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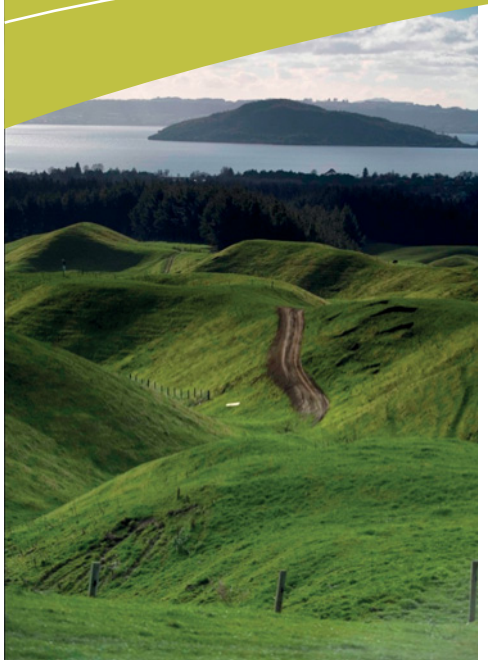


this issue

The theme of the first LWQS scientific symposium in 2001 was *"Research Needs for the Rotorua Lakes"*. This provided impetus for the establishment of the *BOP Regional Council Chair in Lakes Management and Restoration* from which much of the quality science which underpins the Rotorua Lakes Restoration Programme has originated. Our 2011 symposium *"Fix a Lake and Grow a City"* encouraged a focus on economic development and was instrumental in the establishment of *Grow Rotorua*, a Council Controlled Organisation mandated to guide economic development for the Rotorua District. Throughout the latter part of 2011 LWQS also signed an MOU *(the Waiora Agreement)* with the Lake Rotorua Primary Producers Collective to work collaboratively to influence policy and implementation surrounding land management and land use change in the Lake Rotorua catchment. This has resulted in the establishment of a Stakeholder Advisory Group (StAG) of 12-15 appointees to work with the Lakes Strategy Group partners on water quality and land use policy for the decades ahead. LWQS has two appointees on this group, so is well positioned to continue effective water quality advocacy into the future. *John Green, LWQS Chair*

Water Quality and TDRs

The Rotorua District Council is proposing as part of the draft District Plan, notified 31 October, to introduce Transferable Development Rights (TDR's) to complement other initiatives by the Rotorua Lakes Strategy Group and BOP Regional Council to encourage the reduction of nutrient leaching from rural land.

What are Transferable Development Rights? TDRs encourage landowners to make a change to the use of their land that results in a reduction of nutrients entering waterways. This particularly applies to Nitrogen. It is intended that this may lead to new land uses that have less impact on water quality.

How does it work? If a landowner can demonstrate that a proposed change to their land will reduce nutrient losses beyond a 500kg minimum benchmark, then a TDR may be granted by the Rotorua District Council and registered to the property title. The N equivalence of each TDR has yet to be decided, but it is proposed that each TDR will create an opportunity for one extra subdivided lot, allowing a higher density development than would normally be approved in a rural area.

MyLand – a new web-based tool to support land use decision making

Crown Research Institute Scion is working with key agricultural partners to develop a tool called *MyLand* which will help farmers and growers make good long-term decisions about their land use.

MyLand, which is at the working prototype stage, integrates many new technologies, research results and land resource information, and makes these available on a home computer.

MyLand will enable land managers to weigh up long-term economic and environmental considerations as they look at different land use options. These could include combining hill country sheep farming with forest woodlots, or stream-side planting on dairy farms.

The software project has received backing from several organisations keen to support farmers to explore sustainable land options, particularly in areas where soil erosion and water quality are causing problems.

Project leader Graham West says *MyLand* offers a good fit with regional sustainable land-use initiatives.

"Sustainable land use often means making long-term changes. Land managers need to think about how different objectives and goals can be analysed and how the transition can be afforded," he explains.

Land-use change has practical and often economic implications. The geographical database underpinning *MyLand* is powerful in providing land resource information and visualising different scenarios." *MyLand* overcomes many past hurdles by integrating results from research into land capability, environmental impacts, agricultural systems and forestry options. It also enables a user to consider multiple land uses down to a paddock level. It is a framework that could be extended to any combination of land-use options.

Graham says the tool is designed to be used by landowners or their advisors, to easily evaluate the trade-offs between profitability and environmental impacts. An industry steering group has been important in guiding *MyLand* development over the past three years.

"Land owners will be able to view high-quality aerial photos of their property, establish paddock sizes and resources such as soil type, input estimates of their production and explore scenarios for more sustainable land uses," he explains.

"The agricultural sector already has access to many tools that support short term operational farming decisions, but this is the first system that can be used to make long term, inter-generational decisions that include forestry options." *Ref : www.scionresearch.com*

Destratification

Grant Tempero, University of Waikato

Lake Rotoehu is a eutrophic lake located in a mixed forestry and agriculture catchment. It is a warm polymictic lake with a surface area of 8 km2 and a mean depth of 8 m. The 3-year average Trophic Level Index (TLI) for Lake Rotoehu has been above 4.5 since the early 1990s. The TLI target for the lake is 3.9 according to the Bay of Plenty Regional Council Regional Water and Land Plan. As part of the Lake Rotoehu Action Plan, formulated in 2007, two destratification devices were installed in Lake Rotoehu in July 2012. The purpose of these devices is to entrain water from deeper waters and lift it to the surface, thereby mixing the water column and preventing deoxygenation of bottom waters and the associated nutrient releases.

While artificial de-stratification is a well-known lake restoration technique in the northern hemisphere, in New Zealand this method has not been attempted on the scale of Lake Rotoehu. A comprehensive monitoring programme was implemented in December 2011 to assess the effects of the de-stratification devices on the lake's ecology and nutrient chemistry. Monitoring included monthly sampling of several water quality variables at various point locations within the lake and also continuously across the lake, as well as high frequency data from one central location.

Lake Rotoehu Aeration Trials

The regional council is trialling a new method to reduce the impact of nutrients that settle on the lakebeds.

Over the course of a year changing water temperatures within the lake and a lack of oxygen in the deep waters can cause nutrients on the lakebed to release back into the lake. This can contribute to algal blooms. A method of aeration is being trialled to mix-up the lake waters to prevent the release of lakebed nutrients.

This technique, adapted for specific local conditions, uses large air pumps to push air into the lower levels of the lake to mix up the water. This helps stop the release of nutrients from the lakebed. Trials on Lake Rotoehu are being undertaken to assess how this innovative intervention can be used in Lake Rotorua.

The trial will test for flow, velocity and distribution. This will have no effect on lake water quality but will provide the information needed to upgrade the hydrodynamic lake model which the University of Waikato is running. The trial work to test the impact upon destratification of the lake will take place over the summer of 2012/13; weather conditions over that period will influence whether further assessment will be required.

The next step will be to test the application of this technique on Lake Rotorua itself.

Weed Harvesting

Lake Rotoehu's water quality continues to improve with no algal blooms over the last three summers.

A large factor in the improved water quality is weed harvesting. This will be the fourth year of weed harvesting in Lake Rotoehu and expectations are to remove 1,500 – 3,000 tonnes of hornwort from the lake, thus removing between 3.5 and 7.0 tonnes of nitrogen.

Weed harvesting is scheduled to commence in March 2013 when the weed is most prolific and the maximum benefit for water quality is obtained.

Lake Rotorua

Lake Rotorua's water quality continues to improve with the 2011-2012 monitoring year showing the best water quality in decades. This fantastic result is likely to be due to a cold and windy summer which stopped nutrients on the lakebed being released in combination with significant alum dosing of the Utuhina and Puarenga streams. More information and modelling are required to better understand the effects alum dosing is having on lake water quality.

Constructed Floating Wetlands

Two of the largest floating wetlands have been constructed for Lake Rotorua and Lake Rotoehu. Lake Rotoehu now boasts a 2,800 m2 floating wetland. The wetland was built from more than 364,000 recycled plastic bottles and planted in native wetland species sourced from around the district. The roots of the plants reach into the water, removing nitrogen as the plants grow. The Lake Rotorua wetland is about the size of one-and-a-half rugby fields and spells out 'Rotorua' in giant floating letters. More than 20,000 native plants have been sewn into the constructed wetland. Lake Rotorua's wetland is currently moored at Sulphur Point and when fully established it will be towed out to its final spot near the airport. Once established, floating wetlands will reduce nitrogen and phosphorus in the lake. Floating wetlands also provide additional benefits such as a nursery for koura, nesting options for birds, enhanced fisheries and wave dampening.

Waste Water Treatment Technology
TERAX technology successfully piloted

In partnership with the Rotorua District Council (RDC), Crown Research Institute Scion has developed and successfully tested a technology, called TERAX™, to treat solid organic waste.

Developed here in Rotorua, this clean technology, invented and patented by Scion, is a world-leading technology for the treatment of organic wastes. Its combined environmental and economic benefits are greater than other known waste management technologies.

TERAX™ comprises two steps. A biological stage pre-treats the organic waste and decreases the volume of solid material. Secondly, a high pressure and temperature process breaks down the waste material to derive useful industrial compounds. The final products can be used as building blocks for bioplastics, bioenergy, fertilisers, or for electricity production.

A pilot plant located at RDC's wastewater treatment facility shows the technology can reduce over 95% of waste volume. In addition, the TERAX™ technology detoxifies the sludge waste stream, kills pathogens and produces sterile outputs.

It is a new high-tech solution to an old problem. Landfilling of organic wastes such as sewage sludge is an increasingly expensive and environmentally unsustainable option for local bodies and now strongly discouraged by the Government via the Waste Minimisation Act 2008.

However, only a small fraction of New Zealand's 2.5 million tonnes of organic wastes and sewage sludge are being diverted away from landfills. The underlying causes for this failure lie in the economics, performance and market constraints of existing technology options. This poses a major cost and challenge for territorial authorities and industries like pulp and paper, dairy, horticulture and meat processing.

Scion's General Manager for Sustainable Design, Dr Trevor Stuthridge explains:

"TERAX was developed to overcome the current limitations to organic waste diversion by developing a process that ensures substantial volume reductions, energy and chemical recovery and harmful contaminants are destroyed or segregated. The need for this sort of technology from territorial authorities was loud and clear".

Scion had a ready and willing partner on its doorstep to help trial the technology. At the same time that promising laboratory-scale experiments in treating pulp waste were being completed at Scion, RDC was searching for a solution to reduce the volume and cost of sewage sludge reaching landfill, reduce leachates entering waterways (such as Lake Rotorua) and to lower the costs of wastewater treatment.

Rotorua is already something of a leader in organic waste management. RDC was the first council in the country to construct a composting facility for sewerage derived biosolids some 20 years ago. In 2008 RDC partnered with Scion to undertake research on hydrothermal deconstruction technologies that could be applied to its municipal waste. In the following year, laboratory-scale trials of the process were completed with very promising results.

In August 2010, the partnership was awarded $1 million over two years from the Ministry for the Environment's Waste Minimisation Fund. This was for the successful development of the pilot plant.

With 18 months of trials completed, pilot plant results show sludge being sent to landfill would be reduced from 8,500 tonnes per year to approximately 275 tonnes (a 95% reduction). The net benefit would be a 50 to 75% reduction in current costs of disposal, saving $700,000 per year. In addition, use of TERAX™ products by RDC could save an additional $600,000 in wastewater treatment chemical costs.

For New Zealand, the technology has potential to reduce volumes of organic material going to landfill by over 60%, with sewage sludge reduced up to 30-fold. For larger cities, the savings approach $25 million per year and landfill life extended by 30 years.

In late 2012 plans are in place for a full scale demonstration plant at RDC's wastewater treatment facility. At this scale, all of Rotorua's sewage sludge would be processed through the TERAX™ technology. For RDC, not having to dispose of these wastes on land will eliminate the environmental risk and offer a more culturally acceptable option.

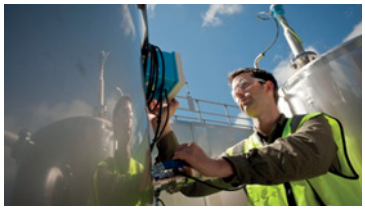
Eventually it is hoped that an additional full scale TERAX™ plant can be constructed, possibly at the landfill to process municipal solid wastes. Mining of the landfill for processing is even a realistic possibility.

Since this New Zealand-developed technology is a step-change in the economics of organic waste management, it should inspire territorial authorities and primary industries to further explore new ways of converting organic waste into valuable products and energy.

Both RDC and Scion recognise the potential for taking this technology beyond just Rotorua's needs and into other industries, such as wood processing and horticulture where large quantities of organic wastes are produced.

Meanwhile, Stuthridge says, Scion has received numerous enquiries from interested parties both in New Zealand and offshore.

More information, including YouTube videos showing the TERAX™ pilot plant, is available at: www.scionresearch.com/terax



Nitrogen removal from geothermal spring

Currently 30 tonnes of nitrogen enters Lake Rotorua annually from the Waiohewa Stream due to geothermal activity.

A de-nitrification plant (above) was built at Tikitere in January 2011 to test the performance of removing the nitrogen from the stream before it enters the water. A major plant revamp occurred this year to solve sediment and pH issues. If successful this intervention could remove a large portion of the nitrogen from the geothermal spring before it ends up in the lake. Another option is using the locally mined zeolite to absorb ammonia in the water before it converts into nitrate. This option was explored several years ago but there was no use for the waste product so it was discarded at the time. With changes in the fertiliser industry in New Zealand there is now potentially a use for the waste product. So in 2013 we will be relooking at this method.

The 2013 zeolite trial will extend the original work undertaken six years ago where zeolite demonstrated to be effective at absorbing ammonia. The new trial will test a range of flow configurations to find the optimal operating conditions. When these are established, and if the results of the trial are positive, then further testing will be undertaken on a larger scale.

The trial results will be compared with the de-nitrification work to determine which option will provide the best long-term process for a full scale plant to remove nitrogen from the Waiohewa Stream before it enters Lake Rotorua.

NZ Freshwater Sciences Conference 2012

Fig.1 Lake Benmore has the best water quality in New Zealand.

The 2012 conference theme 'Beyond the Limits' focused on the capacity of freshwater ecosystems in New Zealand and elsewhere to cope with current and future intensification of land use. Waikato University sent an 18 strong contingent of researchers, MSc students and PhD students to the annual conference held in Dunedin where they delivered both oral and poster presentations.

For Professor David Hamilton as president of the New Zealand Freshwater Sciences Society and Chief Science Officer of LERNZ at the University of Waikato, the NZFSS annual conference represented a great opportunity for members to connect with others who have different levels of experience and areas of expertise.

Trout Size and Climate Change

Jennifer Blair - The Univ. of Waikato

The growth patterns of rainbow trout (Oncorhynchus mykiss) were investigated in nine warm-temperate New Zealand lakes of contrasting form, mixing regime, and trophic state to better understand the combined effects of environmental factors on fish growth in natural lakes. Mark-recapture data (some collected by anglers) from hatchery trout releases during eight consecutive years were used to calculate growth parameters and body condition factor.

Overall, growth rates increased with increasing lake size and minimum annual volume of favourable habitat (i.e. dissolved oxygen >6.0 mg L-1 and temperature <21°C), but decreased with poor clarity and increasing chlorophyll a. and nitrogen concentrations. Analysis showed that indicators of habitat volume were the most important determinants of trout growth rate, and correlates of trophic state (chlorophyll a, conductivity) were important secondary determinants of growth rate.

Effects Of Climate Change On New Zealand Lakes

David Hamilton – The University of Waikato

How will climate change impact lake ecosystems in New Zealand? Over an extended time period, North Island lakes have thus far shown no significant changes in seasonally-corrected surface water temperature. However, other climatic signals such as ENSO cycles - El Nino Southern Oscillation - and specifically an intense El Niño in 1998-99, coincided with reduced vertical mixing of deep lakes in winter. This altered mixing regime led to greater depletion of dissolved oxygen in bottom waters of lakes Taupo and Pupuke (near Takapuna, Auckland). A warming climate may increase periods of temporary stratification in shallow polymictic lakes, with potential for increased deoxygenation of bottom waters in eutrophic systems. Coastal lakes, wetlands and lagoons will be particularly vulnerable to the increase of salt water as a consequence of projected sea level rise.

The overall impacts of climate change on New Zealand lakes are likely to work together, with existing pressures from alien species, water extraction and eutrophication acting in tandem with pressures from forecasted increases in irrigation and water storage, and alien species introductions, to negatively impact upon lake ecology and biodiversity. Empirical evidence and model results indicate that both long-term climate change and short-term extreme climate events should be built into the future management plans for NZ lakes.

Actions to reduce nutrient and sediment loads to lakes will provide greater resilience to storm events. There will be a need to increase surveillance, control and eradication efforts for noxious alien freshwater invaders.

Lake Okaro

Algal blooms in Lake Okaro have been treated with Aqual P, a naturally occurring substance which has been enhanced to take up phosphorus from the water.

The Regional Council, operating within resource consent, has dosed the lake with Aqual P in December 2011, and again in July and August of this year. Water quality in Lake Okaro has fluctuated over the last 10 years and has improved as a result of these interventions. All actions in the Action Plan have been completed. However recent algal blooms indicate a need to review the science and modelling work to understand the long-term changes that maybe occurring in the lake.

Kaimai Catchment

Kaimai catchment's farmer and wetland creator, Paddy Sheely, features in the February 2012 edition of the *New Zealand Lifestyle Block* magazine alongside other farmers across New Zealand who have helped to develop wetlands on marginal areas of their land, with multiple flow-on benefits. This case study also features in the Landcare Kaimai catchment's handbook *Managing Land for the Future*, copies of which are available online at www.landcare.org.nz or contact Kate Akers at kate.akers@landcare.org.nz for a print copy.

Lakes WATER QUALITY Society

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