions at sites around the lake for a variety of cultural and ecological objectives. Species have been deliberately planted for mahinga kai, such as timber, birds, shelter, and to return indigenous plants that have been absent to the area. Accordingly biodiversity has increased.

Restoration efforts can improve access by enhancing lake environ experience, repressing

invasive weeds such as marram and willow and bringing a site closer to its original condition. They form part of an overall Te Waihora cultural and environmental improvement package that aims to alleviate an array of issues and enhance a variety of values.

Monitoring and enhancing ecosystem services at Te Waihora/Lake Ellesmere

Steve Wratten, Bio-Protection Research Centre, Lincoln University
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The international importance of Te Waihora/Lake Ellesmere is belied by its gross mis-treatment, especially in terms of pollution and the dominance of non-native vegetation around its borders. Recent and continuing pioneering work to restore some of the original vegetation around the lake is demonstrating clear successes but such work assumes that ecosystem functions are improved as a consequence of re-creating these native plant communities.

When mankind ascribes values to these functions, usually monetary ones, we then call these ecosystem services (ES). There is a sore need to conduct research on monitoring the nature and extent of the ES enhanced by these plantings. Doing this would provide added value other than the aesthetics which they certainly deliver. Scientific monitoring is also required of some of the key fauna associated with the lake. Although amateurs regularly count wading birds, virtually nothing is known about their invertebrate food supplies and how these change with increasing mis-use of the lake. These needs are explored in more detail in this presentation.

Whakaora Te Waihora

Donna Woodley, Environment Canterbury, Donna.Woodley@ecan.govt.nz
Jason Arnold, Te Rūnanga o Ngāi Tahu, Jason.Arnold@ngaitahu.iwi.nz

Whakaora Te Waihora is a cultural and ecological accelerated ecosystem restoration programme for Te Waihora being developed by Ngāi Tahu and Environment Canterbury, with funding support from both those parties and central government through the Ministry for the Environment.

A detailed project plan for the first two years is under development. A range of other stakeholders will also be involved in the implementation of the plan.

An Overview of Recent University Research on Te Waihora/Lake Ellesmere and its Catchment

Jenny Webster-Brown

Waterways Centre for Freshwater Management, University of Canterbury and Lincoln University.

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Over recent years both Lincoln and Canterbury universities have undertaken a significant body of research on Te Waihora/ Lake Ellesmere, its tributaries and neighbouring lakes systems (e.g., Lake Forsyth/Wairewa). This research has largely been undertaken by postgraduate students, under the supervision of academic staff involved in various aspects of water systems research, and who now form the Waterway Centre for Freshwater Management; a research and teaching centre jointly supported by both universities.

Because of the focussed nature of postgraduate research projects, much has been achieved that is of direct relevance to lake restoration and management, and specifically to achieving connectivity and resilience at a catchment scale. However, because of the transient nature of these students, with thesis research being completed in 12-16 months in most cases, there is often limited opportunity to adequately publicise the findings of this research. A review of recent university research of relevance to Te Waihora/ Lake Ellesmere is therefore presented here, under the headings of; contamination and remediation, ecology, lake history, hydrology, management and water quality. The presentation has been compiled from information provided by academic staff, and from theses and documents lodged within the respective academic systems. Key projects under each of these topic areas include;

- Trace element contamination of lake sediments, and immobilisation of contaminants and nutrients from farmland through planting native species
- Food web dynamics in the lake, predator-prey relationships and their relationship to lake conditions
- Tributary nutrient status and riparian management, and how this is reflected in algal growth and invertebrate health
- Historical evolution of the lake and its trophic state as revealed by sediment cores, and of Kaitorete spit, the barrier between the lake and the sea, as well as archaeology of land-based activities in the immediate catchment
- The feasibility of a permanent opening for the lake
- How riparian planting activities have spread through the catchment and their efficacy
- Investigations of the interface between the Ellesmere community and stakeholders, and the lake environment
- Development of the PLOVER model, and computer programmes for rural drain management decision making, and for visualising future lake conditions to support public consultation
- Diurnal fluctuations in water quality parameters in the lake, and nitrogen gas flux from tributary streams in the context of global warming

Finally, key proposed university research and initiatives will be briefly described.

Modelling the water balance of Te Waihora for the National Water Conservation Order amendments

Graeme A. Horrell

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Ngāi Tahu and the Department of Conservation have been successful with amending the National Water Conservation Order (WCO) for Te Waihora (Lake Ellesmere) to better protect and enhance the mahinga kai of the lake. In particular, they propose changing the lake opening schedule so as to improve the opportunity for indigenous fish passage to aid recruitment and migration.

To test the effect of the proposal a 38 year daily time step water balance model was developed and run for three scenarios:

"Actual" – what actually happened in the last 38 years.

"Spring only 0.9" – the previous WCO opening opportunity between 15 September and 15 October at a lake height of 0.9m m.s.l with the normal summer trigger level of 1.05 m.s.l (1 August – 31 March) and winter trigger level of 1.13 m.s.l (1 April – 31 July).

"WCO amendments" – a spring recruitment opening opportunity between 15 September and 15 October at a lake height of 0.9m m.s.l, and autumn migration opportunity between 1 April and 15 June at a lake height of 0.9m m.s.l, with the normal summer trigger level 1.05 m.s.l (1 August – 31 March) and winter trigger level of 1.13 m.s.l (1 April – 31 July).

The modelling results displayed a 70% increase in the number of years with autumn and spring lake openings. This will improve fish migration and recruitment.

The modelling also displayed reduced periods of low lake level in summer which will assist in protecting the lake edge wetland habitat for migratory birds.

Scenario	Years with openings between 1 April and 15 June	Years with openings between 15 Sept and 15 Oct
Actual	18	13
Spring only 0.9 m	16	26
WCO amendments	30 70% increase	22 70% increase

Table 1: Number of years when autumn and spring openings would occur over a 38 year period.

Canterbury Lysimeter Network Project

Maurice Duncan and MS Srinivasan

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Aim

To quantify the contribution from irrigated agriculture to groundwater in Canterbury. This project is an initiative of Environment Canterbury. The project partners are Environment Canbterbury, NIWA, Aqualinc, HydroServices and the farmers who provide sites.

Methods

Sets of three drainage lysimeters 700 mm deep and 500 mm in diameter are installed on three dairy farms near Methven, Dorie, West Eyreton and on a cropping farm at Wakanui. More sites are planned. The drainage from each lysimeter is measured with a tipping bucket rain gauge. Each lysimeter has a neutron probe access tube for the measurement of soil moisture. One lysimeter at each site has three electronic soil moisture sensors with each in a different soil horizon. Each site has a tipping bucket rain gauge to measure rainfall and irrigation and an associated meteorological station with a rain gauge measuring only rainfall. Both lysimeter and meteorological site data are telemetered. One dairy farm and the cropping farm each have an eddy correlation tower for the direct measurement of water (evapotranspiration) and carbon dioxide (CO_2) flux. Thus, at these two sites evapotranspiration can be calculated by water balance and eddy correlation and potential evapotranspiration (PE) can be estimated from meteorological parameters.

Results

Two dairy farm sites (Methven and Dorie) have been operating since July 2010. Results show most of the ground water contribution takes place in the winter and early spring, i.e., outside of the irrigation season. However, some ground water contribution occurred in summer after heavy rain.

The soil moisture levels showed that the pasture was well watered and so was likely to have been transpiring at potential rates. During summer, the eddy correlation evaporation (data available from February 2011) showed a better correlation with Priestly-Taylor (P-T) calculations of PE and back-calculated evaporation from the water balance than from Penman PE estimates. However, during winter, Penman PE seems to more accurately reflect eddy correlation measurements of evaporation and P-T estimates appear to under-estimate PE.

After the August snow storm and the October 16-19 rain event, 91 mm and 16 mm of recharge were recorded respectively by the lysimeters at Wakanui (cropping farm). Recharge events of this type are absolutely essential for supplying groundwater for irrigation and spring-fed streams such as those entering Te Waihora. If this amount of recharge occurred over the area bounded by the foothills at Glentunnel, the Waimakariri and Rakaia Rivers and the sea, there would have been 206 million cubic meters of recharge, or sufficient storage to maintain a mean flow of 6.5 m^3s^{-1} to Te Waihora for a whole year.

Conclusion

Four lysimeter sites have been instrumented and these preliminary results show that they are providing credible measurements of groundwater recharge and evaporation that provide useful insights to the contribution of irrigated agriculture to groundwater recharge.

The Selwyn River/Waikirikiri

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A multidisciplinary study of the Selwyn River/Waikirikiri has been underway since 2003. The objectives of this research are to expand our knowledge of flow-dependent ecological processes, quantify flow-ecology relationships, and provide information and tools needed for sustainable water allocation.

The Selwyn River/Waikirikiri is a remarkably complex river, with strong surface water-groundwater interactions, abutting ephemeral, intermittent, and perennial reaches, and dynamic patterns of flow loss and gain, connection and disconnection, and groundwater versus runoff dominance. One of our first tasks was to develop a tool for predicting flow at any point on the river and visualising spatial and temporal flow variability. That tool is ELFMOD (Empirical Longitudinal Flow Model), a statistical model that combines hydrometric station and spot gauging records, and other datasets to produce flow time series at multiple locations along a river. ELFMOD provided the hydrological variables for quantifying flow-ecology relationships, and for assessing flow variability in other rivers in New Zealand and overseas.

Our hydrological research has also identified several temporal trends in river flow, and has produced modelling methods for predicting groundwater input to rivers.

A wide range of flow-ecology relationships have been explored during the study. We have quantified the effect of flow variation on the abundance and diversity of fish communities, benthic and hyporheic invertebrate communities, nutrient retention, invertebrate life-histories, predator behaviour, periphyton growth, organic matter dynamics, and water quality.

The hydrological variables with the greatest influence on ecological processes and water quality are long-term flow permanence (the proportion of time that the river is flowing at a site), flow duration prior to sampling, and water source (runoff or groundwater).

Runoff-derived river water in the upper reaches is nutrient-poor compared with aquifer-derived water in the lower reaches. These differences affect periphyton growth and composition. We can use quantitative flow-ecology relationships to predict the ecological effects of changes in flow permanence and flow duration. Flow intermittence appears to be increasing in severity in the Selwyn River/Waikirikiri, and we predict that these changes will cause reductions in fish and invertebrate diversity and abundance in the affected reaches.

Flow intermittence and groundwater-river interactions are looming challenges for river management in New Zealand, and the Selwyn River/Waikirikiri can serve as a benchmark system to aid management.

The future of dairying in Selwyn-Waihora –

Todd Muller, manager, Local Government and Regional Relations, Fonterra

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The dairy sector is a significant contributor to the economic, social, cultural and environmental character and distinctiveness of the Selwyn-Waihora catchment. Our farmers are and have been a key part of the fabric of the local community for generations and are profoundly impacted by their relationship with the land and motivated to pass on an improved environment to their children.

Dairy farming today is significantly different from dairy farming even 10 years ago. Farmers monitor the welfare of their animals closely, are investing heavily in modern effluent management infrastructure, document their fertiliser inputs and can model with, increasing accuracy, the potential environmental impact of their farm. However, farmers understand that today's activities will also need to change in the future as all land users respond to the community requirements for water quality and biodiversity.

This presentation will outline the dairy sector journey to date in Selwyn-Waihora and what tomorrow could look like.

Notes

Keynote speaker – David Hamilton

The keynote address for Living Lake, Changing Catchment: 2011 Te Waihora/Lake Ellesmere integrated catchment symposium will be given by Professor David Hamilton, Bay of Plenty Regional Council Chair in Lake Restoration, University of Waikato.

David obtained his Ph.D. degree from the University of Otago with a study that examined water quality in ten coastal lakes on the east coast of the South Island including Lake Ellesmere/Te Waihora. Following his Ph.D., he became a Research Associate at the Centre for Water Research, University of Western Australia (1991-93), and was then appointed to lecturer and senior lecturer in the Department of Environmental Engineering at the University of Western Australia.

In 2002 David returned to New Zealand for a position as the inaugural Bay of Plenty Regional Council Chair in Lake Restoration at Waikato University. In this role he undertakes extensive duties for the Bay of Plenty Regional Council, assisting with its regional environmental policy development, applied lake issues and council and environment court hearings. Hamilton is also the Chief Science Officer of an Outcome Based Investment from the Ministry of Science and Innovation in Lake Biodiversity Restoration.

He has published more than 110 per-reviewed scientific papers, was the original author of the model CAEDYM, which is now used in more than 70 countries around world for predictions of lake water quality, holds editorial board positions with five international journals, and was a founding member of the Global Lake Ecological Observatory Network (GLEON; www.gleon.org). David was the recipient of the 2010 New Zealand Freshwater Sciences Society Medal in recognition of outstanding contributions to freshwater science, was 'Outstanding Reviewer' in 2010 for *Estuaries and Coasts,* held an Adjunct Professor position at the College of Resources and Environment, Huazhong Agricultural University Wuhan, P.R. China (2005-10), and received a University of Waikato Staff Merit Award in 2005 as part of the Lake Restoration team.

David is the current elected President of the New Zealand Freshwater Sciences Society, invited member of the Queensland International Expert Panel reporting to the Queensland State Government on water recycling, and has been active in China, working with colleagues there in addressing their significant lake water quality issues.

Lake restoration: Is there a successful model?

David Hamilton

Bay of Plenty Regional Council Chair in Lake Restoration, University of Waikato

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A simple question may be asked "what are the elements of a successful lake restoration programme?" The answer is infinitely more complex and there are few general models for success.

The reasons for this complexity are numerous but may include:
(1) overly simplistic cause-and-effect assumptions about the way in which lake ecosystems operate,
(2) lack of integration of lake science with policy and management,
(3) failure to adequately monitor the impacts of restoration actions, and
(4) challenges associated with a scientifically well-known hysteresis response in which the degraded ecosystem has significantly reduced resilience compared with the natural one.

With regard to the last point, often lake restoration programmes are only initiated once lake ecosystems have undergone regime shifts to states that may be quite resistant to only modest changes in management practices. A consistent theme of almost all successful programmes (often denoted by what is termed "re-oligotrophication") has been ability to exert controls upon, and to effectively reduce, catchment nutrient loads.

Another common theme has been leadership that has effectively utilised inter-disciplinary science to effect policies and regulations that provide a level of certainty for management actions.

Whilst there is no "right" model, it is useful to examine case studies. I focus upon the Rotorua lakes as a case study of lake restoration and examine elements of it that may be considered to be successful. The science has been integrated through utilisation of expertise that is dispersed amongst universities and Crown Research Institutes, and has been united through a scientific Technical Advisory Group that includes relevant local and regional management authorities and iwi. Process-based modelling has also been important in assisting with this integrated scientific approach. It has provided quantitative targets and increased levels of certainty for water quality outcomes associated with different lake management and restoration scenarios. Effective translation of scientific outcomes into plans and policies is facilitated through communication and ownership of science – not only by scientists – but also by management authorities, iwi and community-based organisations that have been a powerful force in driving improved practices. Ultimately, a lake restoration programme must align all of these facets to be successful.

The Canterbury Water Management Strategy regulatory framework

Peter Skelton, Environment Canterbury Commissioner
Email c/o Robyn.Pay@ecan.govt.nz

The Canterbury Water Management Strategy is being implemented by Environment Canterbury and territorial authorities working with community-led committees.

The Strategy is a non-statutory process developed over a number of years in a wide-ranging collaborative process.

The over-arching statutory framework – under which the CWMS is being implemented – includes the Local Government Act, the Resource Management Act, and the Environment Canterbury Act.

The Environment Canterbury Act gave statutory weight to the Strategy by recognising its vision and fundamental principles. The Environment Canterbury Act also includes special provisions to allow moratoria on consents as well as an amended process for Water Conservation Orders. The Ellesmere (Te Waihora) Water Conservation Order is being amended under the Environment Canterbury Act.

Environment Canterbury is responsible for the planning framework for water in Canterbury, which includes the Regional Policy Statement, the Natural Resources Regional Plan, as well as sub-regional plans for rivers or catchments.

The Canterbury Water Management Strategy committees have been set up to operate as council committees under the Local Government Act. Their job is to develop recommendations for water management taking into account community needs and desires. The committee recommendations must also align with the broad set of agreed goals (known as the targets) for water management.

The committees have a very active role in building community engagement and discussion around water issues, leading to a set of recommendations. These recommendations – once received by councils – are given effect and statutory weight in regional and district plans.

National Water Conservation (Te Waihora/Lake Ellesmere) Order 1990

Craig Pauling and **Jason Arnold**, Te Rūnanga o Ngāi Tahu
Craig.Pauling@ngaitahu.iwi.nz and Jason.Arnold@ngaitahu.iwi.nz

A Ngāi Tahu perspective on the Water Conservation Order and the recent amendments.

Land use and water quality – the Hurunui experience

Ian Brown, Environment Canterbury, Ian.Brown@ecan.govt.nz

There is increasing evidence that parts of Canterbury's freshwater resources are at, or over, their capacity to assimilate nutrients and that some values are becoming degraded. It is also clear that the mix of regulatory and voluntary approaches currently being used to manage diffuse discharges has not worked as well as it could. In some other regions, addressing the problem has become highly adversarial and it is evident that a different approach is needed.

Addressing the water quality issue in Canterbury provides both a challenge and an opportunity for the Canterbury community. The challenge lies in developing effective solutions to address the issue and to minimise or avoid further decline in water quality. The opportunity lies in the possibilities of an integrated management approach that sees improvements not only in the sustainable management of the region's water resources but also facilitates improved economic, social and cultural outcomes.

As signalled through the Canterbury Water Management Strategy (CWMS), a paradigm shift in the way water is managed is required. There is significant capacity for further land use development within the region but it will require existing land users and new water users to improve the way they use water and manage diffuse discharges to water.

The Land Use Water Quality project ("the LUWQ Project") was initiated by Environment Canterbury as a collaborative initiative with Ngāi Tahu, the primary sector, and other key stakeholders to consider approaches for managing the cumulative effects of nutrient enrichment in Canterbury in a manner consistent with the CWMS.

The outcome of the LUWQ project is a 'preferred approach' for managing the cumulative effects of land use on water quality in Canterbury. That approach developed is based on a pilot process of data collection and analysis and stakeholder and community engagement carried out for the Hurunui catchment.

At the heart of the preferred approach is the setting of catchment load limits and a process for managing to these limits. The approach for setting limits includes establishing the priority outcomes for the catchment based upon the values that people and the community hold for freshwater. The process includes technical work spanning the four well-beings; environmental, social, cultural and economic, to inform the discussions on limit setting.

Once limits have been set the key issue is managing to these limits at the Zone, catchment and farm level. The fundamental aspect of the preferred approach is to empower those responsible for, or who benefit from, land use effects on water quality and quantity within a catchment to develop their own catchment-specific and property-specific means to deliver on the agreed management objectives.

Overall, the approach is best described as a *collaborative self management approach* whereby industry and other stakeholders work within an agreed regulatory framework to achieve the desired outcomes.

A number of lessons have been learnt from the Hurunui project. The presentation will expand on these and also touch on some of the implications for other areas within the Canterbury region.

Future proofing through the CWMS

Brett Painter

Project Leader – CWMS Assessments & Evaluations, Environment Canterbury

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The origins of the Canterbury Water Management Strategy (CWMS) can be traced back to the late 1990s when a second severe drought in a decade shook the environmental, cultural, social and economic fabric of Canterbury. Estimation of current and future water balances and the hydrological feasibility of water storage options were the early focus of future proofing investigations. Environmental, social, cultural and economic analysis of these options by multiple stakeholder groups followed, highlighting the wide range of priorities necessary to future proof the region in a changing world. These priorities were built into the vision and principles of the CWMS, which decision-makers must now have particular regard to through the Environment Canterbury (Temporary Commissioners and Improved Water Management) Act 2010.

Implementing the CWMS requires that we continually improve understanding of our water related systems, and potential human and natural impacts on these systems. Canterbury is not alone in this quest, and there has been significant recent progress in the international as well as local communities that can assist our decision makers. Key points for Canterbury include:

- Integrated water and nutrient management at source is essential. Riparian management & lake edge/level/nutrient management can assist.
- Efficient water management requires a high reliability of water supply.
- Run-of-river and groundwater supply will most likely become less reliable during many future summers. In-stream and coastal processes are also vulnerable to forecasted summer conditions.
- Affordable but acceptable off line storage and re-distribution of surface water and groundwater allocations may be required to deliver CWMS targets.
- Some lower catchment drinking water may need to be taken from the deeper aquifers.

CWMS Implementation Programmes (ZIPS & RIP):What have we learned so far?

Miria Goodwin, Programme Advisor, water & land, and

Peter Ramsden, Tangata Whenua Facilitator

Environment Canterbury, Miria.Goodwin@ecan.govt.nz and Peter.Ramsden@ecan.govt.nz

The Canterbury Water Management Strategy (CWMS) has been developed over the past six years as a partnership between Canterbury's ten territorial authorities, the Canterbury Regional Council, and Ngāi Tahu as well as key environmental and industry stakeholders. The desired outcome of the CWMS is *"To enable present and future generations to gain the greatest social, economic, recreational and cultural benefits from our water resources within an environmentally sustainable framework".*

Across Canterbury, the ten zone committees and one regional committee are developing their Zone Implementation Programmes (ZIPS) and the Regional Implementation Programme (RIP). The ZIPs and RIP recommend actions and approaches for integrated water management solutions to achieve the CWMS principles, targets and goals.

This presentation provides information on progress to date, including emerging trends in ZIPs and the RIP, and how the CWMS committees, through their ZIPs, are dealing with decision-making on difficult issues.

Using anecdotes from some of the people involved in the process, we discuss what has been achieved through the process of writing the ZIPs and RIP – how are the CWMS committees prioritising issues for their zone? How is the CWMS process going for rūnanga? What kinds of actions are committees recommending? How well are committees interacting with stakeholders and with their communities?

We finish our presentation with a few 'stories' – practical examples from around the region that have emerged through the CWMS process

Have your say on water management

Selwyn-Waihora Zone Committee

The Canterbury Water Selwyn-Waihora Zone Committee has released its Draft Zone Implementation Programme (ZIP) for public feedback. The draft ZIP recommends actions, responsibilities and time-frames for activities to help achieve the principles, targets and goals set out in the Canterbury Water Management Strategy (CWMS).

The draft Selwyn-Waihora ZIP includes recommendations on four key priority areas; Te Waihora and the lowlands, biodiversity, water supply, as well as voluntary approaches to water and nutrient management.

Copies of the draft Selwyn-Waihora ZIP will be available at the workshop and community members have until 18 November to provide their feedback. The draft ZIP is also available from http://ecan.govt.nz/publications/General/cw-draft-selwyn-waihora-zip.pdf

Visit www.wet.org.nz after the symposium to find further information and copies of the presentations that have been shown over the two days.

Field Trip – Saturday, November 19th

Following on from the symposium and beginning at Lincoln University, a half day field trip from 1 – 5.30pm will provide a chance to visit the lake and part of the catchment by bus. There will be a number of experts on hand to tell us about the challenges and opportunities. Drinks and nibbles will be provided on our return to Lincoln.

Thanks to our sponsors, and to Canterbury Community Trust and Selwyn District Council in particular, for allowing us to keep costs to a minimum. Numbers are very limited, but if you would like to come and have not yet booked your seat, please let us know as soon as possible.

The organising team for Living Lake Changing Catchment: 2011 Te Waihora integrated catchment symposium:

Ken Hughey, WET/ Lincoln University
Ken Taylor, Environment Canterbury
Adrienne Lomax, WET
Brett Painter, WET
Hamish Rennie, WET/Lincoln University
Jason Arnold, Ngāi Tahu
Nic Newman, Environment Canterbury
Kate Lewis, Environment Canterbury
Alison Bower, WET

A huge thank you to the local companies who have supported this event with donations or special deals – just a taste of what Selwyn-Waihora has to offer!

Hazelnut Company
Sandihurst Winery
Lake Forsyth Winery
Straight 8 Estate
Creatively Canterbury
A Cracker of a Nut
The Store at Tai Tapu
Brentwood Wines
Kaituna Valley Winery
Gruff Junction
Gateaux Ciel
Lone Goat winery

The next Living Lake symposium is planned for November 2013. Hope to see you there!

Living Lake, Changing Catchment: 2011 Te Waihora/Lake Ellesmere integrated catchment symposium

Evaluation

Please complete evaluation, tear out, and place in the box on the registration desk in the foyer.

Which day(s) did you attend (please circle)? Tuesday Wednesday

Nov 15 Nov 16

Quick questions – please use the scale 1 – 5 to tell us your thoughts

	Poor excellent				
How was the pre-conference information?	**1**	**2**	**3**	**4**	**5**
The venue?	**1**	**2**	**3**	**4**	**5**
The catering?	**1**	**2**	**3**	**4**	**5**
The mix of topics covered?	**1**	**2**	**3**	**4**	**5**
The length of the presentations?	**1**	**2**	**3**	**4**	**5**
Time available for networking?	**1**	**2**	**3**	**4**	**5**
The symposium in general?	**1**	**2**	**3**	**4**	**5**

Do you have a better understanding of the current state of the lake and catchment? **yes / no**

Do you have a better understanding of how the lake and catchment are being managed/will be managed in future? **yes / no**

Tell us something new you learned….

What would you have liked more time on?

If you attended on Wednesday, how valuable did you find having a public feedback session incorporated into the symposium?

The next Living Lake symposium will be in 2013 – any comments on what the themes should be?

Any general comments or suggestions for how we can make the next symposium better?

Please complete and place in the box on registration desk before you leave, or return to Adrienne Lomax, WET, PO Box 198 Tai Tapu, 7645, email manager@wet.org.nz