

Biowastes Project

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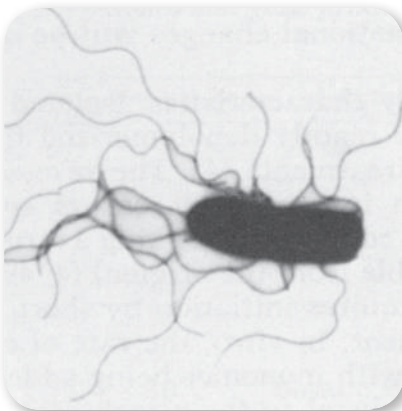
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News from the Programme Manager

– Jacqui Horswell

Welcome to the Autumn/Winter “Biowastes” newsletter.

Most of this quarter has been taken up with planning and running our third and final hui in Kaikōura. Lisa, Alan and Jamie, with help from Sara and Raewyn on the ground at Kaikōura, put a huge effort into developing the methodology behind how this hui should run. The hui was held at the Takahanga marae, thanks once again for your wonderful hospitality. Approximately 25 representatives of the community attended and a full facilitated discussion of preferred options for the communities’ biosolids reuse options was held. For the first time we were able to present information on Life Cycle Assessment (LCA – an environmental foot print) for each re-use option and also the costs in economic terms of each option – the attendees found this really useful in their decision making and for some the results were very surprising! Another ‘first’ for us was the science communication method. Jamie provided us ‘boffins’ with suggestions on how to effectively communicate after looking at a number of excellent methods such as ‘pecha kucha’, ignite, speed dating and ‘7x7’. Scientists are sometimes not the best at presenting their work in a way that is easy to understand. After initial moaning and groaning we all embraced this and it was a huge success – thanks Jamie!

You can read more about the hui on page 2.

The Biowastes research programme has strong linkages with the New Zealand Land Treatment Collective (NZLTC), a national organisation whose membership includes regional and district councils, MfE, CRI’s, and Universities. The NZLTC annual conference represents an important conduit for the programme to transfer research results and engage with end-users. This quarter a number of us attended the NZLTC conference in Tauranga (28-30th March). Grant Northcott was a keynote speaker, and was awarded Best Technical Paper by the Conference Committee. Louis Tremblay ran a discussion session on “Emerging Contaminants” and the programme presented a total of five oral presentations and two posters so a very high profile– well done everybody.

We have been developing several new research streams to run along side our biosolids work and in this issue you can read more about them (Greywater and ‘Up the Pipe’ page 5).

Finally, this quarter we met with the Programme Advisory Group (18th January in Wellington). Biowastes programme collaborators from ESR, Scion, Landcare Research and Cawthron participated giving programme updates and discussing programme milestones. I’d like to take this opportunity to thank all members of the Advisory Group for providing guidance and direction on programme milestones and outputs.

Jacqui



See page 4



Photo courtesy The Marlborough Express

Updates from the Social and Cultural Team

Alan Leckie, Lisa Langer and James Ataria

Community Hui – March 5th 2012, Takahanga Marae, Kaikōura

Tena koutou katoa

A fourth hui was held in Kaikōura at Takahanga Marae to bring together about 25 key stakeholders and members of the broader community to discuss and propose preferred options for the sustainable reuse of 1500 tonnes of stockpiled sewage sludge (biosolids). The biosolids have been stockpiled for five years and with less than half of the time remaining for consented storage the council was keen to engage with the community to explore beneficial reuse options.

The options discussed at the hui had been selected at a key stakeholder hui in February 2011 following an evaluation of a comprehensive range of options. They were grouped as follows:

- a) No further treatment of the biosolids and
 - application to forestry,
 - application to farmland outside the food chain,
 - application to rehabilitate land to grow native plants
- b) Further treatment of the biosolids and
 - open air composting and sold to the public
 - vermicomposting and sold to the public

This hui was run in three distinct phases:

Phase 1: Research results and expert opinion

Six researchers were each given 5 minutes to summarise pertinent data and present key messages from their research to the Kaikōura community. Information presented covered the characteristics of the Kaikōura biosolids, results from previous community dialogue, data from vermi-composting and pot trials, economic comparisons and a life cycle assessment. Each presentation was followed by 5 minutes for questions for clarification and comments.

Phase 2: Community dialogue on proposed options for reuse

Open forum between the community and the researchers with each of the five options discussed in small groups. All views and opinions of the participants were recorded as to whether they *supported* or *did not support* each option.

Phase 3: Community participant voting and presentation of preferred option(s)

Participants voted on their preferred option(s). Each participant was given 5 votes and asked to rate the options according to their preference.

HUI OUTCOMES

The hui was very successful in bringing members of the community together to discuss and debate their views on biosolids reuse which concluded with the community determining their preferred options.

Community voting supported biosolids application to exotic forest plantations, application to rehabilitate land with native plants; and composting biosolids (both open air composting and vermicomposting) prior to being sold to the public. Farmland application outside the food chain received low support.

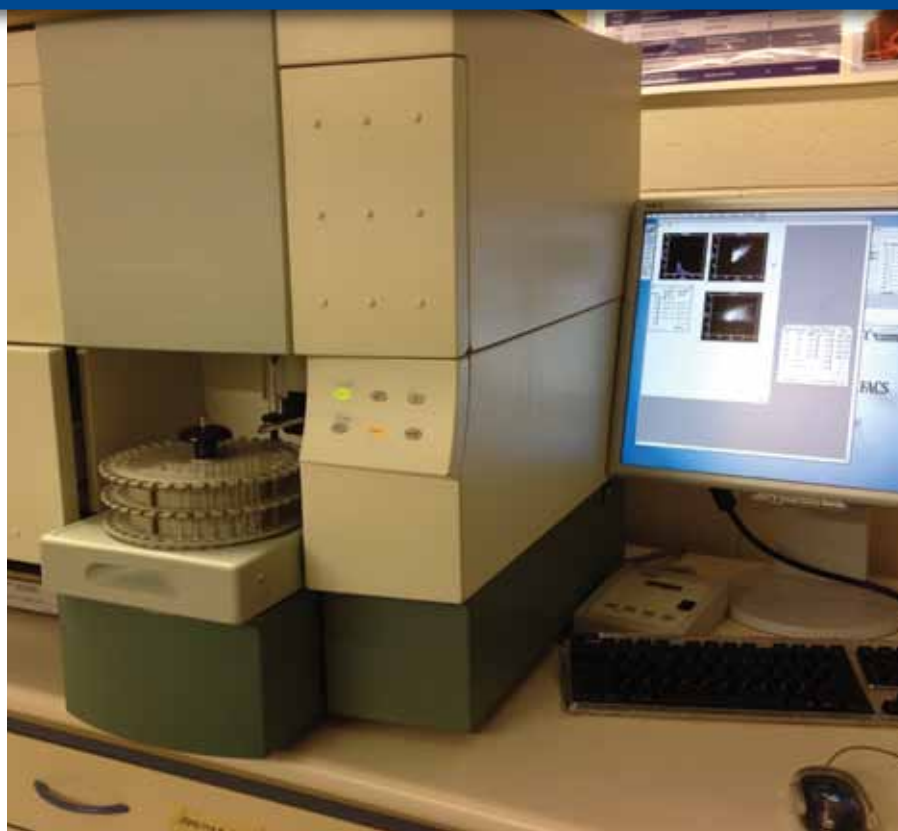
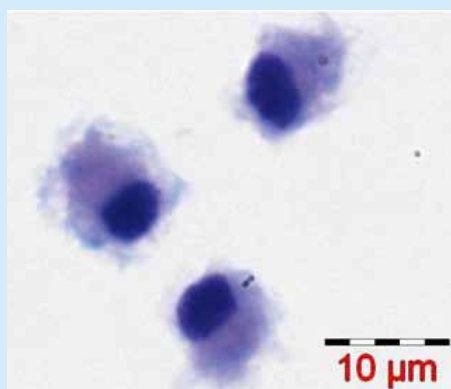
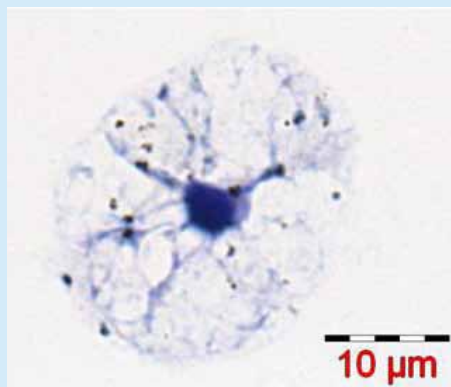
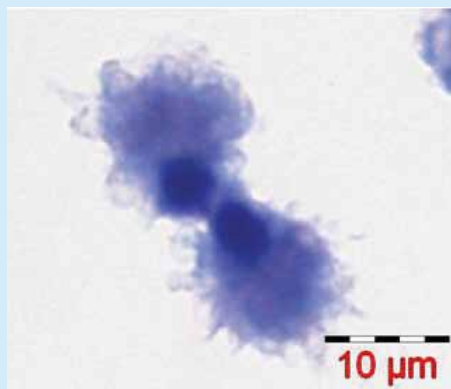
Although the exotic plantation application option received the most support, the community favoured a multi solution approach with biosolids reused in more than one option.

Kaikōura District Council took part in the hui and received the community recommendations for preferred reuse.

The community provided well considered and described input in the reuse option evaluation process and the Biowastes research team received very positive feedback and comments about the process which was designed and tailored specifically for this community/ event. Results of this community dialogue process have been presented at the New Zealand Land Treatment Collective conference in Tauranga and also the New Zealand Life Cycle Assessment conference in Auckland, both held in March.

Updates from the Ecotox Team – Louis Tremblay

Overall the ecotoxicology research on risk of micro-contaminants is going well, and everybody has been very productive. Marie Dennis is investigating the effects of contaminants that are commonly found in biosolids on earth worms by looking at their immune system, specifically by looking at immune cells that are called coelomocytes.



Left: Images of coelomocytes from worms.
Above: Scion's Facs Calibur flow cytometer computer.

Marie has completed the worm coelomocyte cell counts from both the vermicomposted Kaikōura and Taupo municipal biosolids and has found distinct differences between the two biosolids. Colleagues at Landcare Research in Lincoln have been measuring the toxicity of the anti-microbial triclosan and the plasticizer bisphenol A to earthworms and Marie went down to Lincoln at the end of the trial to collect some worm coelomocytes for her work.

This is important as the cells cannot be preserved and must be counted fresh. Once all the results have been collated and analysed the overall story may be very interesting. Scion has now commissioned a new piece of equipment, the Facs Calibur flow cytometer that will increase the ability

to process samples relatively easily with minimal operator input.

Marie is also working on the development of new methodology that will assist us to further assess the toxicity of the various contaminants that are found in biosolids. This in vitro assay uses harvested worm immune cells to test the effect of different contaminants on the cells. The method is now giving very reproducible results for live cells. Cells cannot be stored, and any live assays need to be undertaken within 24 hours of harvest; this means that Marie will have a few late nights in the lab! There are still many steps required to fully validate the assay but once ready, this assay will enable us to test a wide range of chemicals very rapidly.

Updates from the soil and micro group

– Jianming Xue

Vermicomposting of biosolids is increasingly used in New Zealand. However, little is known about the impact of vermicomposted biosolids on soil biological processes and tree growth of exotic and native species.

Recently, we completed a 9-month long glasshouse pot trial, which was conducted to investigate the effect of two biosolids and two vermicomposted biosolids on the seedling growth of three tree species and their uptake of nutrients and heavy metals.

Overall, the addition of biosolids and vermicomposted biosolids improved the seedling growth of exotic (radiata pine) and native (mānuka and tōtara) tree species grown on a low fertility soil, which was comparable with diammonium phosphate (DAP – an inorganic fertiliser) applied at a rate equivalent to 133.3 kg N ha⁻¹.

Addition of biosolids and vermicomposted biosolids DAP increased needle net photosynthesis and root *ectomycorrhizal* colonization of radiata pine (ectomycorrhiza help the plant absorb water and minerals). Radiata pine grew faster (than mānuka and tōtara) and larger in the soils amended with Taupō (fresh) biosolids and two vermicomposted biosolids.

Mānuka and tōtara grew relatively slowly but had greater growth in the treatment amended with vermicomposted Taupō biosolids than other treatments. Kaikōura (aged) biosolids was less effective in stimulating seedling growth compared to Taupō (fresh) biosolids and two vermicomposted biosolids.

The increased seedling growth of exotic and native species after the addition of biosolids and vermicomposted biosolids was related to the improved plant nutrition, mainly N and P. Application of biosolids and vermicomposted biosolids at the loading rate of 400 kg nitrogen ha⁻¹ had little effect on the uptake of heavy metals by both radiata pine and tōtara.

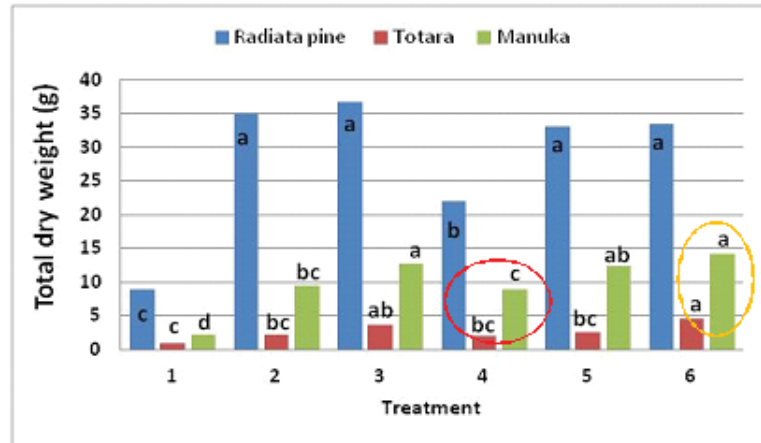
A new pot trial with similar experimental design to the above study was established in the glasshouse at Scion Rotorua in April 2012 using the vermicomposted septic tank waste collected at Mokai. This pot trial

Vermicomposting is good for recycling biowastes into valuable organic fertiliser – evidence from a glasshouse pot trial

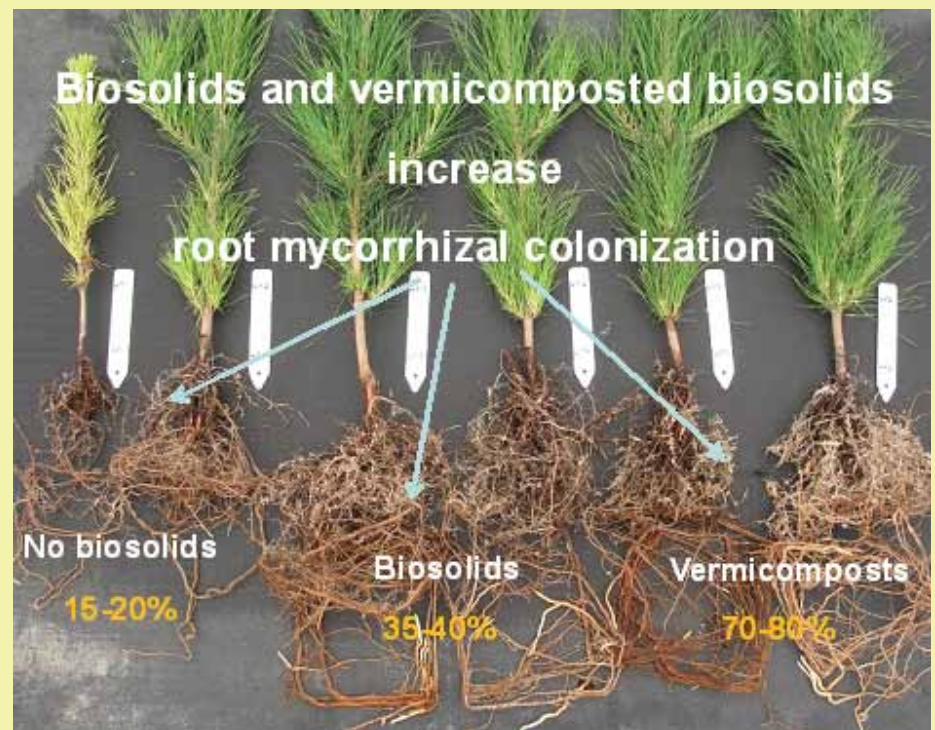
is conducted to test if vermicomposting effectively converts septic tank waste into a product rich in plant nutrients, but with reduced organic contaminants and

bioavailability of metals, which can be used as a high value fertiliser. More information will be provided in the next issue of Biowastes Project Newsletter.

Treatment effect on total dry weights of radiata pine, totara and manuka



(1- Control, 2- DAP, 3- Taupo-FB, 4- Kaikoura-AB, 5- vermiKaikoura-AB, 6- vermiTaupo-FB)



Up the pipe solutions

– Louis Tremblay



From red flag raisers to solution-driven research

Too often in environmental research, we tend to assess and characterise the presence of contaminants that are found in the environment. In an effort to include more solution-driven research, we developed the ‘Up the Pipe’ solutions project, funded by the Ministry for the Environment’s Waste Minimisation Fund and building on the Biowastes multi-disciplinary team to explore how individuals can contribute to reduce the contamination found in household wastes. The project combines cutting edge biophysical science on emerging contaminants and community engagement approaches to raise awareness and make ‘visible’ the concentrations of contaminants in household wastes, and help reduce the contaminant loadings in the receiving environment. The biophysical science will focus on a waste of significance to small rural communities from across New Zealand; septic tank sludge. The community will be engaged by involving secondary school children to identify commonly used products, and to stimulate discussions about behavioural patterns and motivations behind the use of household products. The Natural Step (TNS) framework will help inform this process. The research team will assess the risk associated with the presence of toxicants in the commonly used products. The project is a natural extension of the biowastes programme and builds on our strong track record working in close partnership with community. The aim is to develop a framework that can be used to reduce the release of persistent contaminants across a range of daily activities from domestic to industrial.

Introducing Greywater – Alma Siggins

The use of greywater (wastewater originating from laundry, showers and bathroom sinks) for practices such as garden irrigation is increasing in popularity in New Zealand. As such, many regional and district councils are now considering greywater re-use as part of their water management strategies and are putting regional-specific guidelines in place to control this process. By nature, greywater is highly variable and is likely to contain high levels of chemical and microbial contaminants, although the environmental and public health implications of its reuse are not fully understood. Some reuse options, such as sub-surface irrigation, may not require treatment of the greywater stream as the breakdown of contaminants in the soil environment is generally considered to be sufficient. Other options, for example toilet flushing, are thought to require some degree of greywater treatment to minimise any potential public health risks. The cost factor for treatment of greywater prior to use must be balanced with the environmental and public health risks involved; however there is little NZ-specific risk assessment data available.

Greywater is a new research path within the Biowastes programme, contributing towards our goal of a “whole waste” solution. This research will investigate issues regarding greywater reuse and ultimately provide a set of nationally applicable guidelines, specific to New Zealand conditions. To achieve this goal, this research must be strongly “end-user” driven. Consequently, in addition to ESR researchers, our project advisory group includes partners from: industry (Steven Roberts – Watersmart), district councils (Ben Thompson – Kapiti Coast District Council; Judith Robertson – Gisborne District Council), public health (Jill McKenzie – Regional Public Health), educational research (David Horne – Massey University) and environmental consultancy (Hamish Lowe and Katie Beecroft – Lowe Environmental Impact).

The first research question being addressed by the greywater team is based on anecdotal evidence that removing greywater from a failing septic tank system will improve the treatment efficiency of that system. Older style, single chamber septic systems may not be able to cope with the increasing hydraulic requirements of modern lifestyle. This overloading may result in the discharge of partially treated liquids and solids leading to clogging of the soakage area and surface pooling of wastewater. As greywater represents a significant volume of waste entering a septic tank, its diversion for re-use will increase the retention time of blackwater (wastewater originating from toilets, kitchen sinks and dishwashers) in the septic system, potentially resulting in improved treatment. However, it is not known if the change in the volume and composition of wastewater entering the septic tank would instead have a negative impact on the treatment efficiency of the system. To investigate the impact of greywater diversion on the treatment efficiency of a septic tank we are currently sampling septic tank effluent and diverted greywater from a property in Paekakariki, with a second property in Christchurch to begin sampling shortly. Several experimental plans are currently in the pipeline and will be discussed in future newsletters along with updates from the septic tank study.



The septic tank in Paekakariki is covered in a sand layer, and located underneath a decked area.



Open lid of septic tank – showing the effluent pipe

Below: Samples are taken from within the septic tank effluent pipe



Advisory group feature

The role of the Biowastes Advisory Group is to provide guidance and direction into the long-term direction of the programme. They are a panel of Industry, Government and Non-Government representatives with a keen interest and/or expertise in the Biowastes area. This quarter we feature two members of the panel, Chrissie Williams and Mike Ennis.

Chrissie Williams – Science Adviser, Earthquake Response for Ngāi Tahu

For many years Chrissie was a Councillor at the Christchurch City Council (CCC), now Science Adviser, Earthquake Response for Ngāi Tahu. Chrissie has been involved in the Waste to Resource (W2R) Biosolids Research Programme in Christchurch with Scion colleagues for over 10 years. Chrissie joined the Biowastes Advisory Group in 2011 and is an active member of the group, attending the Hui in Kaikōura in March where her contribution was much appreciated.

What is your interest in the Biowaste Programme?

Since my early days as an elected member of Christchurch City Council – first as a community board member and chair, and then as a city councillor, I have had an interest in integrated water management. I was a member of the community working party set up in 1996 to consider options for the discharge of wastewater from the Christchurch WTP – with the eventual result being diversion from the Avon

Heathcote Estuary/Ihutai and direct discharge to the ocean through a 3km pipeline.

In the past Christchurch biosolids have been spread on farmland and forest, or used for capping landfill. With these options reduced, CCC in 2005 asked the Scion led Waste to Resources Group to lead a consultation process involving all stakeholder groups to recommend to the Council a preferred future direction for the use of biosolids. The preferred option was to use of biosolids as a fuel source, with application to non-food producing land as the other option. As a result the biosolids are now dried meaning the 6000 dry tonnes produced annually can be used for energy or fertiliser. Solid Energy NZ is taking the product to the West Coast for reuse in rehabilitating Stockton Mine. See <http://www.ccc.govt.nz/homeliving/wastewater/treatmentplant/chchwastewatertreatmentplant/biosolids.aspx>

My interest in the Biowaste programme is to promote community participation in decision-making with councils to ensure the biowastes are used as a resource. I support on-site and distributed systems which can reduce the contamination and high volume problems of centralised systems.

How do you see the information produced being useful to you and to NZ?

The learning from the programme, particularly the case studies, will provide good practice examples of community engagement, and the application of scientific knowledge to decision making. Tracking



how this process is recognised by councils and how it influences their decisions is an important part of the project.

What else would you like to see in the programme?

Having the up-the pipe work extend to trade waste/industrial waste to reduce the heavy metals in biosolids.

If you had a million research dollars how would you spend them?

- Demonstrating and monitoring composting toilets in an urban setting to assess the risks of on-site systems compared with a reticulated system
- Define best practice for response and recovery following the loss of a wastewater system because of a disaster. (There must be better options than chemical toilets and sparsely distributed porta-loos!!).



Mike Ennis – Friends of the Earth (NZ)

Mike represents Friends of the Earth (FoE) New Zealand on the Advisory Group. Friends of the Earth is a voluntary research focussed environmental watchdog group. It is part of the most extensive environmental network worldwide, with over 75 autonomous national organisations. FoE(NZ) has been active since 1975, and is one of the earlier members of the federation. Our commitment is to the conservation, restoration and rational use of the ecosystem. Friends of the Earth have been part of the Biosolids research for over ten years and were part of the Steering Group for the NZ Biosolids Guidelines, and currently co-directors Mike Ennis and Bob Tait are members of the Biowastes Advisory Group and the Watercare Environment Advisory Group, respectively

Left: Mike Ennis

Native plants and pathogen problems



Mākūka, kākūka and pasture plants set up in the glasshouse in 2.5 L pots at Lincoln University

Jennifer Prosser, Brett Robinson and Roshean Fitzgerald

Within the biowastes team we have been investigating the potential for utilising the natural antiseptic properties of plants to reduce pathogens from biowastes applied to soil. So far our results are very interesting, and it seems a new area of work has opened up.

Pathogenic organisms that infect humans can end up in a soil system via a number of pathways. One pathway of particular interest to us is the recycling of biowastes to land (although this is not a problem if biowaste is adequately treated prior to application). Land application is considered by many to be a beneficial means of re-using an otherwise unwanted waste product. It can improve the physical, chemical and biochemical properties of soil, reducing the need for inorganic fertilisers.

What is your interest in the Biowaste Programme?

I have been working on Biowaste issues for a number of years. My initial interest was trade waste contaminants – heavy metals, chemicals etc. Over the last 10 years my interest has focused on what have been termed emerging issues – the effects of contaminants such as personal care products, pharmaceutical residues, hormones, analgesics & particularly endocrine disrupting chemicals (EDCs).

How do you see the information produced being useful to you and to NZ?

The information gives a clear database of the effects of contaminants.

What else would you like to see in the programme?

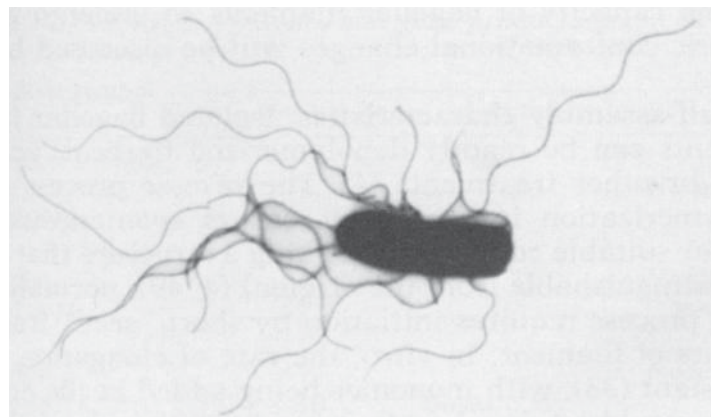
I would like to see wider investigation of the effects of EDCs.

If you had a million research dollars how would you spend them

The detailed analysis of the biowaste stream, both liquid & sludge. This would give baseline information on exactly what is going into the environment and in what quantities.

Land application of biosolids is not without its drawbacks and there is potential to introduce contaminants such as pathogenic microorganisms into the environment when used in this way. Within the Biowaste Team we are researching novel ways to prevent pathogen contamination from this practice.

One way this might be achieved is by utilising the unique antiseptic properties of native New Zealand plants such as mākūka (*Leptospermum scoparium*) and kākūka (*Kunzea ericoides*). Mākūka is a shrub that is known to be hardy and tolerant to varying conditions and commonly used in land restoration projects in New Zealand. Mākūka components were first used by Māori in medicinal preparations long before European settlement. Many studies have confirmed the antibacterial activity of mākūka honey and oil, and today mākūka products are sold widely throughout the world as natural remedies for minor infections and ailments. Kākūka is less widely researched, but also has recorded antiseptic properties.



Microscope enlargement of salmonella spp. One bacterial species of interest with respect to human infection from biowastes

Experiments conducted by Jen Prosser as part of her Masters project (co-supervised by Dr Chris Anderson from Massey University) in 2010 found an inhibitory effect of mākūka, extracted into water, on the growth of five pathogenic bacterial strains that are potentially found in biosolids (*Salmonella typhimurium*, *Escherichia coli* 0157, *Clostridium perfringens*, *Campylobacter jejuni* and *Listeria monocytogenes*). The same study also noted an inhibitory response of mākūka extracts to a bacterial based bioassay (*E. coli* lux biosensor). In this experiment, bacterial luminescence was significantly inhibited by the mākūka leaf

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extract, mānuka root extract and pure mānuka oil, indicating antibacterial properties of the extracts. Leading on from this, a pot trial was set up at Lincoln University in 2011 to look at the effect of mānuka and kānuka on the die-off rate of spiked pathogens in soil. These recent experiments carried out at Lincoln have demonstrated an apparent ability of both mānuka and kānuka plants to increase die off of spiked *E. coli* in pots. From this we have developed the hypothesis that growing mānuka and/or kānuka may be a method to manage the levels of pathogenic microorganisms from land application of biowaste. In collaboration with Dr Brent Robinson (Lincoln University), Dr Jacqui Horswell and Jennifer Prosser (ESR) and Mark Ross (Whenua.Biz) we are currently seeking to recruit a PhD student to carry on this work. This PhD will aim to expand on the knowledge we already have by looking at a greater array of pathogens, including plant pathogens, and more intricate soil/plant systems. This should be underway in late 2012, so watch this space!

Mānuka (foreground) and Kānuka (background) plants from the plant pot trial based at Lincoln University



Staff changes

This quarter we welcome **Morkel Zaayman** to the biowaste team. Morkel is a graduate from the University of Pretoria and has a history in teaching and solid energy analysis. Until recently he was involved in water, soil, foliage and other environmental analysis at Scion, Rotorua. Morkel was also involved in a waste water project aiming to deconstruct waste and find alternative uses for its products. After recently deciding to further develop his research skills he is now undertaking a master's degree at ESR working on greywater, focusing on soil irrigation and contaminants found in greywater.



Morkel Zaayman

Also introducing **Caroline Mitchell** and **Susie Scobie**. Caroline joined Landcare Research in 2011 and since then has been involved in the biowaste research programme. She works with Jo Cavanagh and Katherine Trought as a technician providing laboratory support for toxicity testing of biosolids and contaminants of interest using in vitro assays. Susie Scobie is a highly experienced technician at Landcare Research and has recently joined the biowaste research programme as a technician assisting Lynn Booth undertake toxicity testing using soil invertebrates. Caroline and Susie provide much needed additional technical support for Kat and we welcome them both.



Caroline Mitchell



Susie Scobie

Louis Tremblay has started a joint-appointment between the Cawthron Institute and the University Of Auckland School Of Biological Sciences. The aim of this is to supervise graduate students in the field of ecotoxicology and to raise its profile within the curriculum through guest lectures.

Prof Evan Gallagher completed his visit to Cawthron as part of his sabbatical leave from the University of Washington. There is a good chance that Evan will visit again next year as he has secured funding from CSIRO for some research on ecotoxicology. Evan's visit coincided with the hui in Kaikōura and he thoroughly enjoyed the experience, and he was a great addition to the team! We are collaborating on a few projects around the risk assessment of emerging contaminants in fish with a focus on oxidative stress markers.

The Cawthron ecotoxicology group hosted for two weeks **Prof Thomas Braunbeck** from the University of Heidelberg in Germany. PhD candidate Ruben Strecker also visited as part of a programme financed by the German Bilateral Exchange of Scientists programme (BMELV) and the New Zealand International Mobility Fund (IMF). Thomas gave a seminar: "The zebrafish embryo – not

only an alternative to the classic acute fish toxicity test", and participated to a range of meetings around ecotoxicology. We are developing a research proposal for funding a PhD student to adapt the zebrafish test to New Zealand native species.

Up and coming events

Louis Tremblay and Scion colleagues are discussing the possibility of hosting the combined Society of Environmental Toxicology and Chemistry (SETAC) Australasia and the International Water Association (IWA) forest/pulp and paper effects conferences in Nelson in 2015.

Marie Dennis and **Olivier Champeau** will play a role in the organisation of those meetings and it will provide a great opportunity to showcase aspects of our research programme on waste management.

The biowastes programme planning meeting will be held at ESR in Wellington on the 18th of July, 2012.

At this meeting members of the biowaste group will get together to share and discuss the previous years work, and lay down plans for the upcoming year.

If you would like further information on the programme or have any questions please contact a member of the Science Leadership Team:

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