THE CHANGING FACE OF LAKE OKATAINA'S 'PHOSPHORUS SCAPE': WHO IS THE CULPRIT?

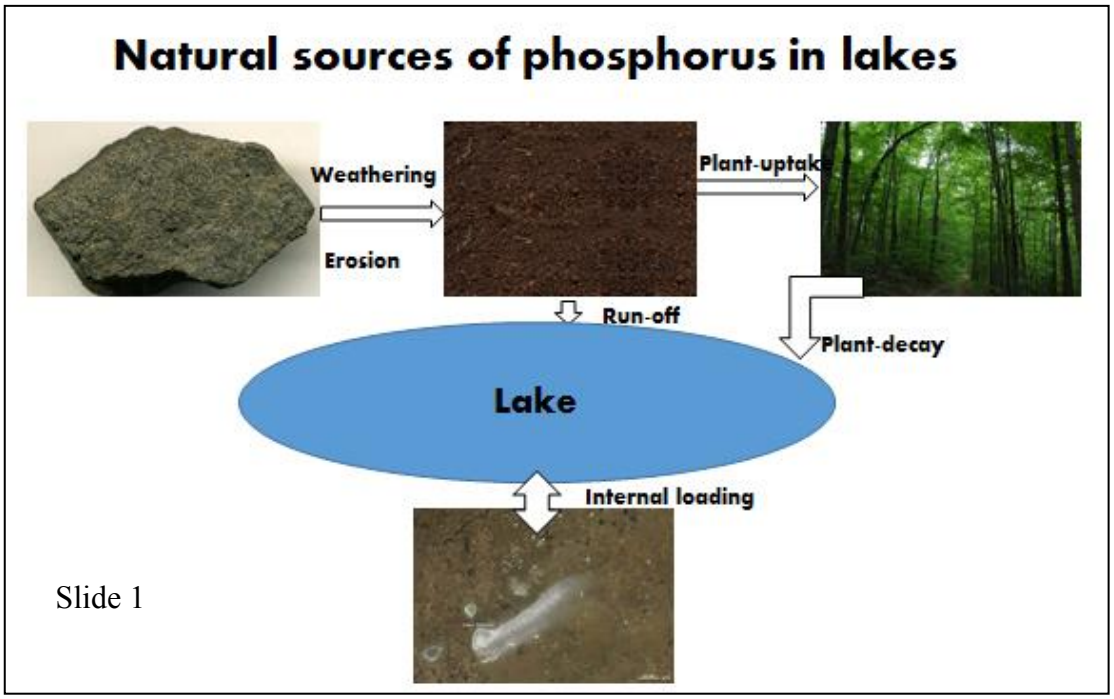
Theodore Kpodonu
with support from David Hamilton, Adam Hartland, Daniel Laughlin and Chris Lusk
Environmental Research Institute, School of Science, University of Waikato, Hamilton
ak225@students.waikato.ac.nz

Theodore is currently a PhD student under the tutelage of Prof David Hamilton at the University of Waikato. He holds a Master of Science Degree in environmental resource management with specialisation in aquatic geochemistry. Prior to taking up the PhD studentship, he held an academic position in the University for Development Studies, Ghana, where he taught papers in limnology and watershed management, amongst others. During his tenure there, he carried out research into geochemical controls on nutrients in lake sediments, agricultural pollutants in lakes and phytoremediation of trace metals and pharmaceutically active substances in lakes. His current research interest is limnogeology, and nutrient and trace metal geochemistry in lake sediments. In recent conferences he has presented papers on phosphorus speciation in lakes, and trace metals from agricultural sources.

ABSTRACT
Lake sediments contain a great wealth of data on biogeochemical and limnological processes of historical importance, which can be used to interpret natural ecosystem dynamics, and climatic and anthropogenic impacts. In this study, this information was used to understand the dynamics of phosphorus speciation in deep Lake Okataina, to assist with understanding how changes in the catchment influence lake productivity. A 49-cm sediment core was retrieved from Lake Okataina and its depositional history was dated using ^{210}Pb and tephra chronology. Amongst New Zealand lakes, Okataina may be considered close to a 'reference' lake, with 89% native forest and without a significant change in its land use in the past c. 800 years. However, perturbations to the lake during this time may be due to expanding populations of invasive terrestrial mammals, earthquakes, volcanic eruptions and tree felling, which may alter the geochemistry of the soils in the catchment, composition of runoff and, ultimately, the composition of the bottom sediments of the lake. We hypothesised that changes in soil phosphorus geochemistry in the catchment will result in a changing phosphorus species in the lake sediments.

TRANSCRIPT
I will be talking about lake effects and the introduction of mammals into New Zealand on lake water quality, looking at phosphorus specifically, because one of the things that Professor Hamilton mentioned was nutrients: added nitrogen or phosphorus plays a big role in the quality of water. So there is the need to look at how catchments influence water quality generally.

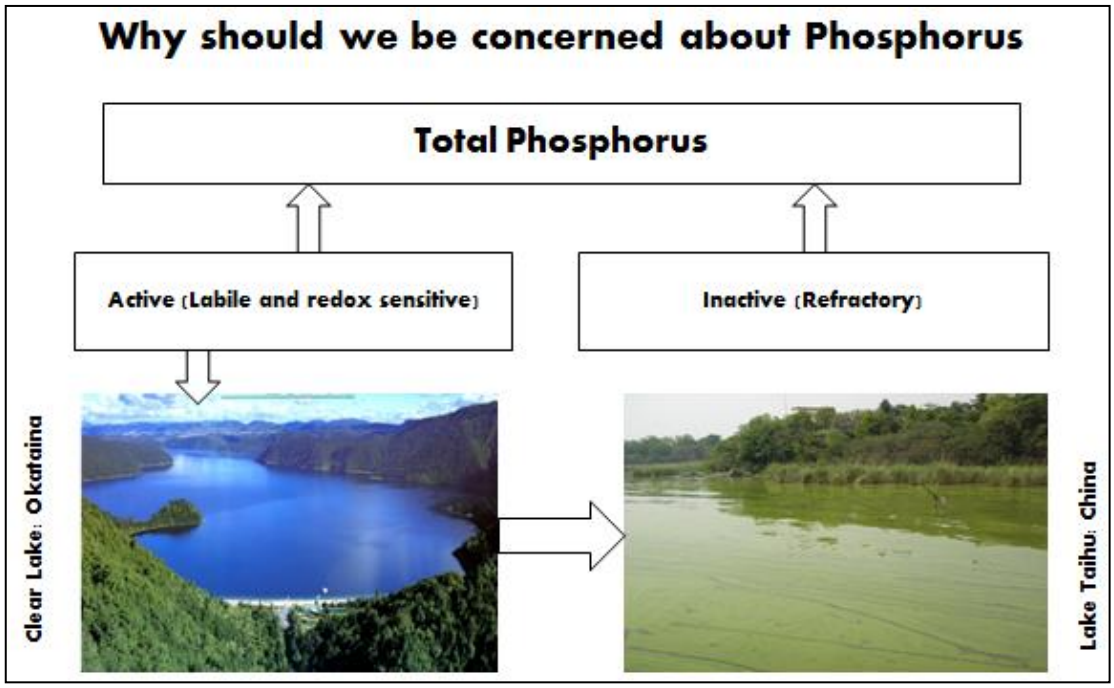
The main source of phosphorus is from weathering of rocks. When rocks weather soils are created and nutrients are taken up by plants, but some nutrients in the soils are directly routed into the lake. Plant decay also contributes nutrients to the soil and these can also be routed into the water or back to living plants themselves. When there is erosion, sediments and nutrients are washed into the lake. There is also the contribution of nutrients from bottom sediments into the lake directly. **Slide 1** is a simplified diagram of phosphorus cycling in a lake system.



Why should we be concerned about phosphorus? It contributes to productivity of the lake. If you have a lake that we know does not have a lot of nutrients and all of a sudden we see increases in nutrients then we should be concerned and say, 'Where is the source of the nutrients and what would be the effect of the nutrients on the water?'

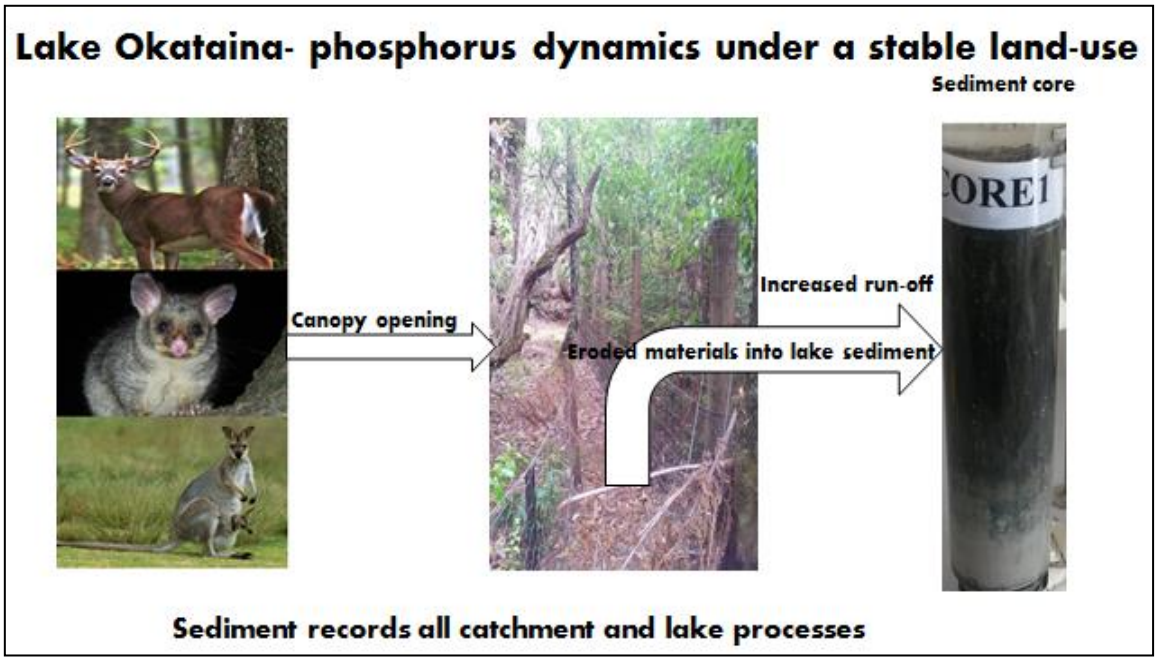
We talk about total phosphorus which has many aspects, classified as active and inactive. Active means the component that directly contributes to the lake productivity (bioavailable). The inactive component does not directly influence plant growth but can be recycled back to an active form.

In **Slide 2** we have active phosphorus going into a clear lake like Okataina, but a turbid lake like Lake Taihu in China already has a large biomass of algae. We cannot swim in it,



we cannot drink the water, we cannot take fish from it and the lake quality is terrible and it has a large bioavailable phosphorus supply. My interest here is to look at whether we have seen any changes in phosphorus in our lakes.

Because we are at a 'weed and wallaby symposium' I will look at the influence of deer, possum and wallaby. One of the things that occurs from their browsing is to open the canopy. In **Slide 3** showing an exclusion zone we can see that inside the fence are very lush plants but outside it is mostly dry and open. Changes in the composition or species numbers are therefore important to my study. It is important to evaluate these recent changes against influences of earthquakes and landslides, which also lead to instability in the catchment sediment and nutrient delivery. Anything that exposes the soil influences whether we have phosphorus entering the lakes or not.



Lake sediments act as an historian, an archive. They store data over thousands of years, so whatever happens in the catchment and the lake is stored in the sediment. We can make inferences about past history of the catchment and lake.

In Lake Okataina we have two recent tephra in the bottom sediments, Kaharoa and Tarawera. We know the Kaharoa eruption happened around 1314AD plus or minus 12 years and we know the Tarawera eruption happened in June 1886. We use other dating techniques lead-210 to be able to constrain the date. Every 1 centimetre of the core has a date, the top is 2009 and the bottom is the tephra of 1314AD. So between these two, 1314AD and 1886AD, there have been Maori and European settlements which would have influenced the forest.

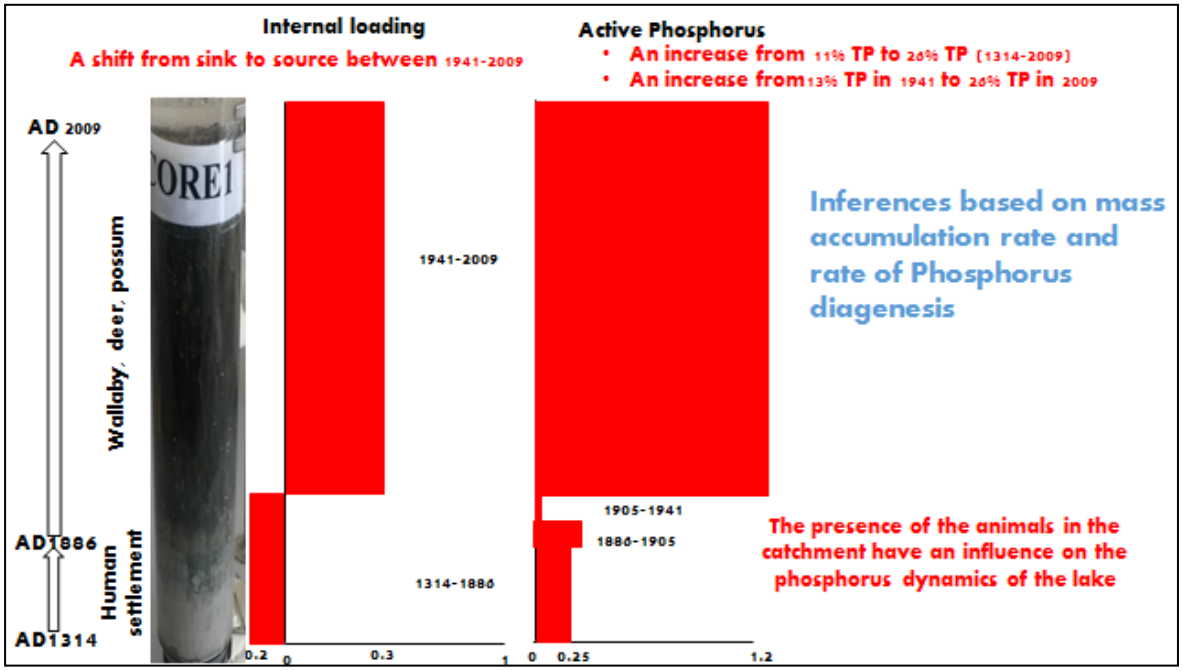
In 1931, for instance, there was an earthquake in Napier and a few days after that the lake height reduced significantly. In terms of sediment loading of nutrients prior to 1941 the lake was a sink of phosphorus. It means that whatever phosphorus that went into the lake was trapped and very little was released back into the lake. But after 1941 one of things we saw was that the lake sediment began to release phosphorus back into the lake.

We can also re-create erosion patterns in the catchment from the sediment cores. There has been an increase in erosion over time and increased inputs of organic material in the lake would remove oxygen from the bottom waters of the lake. Where we have decreased oxygen concentration in the sediment it leads to dissolution of iron that is bound to sediments and therefore to bound phosphorus, which is also released into the system. Aluminium also has bound phosphorus and depends on pH, which is mostly stable in Okataina.

Lake Okataina is anoxic in the bottom waters during summer stratification. You will find deeper bottom waters in deeper lakes like Tarawera and Rotoma are not anoxic. One of the reasons could be the V-shape of the basin itself, resulting in sediments accumulating, less water to buffer oxygen consumption, and therefore release of phosphorus. We found that the lake became a source of phosphorus after 1941 and this could be as a result of the disturbances in the catchment.

I have read quite diverse literature on increases in the animal population and other pests in the catchment. I learnt that from around 1935 the population of mammalian animals increased. Could that be a factor in the change in the lake in 1941? Or could it be shoreline erosion? We have examined remote sensing images in this catchment from the 1990s to see whether there is any opening of the canopy. We realise that there has been very little, not as much as logging would do. But the opening could also be a result of the landslides. The most obvious culprit for material going into the lake at a fast rate and internal loading still appears to be mammalian browsing.

Between 1314 and 1886 about 5% of the total phosphorus in the lake's sediments could be categorised as 'active phosphorus'. **(Slide 4)** Right after the Tarawera eruption this increased, but later we saw a reduction in the percentage. I would imagine that after the eruption there was regeneration of forest growth and therefore not a lot of erosion or materials going into the lake.



However we have seen a big jump from the 1941 baseline. We also cannot discount the effects of changes in climate and there are predictions of the lake's response for different climate change scenarios.

I would like to acknowledge the Bay Of Plenty Regional Council who have funded my PhD. The have also helped with provision of the data. I also want to thank the Lake Okataina Scenic Board. They have been very helpful and always want to know what is happening in the lake. I am grateful for the opportunity to talk to you, thank you very much.

THE LINK BETWEEN EROSION, PHOSPHORUS AND WATER QUALITY

Max Gibbs
Water Quality Scientist, NIWA
Max.Gibbs@niwa.co.nz

Max was trained as an analytical chemist and has worked for NIWA (and its predecessor, DSIR) for 50 years, initially in the field of pesticides and forensic analysis and subsequently studying eutrophication in freshwater. For the last 42 years, Max has worked on lakes around most of New Zealand, primarily on Lake Taupo and the restoration of Lake Rotorua, and Lake Horowhenua. He was instrumental in the identification of the hydraulic coupling between Lake Rotorua and Lake Rotoiti, which eventually lead to the installation of the diversion wall. He has used his experience of iron cycling, obtained as a fellow at Edinburgh University and the Lake District in 1980, to help in the understanding of phosphorus interactions across the sediment-water interface in New Zealand lakes. He was awarded an Honorary Doctorate of the University of Waikato in 2010 for his work with lake restoration and the assistance and mentoring of students. Recently Max developed an internationally acclaimed forensic stable isotope technique that enables the identification and apportionment of sediment sources by land use in the catchment and he has extensive knowledge of the linkages between erosion and the impacts of fine sediment in lakes, rivers and estuaries.

ABSTRACT
In lakes, the solubility of phosphorus (P) in water, and therefore its availability to aquatic plants (macrophytes and algae) for growth, is controlled by oxygen and pH. The supply of dissolved reactive P (DRP) to the lake water column is mostly from sediment release from decomposing plant material and iron oxides during periods of low oxygen, although in Lake Rotorua and most of the other lakes on the central volcanic plateau, spring-fed streams carry relatively high concentrations of DRP into the lakes. The mechanism for releasing iron-bound DRP from the sediment focusses around the oxidation state iron (Fe) and manganese (Mn). In well oxygenated conditions iron exists in the oxidised state as ferric ions which form ferric oxides that are insoluble in water. These oxides sequester DRP as they precipitate and remove it from the water column. When the oxygen concentration falls to zero (anoxic conditions) iron exists in the reduced state as ferrous ions, which are soluble in water. As the ferric form reduces to the ferrous form it dissolves and the DRP bound to the iron is released into the water column where it is used by algae for growth. The algae eventually senesce and die, returning the P to the sediment as particulate P, where it can be recycled during the next period of anoxia.

Apart from recycling of algal biomass, P also comes from the catchment, bound to the iron oxides in soil particles. The P content of the soil is greatest in the finest soil particles, which are the first to be eroded by rainfall and do not settle until they reach the calm waters of a lake. There they augment the P load from the senescing algal biomass, thereby increasing the amount of DRP that can be released during the next anoxic event. Because of the high background concentration of dissolved inorganic nitrogen in the lake water, the addition of any DRP will stimulate algal growth and thus result in a deterioration of lake water quality. Land management strategies to reduce soil erosion include changes to the way land is farmed and the interception and retention of fine sediment using detention bunds.

TRANSCRIPT

Sediment from land erosion is the largest contaminant of water and costs over $US500 billion per year. This is due to sediment costs for potable water and the treatment required cleaning it up. Sediment from land erosion represents threats to sustainable food production and the loss through soil from arable land and of course sediment can adversely affect the aquatic ecosystem affecting biodiversity and the water quality in the lakes.

My talk today examines the link between erosion, phosphorus and water quality. The previous speakers have talked about the cause of sediments, of landslides, bank erosion, flood events, etc. I am going to focus on fine sediment; the particle size is typically less than 20 microns, i.e. the clays, silts and muds, all very fine material.

Unlike an estuary where fine sediment flocs when it meets the sea water and settles, fine sediment entering a lake remains as a suspension of fine particles for extended periods. These suspended solids affect water clarity by reducing light penetration and cause light limitation for aquatic plants, native species and exotic species alike. In Okataina there could be weed beds smothered because fine sediment is coming into the water. Over time the fine sediment eventually settles to the lake bed and lake currents cause it to move into the deeper parts of the lake, a process called sediment focusing. As Theodore Knodonu referred, the sediment eventually gets to the bottom of the lake. The deeper parts of the lake may become anoxic below the summer thermocline due to decomposition of organic matter from weeds and algae.

Erosion is a process destabilising soil and causing it to move. Wind driven erosion (Aeolian) is common in the dry parts of the world. Water driven erosion is the most common form in New Zealand. If you take plants off the ridges and put in place grasslands, they cannot hold the soil on the steep slopes. If you have forests which are removed by clear felling the period of clear felling leaves exposed land which is not going to stop rain from eroding the soil. If you have farmers that cultivate the land right to the edge of the streams, in fact run their ploughs almost into the streams, nothing will stop sediment getting into the system. The common factor here is that bare soil washes away in rainfall events.

Sediment can come from land slips and we have already seen these. Willy Shaw showed close ups of slips in Okataina. We see bank erosion in Okataina and around other lakes. Theodore referred to the denudation of the forest understorey by animal grazing and the effects of wallaby in the Okataina catchment.

Sediment can come from land slips

Or bank erosion

Or denudation of forest understory by animal grazing

Erosion occurs at all stages of rainfall events with different parts of the landscape being affected depending on the previous rainfall history and intensity. In most cases it is the surface soil that is eroded first with the very fine particles moving even with light rain. The slip faces that came down in a big event continue to leach fine sediment with fine rain washing off that surface all the time.

The fine sediment in surface runoff may not be considered important. For example, in the Okataina water quality Background Information 2012 there is a surprising statement that says –

'*There are small areas of bare ground and built areas in the Lake Okataina catchment, but it is thought that only a trace amount of nutrient input, (10 grams of phosphorus and 110 grams of nitrogen a year) is generated from these.*'

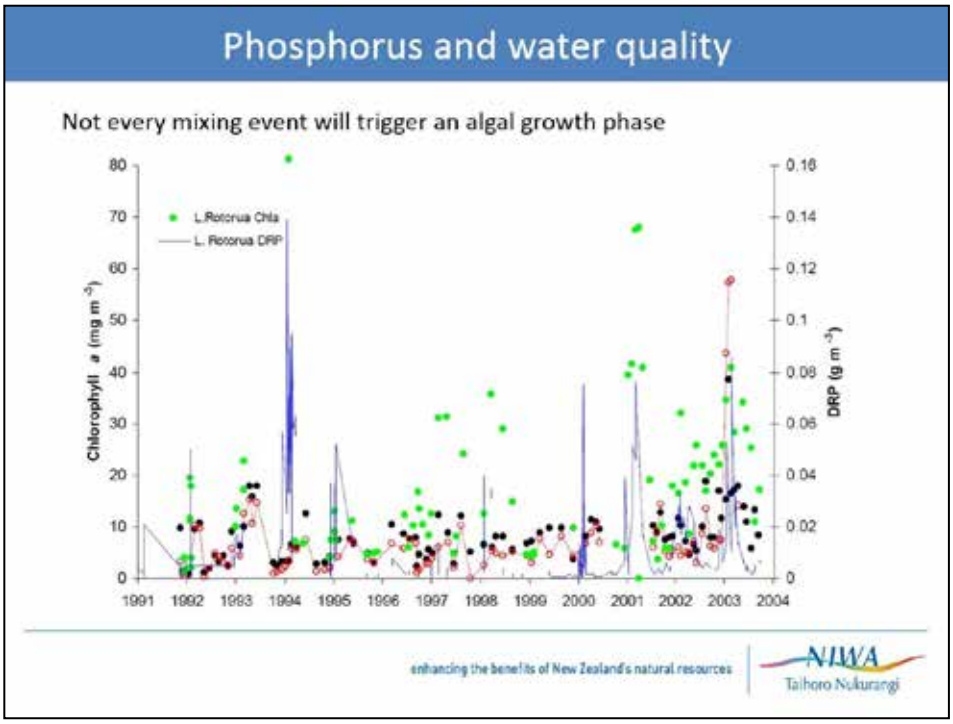
Where does the P come from? Fine sediment has the highest concentration of phosphorus P of any sediment. Pumice soil is naturally high in phosphorus and that is due to the feldspars that are in the pumice. Elsewhere farm fertiliser application and animal waste applied to land can be a major source.

Phosphorus as dissolved reactive phosphorus (DRP) is rarely found in abundance in freshwater streams or lakes. The exceptions are the natural spring waters of the central volcanic plateau. Theodore referred to these as the mineralisation leaking from the rocks. Lakes are thermally stratified with anoxic bottom waters which also produce phosphorus. Phosphorus concentrations are controlled by dissolved oxygen (DO) concentrations in the water. With high DO concentrations minerals, such as iron, form insoluble oxy hydroxides or oxides which sequester the phosphorus to their surface, in other words iron binding. These remove the phosphorus particles from availability to algal plants in the water column. With zero oxygen, in other words anoxia, the insoluble iron oxide dissolves and releases the phosphorus as DRP into the water column where they are available for algal growth.

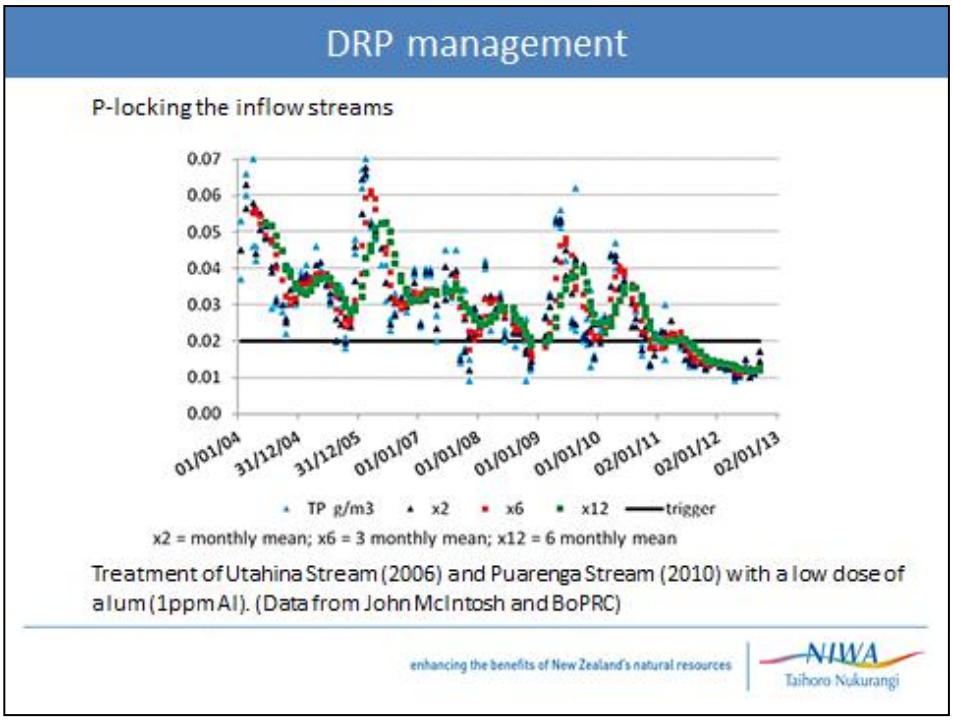
What is so special about phosphorus? All plants need phosphorus and nitrogen for growth, typically in a mass ratio of N : P of 7.2 : 1. These are as dissolved inorganic nitrogen (DIN) and phosphate, i.e. DRP, not total phosphorus or total nitrogen. If either DIN or DRP are in short supply plant growth may be limited. In most New Zealand lakes there is an elevated concentration of dissolved organic nitrogen and low concentrations of phosphorus. This implies that phosphorus is the nutrient most likely to limit algal growth in lakes. It also implies that if phosphorus is added algae are likely to grow and sometimes quite rapidly. Consequently after thermal stratification with bottom water anoxia (DPR) phosphorus concentrations will increase in the lake when the lake mixes and algae will grow.

Lake Rotorua is polymictic; it thermally stratifies and then mixes. Historically it has produced high phosphorus concentrations when stratifying and these are released into the overlying water column when it mixes. In **Slide 1** the data set ranges from 1991 to 2004 and we can see events where the blue line is phosphorus; the green spots are the chlorophyll concentrations. Phosphorus release chlorophyll. Not every mixing event will trigger an algal growth phase. We have situations here where there is phosphorus release but no algal growth. I do not know why, it just happens that way. We saw in previous talks yesterday the way of managing phosphorus in a lake. If you treat the streams you can reduce the phosphorus entering the lake from the streams. **(Slide 2)**

Slide 1



Slide 2



Fine sediment is a bit more difficult to manage because it comes off farm land, slips and other sources. The Bay of Plenty Regional Council has developed detention bunds which are stretched across an ephemeral channel in a paddock. **(Slide 3)**

Slide 3

Slide 4 looks downstream in a paddock towards an ephemeral detention bund.

Slide 4

The device in **Slide 5** is the outlet for the water level control for the detention bund. They hold water with fine sediment eroded by rain allowing most of the sediment to settle in the

Slide 5

paddock. A surprising amount of fine sediment is washed off pasture. It does not look like a major source but 80 to 90% of the catchment in pasture produces a tremendous amount of very fine sediment with very high concentrations of phosphorus.

In conclusion, the link between erosion, phosphorus and water quality is fine sediment. Fine sediment is eroded from the land even with light rain, so just a light shower and phosphorus is moving. Fine sediment carries the highest concentration of iron-bound phosphorus. It is the vector for inorganic phosphorus from land to the streams and lakes. The fine sediment is very slow to settle making this a one step process. It does not move down a bit and wait for the next rainfall; it goes with the rain the full distance. Fine sediment is focussed into the deeper parts of the lake by lake currents and the bottom waters are more likely to become anoxic in summer. Anoxia releases iron-bound phosphorus which may stimulate algal growth when the lake mixes. An excess of dissolved reactive phosphorus in a lake favours the growth of cyanobacteria and there goes your water quality.

QUESTIONS

Eugenie Sage, Green MP: Thank you, they have all been very interesting presentations. In terms of climate change and intense storm events, it seems that we have to really lift our game with erosion control and ensuring that sediment does not get into lakes. What thinking has been done about significantly stepping up our work in this area?

Max Gibbs, NIWA: The work that Bay of Plenty Regional Council are doing using detention bunds, traps and other actions in the catchment is designed to reduce the impact of fine sediment or any sediment coming down. There is nothing you can do about a weather bomb, it will come through, but it is vital to employ good farming practices and such things as the timing of bare ground. Our climate change seems to have given us a wet season and a dry season, so these things need to be considered when managing farms and developing farm plans. Knowing that the rainy season is coming, you would not harvest your corn crop and leave it bare, you would want the paddock covered fairly quickly.

Ian McLean, LWQS: I would like to ask the speakers who described processes that have gone on since the Tarawera eruption, with change taking place in the soil and forest, why is the water quality in Lake Okataina getting worse? What is making the change? Why is something changing right now when these processes have been happening for many decades?

Theodore Kpodonu, Waikato University: If you look at the chlorophyll *a* data of the lake it seems to be stable. However in calculating the TLI, we use other indexes like total phosphorus and total nitrogen and there is an increase in both. However if you look at the productivity of chlorophyll *a,* the lake data does not change in quality per se. Going back to a thesis from the 1950s and research in the 1970s there was gradual change from the 1950s through the 1970s. But from the 1990s until now there has been stability in the water quality. But because we use various indexes in the calculation of the TLI it shows the quality of the water going up and down.

Don Atkinson, LWQS: Is the suggestion of moas' grazing in earlier pre-European occupation comparable to the current grazing from our introduced species of mammals?

Rob Allen, Landcare Research: You raise an ongoing discussion there, probably the most recent statement is from the Feathers to Fur Symposium, run by the New Zealand Ecological Society in 2010, in which one of the papers presented compares the diet of moa and deer, and there is huge overlap.[1]

David Hamilton, Waikato University: Part of the significance of Lake Okataina is that it is a reference lake. The concept of a reference lake is that it is an un-impacted lake. In terms of the National Policy Statement for Fresh Water Management we want these reference lakes because there are impacted lakes around the country that we are trying to return to the condition that approximates somewhere between where it is now and a reference lake. I wondered if Willie, Rob and Theodore would comment on the concept of 'reference state' and with so much variability when should we consider things to be in a reference state? Here is a lake that has 89% of its vegetation in indigenous forest and for us in the Rotorua Lakes that would be the reference state almost.

[1] David M. Forsyth, Janet M. Wilmshurst, Robert B. Allen and David A. Coomes, 2009. *Impacts of introduced deer and extinct moa on New Zealand Ecosystems,* http://newzealandecology.org/nzje/2913.pdf

Rob Allen, Landcare Research: I do not support the notion of a stable reference point, it should be a changing reference point. In many respects I agree with what you are saying, it is a lake that is operating without a dominating human influence driving those changes. But we have to be careful to partition out the fact that humans are not the driving force. One of the aspects I talked about was the even aged nature of the forests and that drives nutrient dynamics in the systems. Those forests to some degree have not even aged as an artefact of past human activity. So you have to keep an open mind and think what the lake is like and what are the driving factors and are they different from a set of factors in another lake. I have not had much to do with the Rotorua Lakes but I look at 13 lakes and think – hmm, a pity they did not have a few more to partition out the variants.

Willie Shaw, Wildland Consultants: It is fine to use the concept of reference lakes but you have to understand what is going on with them and their catchments in particular. For Okataina we do not understand the variation over time of what appears to be a very natural system. All the preparation on my presentation did for me was raise question after question about what IS going on. The session this morning has added another level of complexity because there are not only erosional processes carrying core sediment into the lake, but as we heard from Max, the fine sediment processes as well. Look at the steepness level increases and we can relate that to simple measures like bank collapse or landslide occurrence, but what about the fine sediment carried through all those high rainfall events. There has certainly been some accumulation of high rain events which have led to those spikes and the related effects around the shoreline. So the concept is fine but we have to understand what is going on in the system as a whole.

Theodore Kpodonu, Waikato University: The concept of reference used in restoration; restoring the lake to pre-disturbance period. What is the definition of pre-disturbance? Is it pre-human disturbance? Is it pre-climatic disturbance? Pre-what disturbance? I look to what Rob is saying that there should be an evolving concept. I looked at a 10 year window of Lake Okataina water quality data in terms of climate change and how much control climate has. We have about 50% variability in the data explained by climate alone which is quite high, compared to many lakes in other places.

We could see that climate plays a major role and so, what is pre-disturbance? We need to look at our 3 year TLI concept again and the reference conditions for restoration. Maybe it needs a bigger forum to look at what we should do with lakes' restoration or we will be taken by surprise one day. We think we are doing all the right things with no dairy farming, no this and that, but the lake is still deteriorating. We should look at reference conditions in terms of climate, natural drivers and anthropogenic drivers of ecosystem change and then we can set good conditions for our lakes.

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Session Six : Control of Animal Pests

SESSION CHAIR – Dr Ken Hughey, Chief Science Advisor, DOC

CONTROL OF PESTS IN LAKE CATCHMENTS – THE DEPARTMENT OF CONSERVATION'S PERSPECTIVE

Dr Alastair Fairweather
Technical Advisor, Transformation and Threats Group, DOC, Hamilton
afairweather@doc.govt.nz

Alastair began his career working as a Science Technician for the Ecology Division, DSIR, after getting a degree in biology from Waikato University. He then went overseas, working as a wildlife ranger in Scotland and as a Wildlife Biologist for Raleigh International in Chile while studying for a PhD in ecology at the University Of Aberdeen. On returning to New Zealand, he joined the Department of Conservation. Alastair is currently a Technical Advisor in the Transformation and Threats Unit providing advice on animal pest issues. The work includes developing best practice for pest control, registration and use of pesticides, and advice to staff conducting pest control operations.

ABSTRACT
A key part of the Department of Conservation's (DOC) work is to ensure the diversity of New Zealand's natural heritage is maintained and restored. However, is a huge task and DOC's resources cannot stretch to do everything everywhere. DOC therefore has to make decisions about what work to do and not do, juggling limited resources while meeting both biodiversity and community needs.

To help make these decisions, DOC has developed the Natural Heritage Management System (NHMS) Programme which identifies the highest priority sites (both terrestrial and freshwater) that need to be protected and where work needs to be done. For NHMS to correctly identify the priority sites and what work it needs to be done at the sites, it relies on good information. For the freshwater sites, the data came out of the Freshwater Ecosystems of New Zealand (FENZ) dataset. This data set describes the environmental and biological patterns in NZ's freshwater ecosystems (rivers, lakes and wetlands). Once priority sites have been identified, it is important to understand what pressures the sites face and what activities, including pest control, need to be undertaken to reduce these pressures.

In this presentation, the Rotorua lakes, with particular reference to Lake Okataina, will be placed in the context of this prioritisation process, the pressures they face and pest control activities DOC has identified as necessary to ensure the priority lakes are protected.

TRANSCRIPT
My presentation will give the Department of Conservation's (DOC) perspective on when terrestrial pest control may be an appropriate management activity in lake catchments to improve the lakes' ecosystems. However before deciding on undertaking pest control in lake catchments a decision is made on whether the lake is a priority and whether pest control is really needed.

I have therefore divided this presentation into three parts. Firstly I will provide context around how DOC selects lakes for management and how it prioritises the work that needs to be undertaken at those sites. Then I will talk about when pest control in the catchments may be an appropriate management activity to address the lakes issues and finally we will use Lake Okataina as a case study.

The Government and the public have increased demands for accountability on Government Departments, therefore DOC like all other Government agencies is required to work within the Managing for Outcomes framework. This means DOC's work focus is on achieving long term results that have clear outcomes. DOC's overarching Outcome Statement is that:

> *New Zealanders gain environmental, social and economic benefits from healthy functioning ecosystems, recreational opportunities and living our history.*

Sitting under this overall outcome are what we call five intermediate outcomes and these relate to how DOC intends to do its work in the areas of natural heritage, history, recreation, engagement with the public and business opportunities. The key one relating to the protection of lakes and other ecosystems is:

> *The diversity of our natural heritage is maintained and restored.*

To maintain and restore New Zealand's natural heritage DOC has identified six things that need to be achieved:

1.1) A full range of New Zealand's ecosystems is conserved to a healthy functioning state
1.2) Nationally threatened species are conserved to ensure persistence
1.3) Nationally iconic natural features are maintained or restored
1.4) Nationally iconic species are managed to ensure their populations are maintained or restored
1.5) Locally treasured natural heritage is maintained or restored as partnerships
1.6) Public conservation lands, waters and species are held for now and future generations

The first two objectives 1.1 and 1.2 are about preserving representative functioning examples of ecosystems and preventing the extinction of threatened species. These are decided at a national level on cost-effectiveness and I will explain later how lake ecosystems fit into this. Objectives 1.3 and 1.4 are about nationally iconic features and species and what New Zealanders as a whole value. They will be prioritised based on input from the public. That is still to be done, but it is anticipated that a lot of the nationally iconic features are going to be in National Parks or big scale landscape features.

Objective 1.5 is about local treasures which are what communities value in their area, and it will depend on community interest and involvements. For example if a community values a lake that is not considered a national priority this is where the community can engage with DOC to protect it. What is still to be decided is the priority for resources in this area and the ones chosen may partially depend on their ability to draw on external funding.

Finally there is Objective 1.6. This covers the rest of DOC managed land. These sites will get basic management, for example, biosecurity, fire, legal protection and maybe fencing,

but not much else. This sounds really bad but it is not dissimilar to the current situation for much of public conservation land.

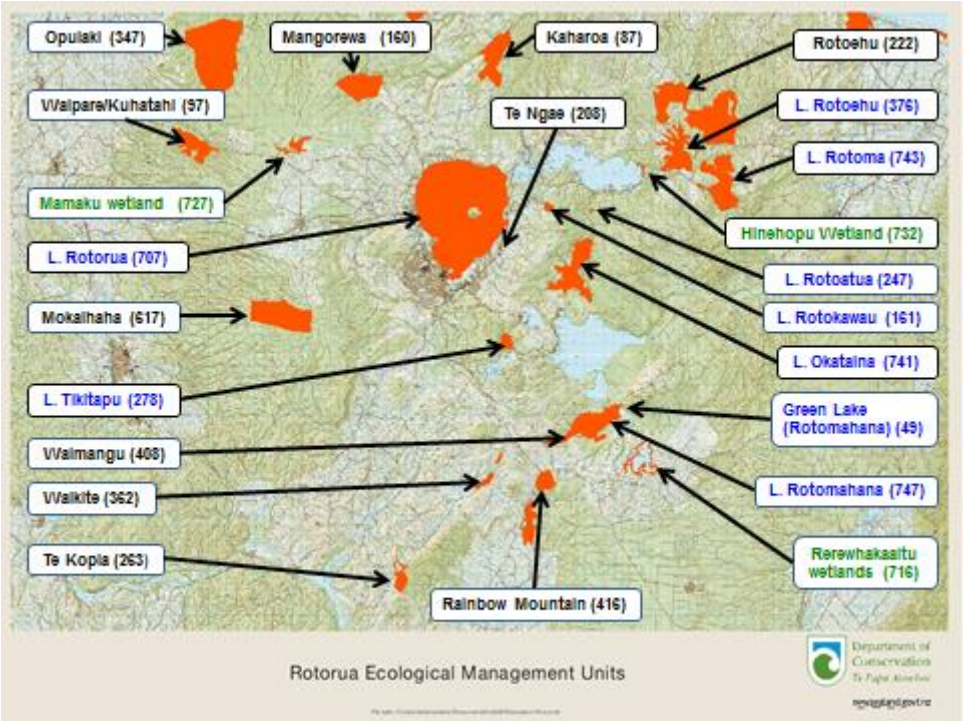
Addressing the first 5 objectives is a huge task. DOC's resources cannot stretch for everything everywhere. DOC therefore has to make decisions about what work to do and what not do, juggling limited resources or meeting both diversity and community needs.

How do we juggle these resources? Returning to Objective 1.1 'protecting national ecosystems', to help make decisions on which nationally important ecosystems need protection, and to identify the most cost effective projects at these sites, DOC has developed a national process called the Natural Heritage Management System, NHMS for short. It aims to maximise the conservation returns within a given budget and management constraints. It identifies the highest priority sites, both terrestrial and freshwater, that need to be protected and what work needs to be done at these sites.

To ensure that there was a full representative set of lakes in the best ecological condition included in NHMS, an expert working group considered information on about 3,800 lakes throughout New Zealand. The information used came from a number of sources including the Freshwater Ecosystems of New Zealand's data set. The type of lake, how pristine it is, its biodiversity and potential for recovery were all important considerations when making recommendations on which lakes should be included into NHMS.

In NHMS there are just over 1,000 terrestrial and freshwater sites that have been identified as important. Approximately 140 of these sites are lakes. All the sites were ranked as a whole, not separately for terrestrial sites and freshwater. For all the sites that are within NHMS DOC has looked at what pressures each site faces, what work needs to be done to address those pressures and a potential cost of the work. Currently DOC is at the point of prioritising which sites will have work undertaken. Unfortunately the amount of public funding will not extend to all of these 1,000 sites. There is going to be some hard decisions on what is the most cost effective work at which sites.

Slide 1



To give you a local flavour **Slide 1** shows the 23 ecosystems within the Rotorua Lakes area that are considered a national priority in NHMS. Nine of these are lakes and their national rankings range from 49 for Green Lake at Rotomahana to 747 for Lake Rotomahana itself. Admittedly there needs to be more fine tuning and over time some sites may be added and others dropped.

Once the lake has been identified as a national priority, or a local priority, it is important to understand what pressures the lake faces and decide on what work is required to address these pressures. There is no point undertaking work that will not address the problems that the lake actually faces.

Some examples of pressures identified for different lakes around New Zealand include:

- Loss of native catchment vegetation resulting in higher run offs, turbidity and declining water quality
- Invasive species such as macrophytes, pest fish and pioneer plants such as willows surrounding the catchment which in turn affects biodiversity, water turbidity and water quality
- Damming, inflow/outflow diversion altering the lake's hydrology and impeding fish passage
- Urbanisation, agriculture and animal pests surrounding the catchment altering water quality by increasing nutrient loadings in the lake

Leading on from this, DOC has identified what work is required to address the pressures. Examples here are:

- Advocacy through the RMA process whether it is submissions on regional plans or resource consents
- Riparian plantings
- Changing water management regimes for the lake
- Stakeholder education around pest species and surveillance control of pest species
- Fencing off water ways
- Pest control in lake catchments.

When might terrestrial pest control on a catchment scale be important for the lake? There are 4 potential areas where pest control may benefit the lake:

- Soil erosion and sediment yield may be affected by pest control
- Potential water run off rates into a lake
- Water quality
- As a holistic catchment based management approach.

While historical New Zealand science literature suggests pest animals were a significant contributor to erosion at a large catchment scale, much of it was anecdotal and non-quantitative. It is now considered largely incorrect. Natural influences such as tectonics, storm intensity and soil geological features have a far greater influence over erosion rates and animal pests at a catchment scale. The largest non-natural influence on erosion rates and sediment yield has been deforestation by humans.

The impacts of pests have largely been discounted when compared to other processes, so animal pest control for catchment scale is unlikely to address erosion issues and reduce sediment yield in a lake.

Deforestation can lead to increased water run off during rain fall events by up to 30-40%. However research indicates that there are unlikely to be detectable changes in water yield unless more than 20% of the catchment is deforested. So the effect of browsing on water yield is unlikely to be significant unless there is large scale canopy collapse and the forest is replaced by grass vegetation.

There is also some minor increase in run off rates as a result of animal pests significantly removing the understorey. However, it is probably not enough to affect lake water levels. Therefore if water yields are key, pressure on the lake pest control is unlikely to be effective in managing this and resources would be better directed to, say, re-vegetation.

The impact of animal pests on water quality is potentially important, however wild animal density is usually 2 to 3 orders of magnitude less than livestock. Their low biomass compared to livestock generally makes it a relatively minor factor in the overall catchment context. Therefore there is probably little point in undertaking pest control in catchments where a large part is under agriculture if you are trying to influence water quality levels in the lake. However, in catchments that are predominately in native forest the impacts of animal pests on water quality may become important and at that point pest control could help. There is also the issue of faecal contamination from pest animals but again magnitude between pest animals and livestock means it is probably going to be fairly minor.

The lack of direct evidence linking animal pests to changes in large scale catchment water quantity and quality does not suggest that they have no impact. All it shows is that their impact is smaller than other influences such as tectonics, large storms, deforestation and intensive agriculture. Therefore one cannot rule out completely pest control in catchments because accumulative impacts could still occur that

currently cannot be measured.

Environmental quality may be changing at a local or small scale that could be locally important, particularly to small lakes. There may be biodiversity benefits for native species that use the lake ecosystem. For example, terrestrial pest control in the Lake Hauroko catchment has been undertaken to protect mottled petrels that breed on the islands in the lake. Of course pest control will benefit the health of the forest ecosystem and the surrounding lake in an holistic approach.

What does this mean for Lake Okataina? It is a good example of a volcanic deep oligotrophic lake that has been ranked 741 in NHMS. It has a 6,290 hectare catchment and between 81% and 89% of the catchment is in native vegetation. While the lake itself is ranked in NHMS the surrounding catchment is not because the vegetation has been so highly modified through extensive logging. Additionally, pest numbers are high and the understory is in a poor state.

DOC staff have identified 3 main pressures that could affect Lake Okataina:

1) Lake macrophytes: lagarosiphon is present and hornwort is being controlled at the moment. But if other aquatic weeds are introduced they would alter the ecosystem.
2) Invasive fish: none, excluding trout, are present, but could have a significant impact if introduced.
3) While the water quality is high, phosphorus levels have increased which could potentially lead to a decline in water quality. I suspect that DOC staff may have talked to staff of both Bay of Plenty Regional Council and Rotorua Lakes Council when determining the pressures Okataina faces as these are the ones that have been identified through the LakesWater Quality Symposium and in council documents.

DOC has identified work required at Lake Okataina to address the pressures. For lake macrophytes and pest fish there are two key management tools. Advocacy work through education and stakeholder involvement is essential. It is far better to keep the invasive species out of Lake Okataina as it will be difficult to eradicate them if they become established. Hand in hand with the advocacy work there needs to be ongoing surveillance and if necessary control to prevent any more invasive species establishing.

There are two areas of work that have been identified to maintain and improve water quality. DOC sees advocacy work as critical to maintaining water quality. DOC has identified that promoting covenance and private forest remnants in the catchment, education, stakeholder involvement and engaging in the RMA process are particularly important. Secondly, since the majority of the catchment is native vegetation pest control in the surrounding catchment may help improve water quality at Lake Okataina.

An Animal Control Plan has been written, Cam Speedy is going to talk about that later, but if pest control is going to occur at Okataina to address water quality there needs to be ongoing monitoring to confirm that the pest control is effective at achieving the improvements required. In addition pest control has linkages to a region wide management of wallabies as part of a holistic approach, and Dale Williams will be talking about this in the next presentation.

In funding the work at Lake Okataina, the advocacy, and ongoing surveillance and control work is seen as a Rotorua Lakes' wide issue and will continue to be supported by DOC.

However a decision is yet to be made on whether DOC has the resources to undertake pest control in the lake's catchment as part of the NHMS process. Unfortunately the lake's ranking of 741 suggests there will be insufficient national funds available to do the work. However there is the ability to move the lake and its catchment into DOC's 1.5 Local Treasures priorities. The concept is that DOC would rate the lake highly under Objective 1.5 if there was significant community interest in it, including a willingness to contribute to the management costs.

In summary DOC has a process for prioritising where work will be done to achieve maximum benefits to New Zealand's natural heritage. Nine Rotorua Lakes including Lake Okataina have been identified as nationally important. DOC also recognises that even if lakes are not considered nationally important they may have local importance. While the impact of animal pests on water quality is generally considered small there may be a case for pest control in catchments that are predominately in native forests and where a holistic approach has been taken.

Finally DOC has identified pest control may be necessary in the Lake Okataina catchment if the lake's water quality is to remain high. What needs to happen now is a discussion between the Department of Conservation and the various Lake Okataina stakeholders on how to fund that control.

DAMA WALLABIES: THEIR HISTORY OF COLONIZATION AND CONTROL AT OKATAINA/TARAWERA

Dale Williams
Bay of Plenty Regional Council
dale.williams@boprc.govt.nz

Dale began work for the New Zealand Forest Service in 1980 as a Science Technician with the Forest Research Institute in Rotorua. Following a restructuring of Crown research, he was transferred into Manaaki Whenua - Landcare Research. As a technician, he supported scientists studying indigenous forest ecology, threatened species such as kokako and pest animals such as rats, possums, and deer.

In 1993 Dale joined the Department of Conservation, as a Technical Support Officer, advising DOC staff on pest animal management within the Bay of Plenty Conservancy. While in that role he completed a Post Graduate Diploma in Wildlife Management through the University of Otago. As part of that course of study, in 1997, he completed a research report, "Evaluation of bait stations and management options for control of dama wallabies (Macropus eugenii) in the Bay of Plenty. University of Otago Wildlife Management Report Number 85". Between 2001 and 2010, he facilitated a national biodiversity training programme for DOC, taking a one year break to work as the Threatened Fauna Programme Manager for the Chatham Islands. Since 2010 he has worked as a Land Management Officer for the Bay of Plenty Regional Council (BOPRC), based out of Rotorua, and advises landowners about Biosecurity, Biodiversity and Sustainable Land Management. Part of this Biosecurity role with the council is to take regional responsibility for issues relating to wallabies and he is part of a multi-agency Wallaby Management Team, which has representatives from DOC, BOPRC and the Waikato Regional Council.

ABSTRACT
Dama wallabies (*Macropus eugenii*) were liberated near the southern end of Lake Okareka in 1912. By the 1970s their numbers had built to high levels in the forests surrounding Okareka, Okataina and Tarawera and the damage they were causing to the forest understorey was marked.

In 1984 the New Zealand Forest Service established a pair of 'exclosure plots' at Okataina designed to isolate the impacts of wallabies from those caused by deer. A decade later when the vegetation plots were remeasured, species diversity had increased by 142% where both deer and wallabies were excluded. Diversity had increased by 57% where wallabies were excluded and continued to decline by 7% where browsing was unrestricted.

Between 1988 and 1999 three aerial poisoning operations and some ground based pest control, targeting wallabies and possums, were carried out around Okataina and the Makatiti Dome.

Though these operations were highly successful at reducing wallaby numbers (93-95% reductions based on cleared-plot faecal pellet counts) remeasurement of permanent 20x20 metre vegetation plots showed no response in the forest understorey. To some extent this is not surprising as the control operations were effectively 'one-offs' in separate areas and only limited follow-up control took place.

Whether the depleted nature of the forest understorey has a significant impact on declining water quality in the Central North Island lakes is a question that will be extremely complex to answer, and to see marked recovery in these forest ecosystems, pest control would need to target a suite of pests and be sustained in perpetuity.

With regards to wallabies, a multi-agency Wallaby Management Team (including staff from the Department of Conservation, the Bay of Plenty and Waikato Regional Councils) are facing a number of issues. The wallaby feral range currently covers approximately 180,000 hectares and continues to expand. A tiny proportion of New Zealand's vertebrate pest research has concentrated on wallabies, so the Management Team faces significant knowledge gaps around wallaby behaviour and they have access to few robust monitoring tools and control methods. A low level of public awareness about the threat to biodiversity posed by wallabies and increasing public concern about some pest control methods exacerbates these issues.

Though monitoring and control methods for wallabies are limited, recent advances include the successful deployment of digital trail cameras, DNA analysis and a wallaby indicating dog to confirm the presence of low density populations in new areas. Bait development work with captive wallabies has identified a number of areas where traditional possum baits can be modified to improve their acceptance by wallabies.

As the Wallaby Management Team plans to proceed with control operations, targeting new incursions and populations outside of the feral range, an "Adaptive Management" approach will be followed. This will maximise the benefits from knowledge gained during the course of the work. To help limit further dispersal of wallabies, the Wallaby Management Team also requires some 'pure science' research on dispersal behaviour, so invasion pathways can be identified and managed.

TRANSCRIPT

My association with the forests of the central North Island goes back to the early 1980s when I began work for the Forest Research Institute as a technician. My dealings with Dama wallabies started in the early 1990s when I took up a role as Technical Support Officer with the Department of Conservation. My return to Rotorua in 2010 to join the team at the Regional Council gave me a chance to take on some unfinished business with wallabies.

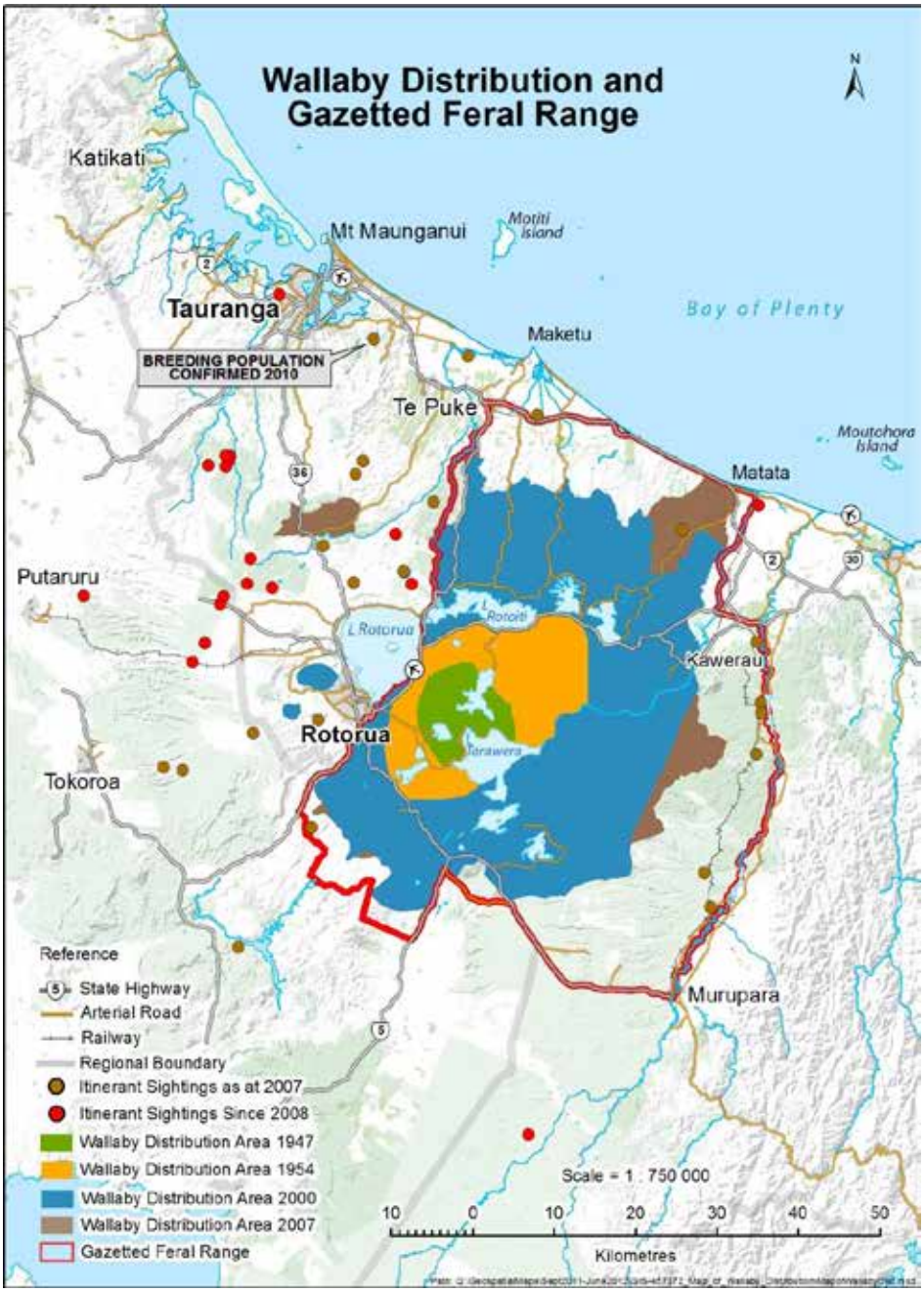
I will talk firstly about the critter and give you the history of their colonisation in the Bay of Plenty and the impact they cause on the forest understorey at Okataina. I will also give a history of the results of past control operations at Okataina, some of the issues inhibiting us from managing wallabies and recent advances, the 'good news' stories, and our future challenges going forward.

The most common statement I hear about Dama wallabies is, 'I didn't know we had wallabies'. They are the smallest of the five species that were introduced to New Zealand. A large male reaches 7 kilos and most of the females are less than 5kg. Compare that with the Bennett's wallabies found in South Canterbury which can be up to 25 kgs. Coincidently, every photograph of a wallaby I have seen at this symposium so far, apart from the one on the front of your document, has been a Bennett's wallaby, so clearly

Google images are lacking a few photos. Because they are small and nocturnal they prefer a scrubby habitat and they are very cryptic. It is not uncommon for land owners who may spotlight their property for deer and possums to be unaware that they have wallabies on their property.

There is a low level of public awareness that we even have feral wallabies in the Bay of Plenty and what is even worse is that people that do know we have wallabies do not see them as a problem; they are often regarded as being cute and harmless.

We have had these animals for 100 years now. They were liberated near Lake Okareka in 1912 and since that time have expanded to cover nearly 180,000 hectares.



Probably of most concern is those little red dots on the western side of the big red line which are confirmed sightings of individual wallabies. I will come back to this map later on.

Wallabies were introduced into New Zealand by Sir George Gray in 1870 when he put four species of wallaby on Kawau Island. In 1912 dama wallabies were transferred from Kawau Island down to the Bay of Plenty where they were let go near Lake Okareka. The orange blob on the map is the distribution in 1954; by that stage they completely surrounded Okareka, Okataina, Makatiti and three sides of Lake Tarawera. By the 1970s the New Zealand Forest Service had already identified they were having a serious impact in the forest understorey.

The photos above show the comparison of the vegetation within an exclosure plot put in by the Forest Service in 1984 and when the plots were re-measured by the Department of Conservation a decade later. The fenced area that excluded both deer and wallabies showed 142% more species diversity (above right). There is also a plot with a lower fence where the wallabies are excluded but deer can hop over the fence and that showed a 57% increase in diversity. Where both deer and wallabies had access diversity continued to decline by 7% (above left). Rob Allen talked about the biased nature of the exclosure plots which are deliberately sited to get a response. Rob said this may not be typical of all Okataina. It would, however be typical of all the second growth kanuka forests, the dry habitat that Willie Shaw referred to.

There has been a history of animal control, in this area, going back to 1962-63 when eight aerial poisoning operations were carried out to ‘protect rateable land’ between Lakes Tarawera and Rotoma. In 1987 there was another aerial operation using 1080 Mapua cereal bait carried out over the east and south of Lake Okataina. The following year that work was extended to include the Makatiti Dome and part of the Tarawera Scenic Reserve. Following on from that in 1989 through to 1991 various ground based control operations were carried out using a variety of methods - 1080 gel, 1080 cereal bait, cereal containing brodifacoum and hand laid cyanide. This work covered areas missed by the previous aerial baiting operations. In 1999 the last operation was carried out at Okataina, it used 1080 carrot and covered the western side of the lake. Bait stations containing Pindone was used in sensitive areas.

We have no idea of the results of the operations in the sixties as they were not monitored, but the other aerial baiting operations achieved high percentage kills ranging from 93% through to 95%:

- 1987 - aerial 1080 **95% reduction in wallabies**
- 1988 - aerial 1080 **93.7% reduction**
- 1989 - 1080 gel foliage baiting trial **87.2% reduction**
- 1999 – aerial 1080 carrot **93% reduction**

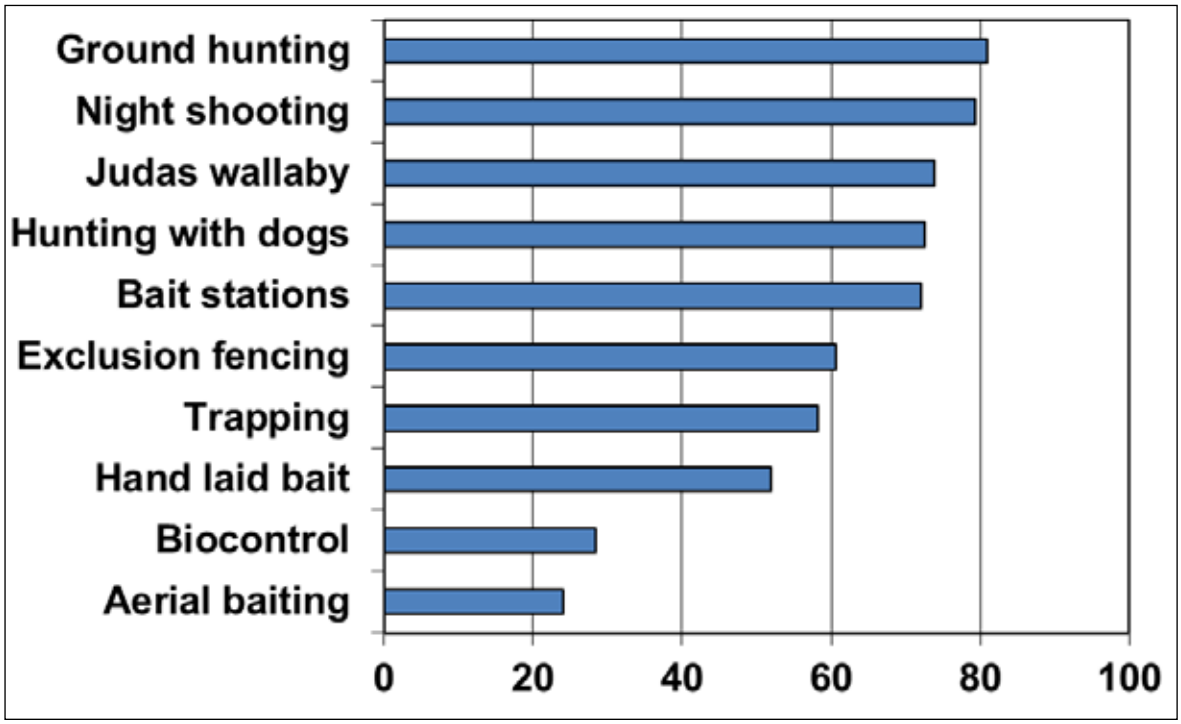
The only ground operation where results were monitored was Bruce Walberton's trial with 1080 foliage bait. That achieved 87.2% kill. These percentages are worked out using cleared plot faecal pellet counts and if any of you had the misfortune of doing faecal pellet counts they are the worst case scenario. You have to remove the pellets from the plot, go back a month later, search for pellets, count the ones that are recruited then do your control operation and repeat it all again. It is my understanding that in the 1999 operation the monitoring cost more than the aerial baiting operation. Despite the cost it is a good tool for moderate to high density wallaby populations but it is not suitable for picking up wallabies in low numbers.

All of these operations had a good result in terms of animal kills but, and that is a very large but, looking at the outcome in terms of forest regeneration, despite the dramatic reduction in wallaby numbers, the re-measurement of a whole series of 20 by 20 plots throughout Okataina showed no significant response in the forest understorey. To some extent that is not surprising because all of those operations were in different areas and there was little or no follow up control. They were essentially 'one offs'. Expecting to see change after doing just one control operation and walking away…it will simply not happen.

Another thing that I believe is going on out there, and Graham Newton saw this with fallow deer in the Blue Mountains, prior to those baiting operations a diet study carried out on wallabies showed they ate a large amount of 'leaf fall mahoe'. If you assume that leaf fall mahoe is less palatable than the small seedlings growing in the understorey, it is likely that the few surviving animals will reject the leaf fall and continue to eat every palatable seedling.

There are still a lot of questions to answer. How do we deal with the impacts of browsing mammals? How low do we need to push wallaby numbers at Okataina to see regeneration of palatable species in the understorey? What other critters do we also need to deal with? And the million dollar question, will sustained multi-species pest control actually improve water quality? More will be said about this in the next presentation and other speakers have already pointed out that even if improved water quality is not one of the outcomes, from multi-species pest control, there are other reasons for doing animal control.

There are some issues inhibiting wallaby management. We only have a handful of baits registered for wallabies and two pesticides (1080 and Cyanide) and clearly 1080 has a high level of public concern. In 2006 APR Consultants carried out a survey of public awareness about wallabies and they asked people about their support for a range of potential wallaby control options. As to be expected, aerial baiting was at the bottom with a low level of public support. Unfortunately it shows an inverse correlation between public support and the method's effectiveness.



Night shooting which had a high level of public support is not effective for broad scale control of wallabies in a forest situation. It is however effective on farm country with small patches of forest. We are reasonably confident that we have eradicated a small population of wallabies on Okere Farm using night shooting.

It is quite reassuring to see that bait stations, which I am a fan of, get around 75% public support, but there are a few issues with wallabies and bait stations which I will come to later.

Another issue inhibiting wallaby management is the low level of public awareness about wallabies. For any control programme to be sustainable the public have to be on side or it is a waste of time.

Wallabies are seen as a regional rather than a national issue so the amount of money spent on funding control operations, developing control techniques, and any sort of research and development, is just a drop in the bucket compared to the millions that have been spent on other pests such as possums and other predators. Unfortunately we are on our own here.

As a result we have very limited control methods available to us. We have a limited understanding of what drives dispersal and that could be helpful in the future. One thing we do know is that wallabies are very timid and neophobic. Neophobic means they are afraid of new things in their environment which also has implications for methods such as bait stations.

I have had some mileage out of this photo over the years. It shows competitive exclusion between possums and wallabies. In 1996 when I took this photo it was part of a pilot study I did to see which bait stations might be best for wallabies. Physically there is no reason they cannot feed from any of these three bait stations, their skull is about the same size as a possums so there is nothing stopping them. But I found that they completely emptied the Marley downpipe bait station, before taking a single bait out of the other two stations including the Philproof feeder.

The Philproof feeder is the best possum bait station on the market for a number of reasons. There is a big veranda on the front which effectively keeps the bait dry. It appears that wallabies do not like putting their head into the bait station because the veranda covers their ears and eyes. Unlike a possum which can climb the nearest tree when danger comes along, a wallaby has to pick up any source of danger with enough advanced warning to run away. Wallabies are very wary and they are constantly listening and watching out for danger. Enlarging the entrance hole on the bait station helps but it is still not ideal. The other issue seen in this photo is that possums will actively exclude wallabies from the bait station. Possums are half the size but twice as stroppy.

The photograph above was taken on Mt Tarawera and a wallaby is feeding quite close to some possums and it is probably a wee bit nervous. In most other video sequences you see the wallabies will depart when possums arrive.

These photos show some good news stories relating to recent advances in wallaby surveillance and monitoring. Firstly an ancient technique (left), a dog. Dogs have been around a long time but we are just starting to make good use of them. This specialised wallaby indicating dog and it handlers have been very successful in locating new wallaby populations on the margin of the range.

The other device shown is a trail camera (right) that is mainly used by deer hunters to get pictures of stags on their favourite wallow. We use these as a surveillance tool to record the presence of wallabies and determine if it is more than one animal. Also as a monitoring tool, by placing them systematically at 500 metre intervals to monitor the success of our control operations. This was how we located the wallabies on Okere farm, an unexpected spin off also recorded the first kiwi in the Rotorua district in the last decade. We also used the cameras to monitor the success of our night shooting operation (i.e. no wallabies have been recorded since).

We have also recently carried out a bait development trial, under contract with Ray Henderson from Pest-Tech Ltd in Lincoln. We have a captive holding facility here in Rotorua. Ray tested and developed various baits, lures and bait delivery systems for control of wallabies. He found that wallabies are strongly neophobic and upset by new things in their environment. He identified the ingredients that wallabies preferred, which were; wheat germ, bran, linseed meal, maize, brown sugar, salt and rolled oats, and combined them to make a palatable paste bait. When doing bait trials we used Connovations' 213 paste, as the comparison or "Control bait". Anything that is as good as that product scores a 50, if it is better it scores higher than 50. Ray's paste bait was a significant improvement on that commercial bait. His cereal bait was only slighter better than 213 paste. By comparison RS5 (the best commercially manufactured cereal bait) only scored 19.8% for wallabies. Ray confirmed that carrot appears to be a good bait for wallabies.

Ray tested 98 different lures. He found that the best wallaby lures were mixed herbs - tarragon, oregano, cloves or eucalyptus and wheat germ oil. Their interest in eucalyptus oil clearly indicates, even after 100 years, they are still pining for home.

One interesting outcome from that work was that cinnamon, which is in the majority of possum baits, is a repellent to wallabies. The only thing worse than cinnamon, that Ray trialled, was persimmon.

The results on delivery systems showed that placing the bait directly on the ground had the highest consumption. Strikers are a little potato starch container with a paste bait inside which are stapled to trees (left) and were also an effective way of distributing bait to wallabies.

At the end of the bait development we offered the wallabies bait with a feratox cyanide capsule inserted in it. Unfortunately the results were really poor. I believe we need to pre-feed with baits containing placebos that closely replicate the cyanide capsules to reduce the chance of the wallabies rejecting the cyanide capsules when the toxic baits are presented to them.

Looking forward, we still need some good wallaby specific control tools. We need to calibrate our monitoring methods. We have two good methods but we do not know their detection probability. We need better understanding of wallaby behaviour and dispersal which is important to improve the efficiency in our surveillance and control.

We need to improve public awareness, but this can be a double edged sword. It is all very well for us to generate motivation from the community but if they then say, 'What are you doing about it?' And we say, 'Mmm not much, we haven't got the tools'. It can come back to bite us, so it is really important to use the current control tools to get some runs on the board.

So what is our end goal? At the moment we are trying to stop further spread of wallabies. The red line on map (see map of distribution) was the gazetted feral range under the old Wild Animal Control Act. We now call that our containment area. The Kaituna River (the north western boundary) and Lake Rotorua itself, has formed an effective barrier to stop wallabies going west. Both the Tarawera River and the Rangitaiki River are good physical barriers and they form our line in the sand as defendable boundary in the east. In the south there is not much stopping them. Unfortunately where wallabies have dispersed west of Rotorua, all the streams are pointing towards the Waikato and are not a physical barrier.

Following our goal of 'stopping the spread', we are trying to eradicate isolated populations such as the Okere population (which we are reasonably confident is gone now) and a isolated population behind Te Puke (which was the result of someone keeping wallabies illegally for export). Once outlying populations are eradicated we can push back towards the middle of their range.

While this is happening the land management team need to decide whether wallabies are having a negative impact on resources within the containment area. If that is the case, it is sustained control, which involves pushing wallaby numbers to low enough levels that they do not impact on those resources.

Finally once making that kind of progress, then it is possible to step back and review whether eradication is achievable over the whole range.

There have been lots of cute photos of wallabies and I will leave you with this one because protecting bio-diversity is about killing things, it is not pretty. But we do need to get some serious runs on the board in pushing back the tide otherwise we run the risk of losing the support of our stakeholders.

I would like to finish up by thanking Guus Knopers and Lynell Barnett, our dog handlers, Lotte the dog and Phil Commons who is my 'go to' man for all wallaby issues. Ray Henderson did the bait trial, Cam Speedy and Nick Singers wrote an awesome report on animal control options for Okataina, which I have plagiarised for this presentation. Thanks also to the Department of Conservation and the Waikato Regional Councils are co-signatories to our wallaby management plan.

PERSPECTIVE OF A CONSULTANT AND CONTRACTOR

Cam Speedy
Wildlife Management Associates, Turangi
ngakowhai@xtra.co.nz

Cam is a free-lance Wildlife Biologist with 30 years management experience in a wide range of both native and introduced wildlife, from roles in the New Zealand Forest Service, Department of Conservation and in both the corporate and private sectors. He is the director of Wildlife Management Associates, a business committed to working collaboratively with stakeholders to find practical, sustainable solutions to New Zealand's unique wildlife management issues. Cam developed and project managed the eradication operation for more than a dozen introduced mammalian species from the Maungatautari Reserve between 2004 and 2008. Perhaps his greatest passion is sika deer, which Cam has studied for 25 years.

ABSTRACT
Pest management can be a very polarising issue. Every pest management operation is different, reflecting variations in terrain, accessibility, ecology, the types of pests present and the nature and scale of previous pest management. Most importantly, stakeholders often seek different outcomes based on very diverse drivers and beliefs. There is no 'one-size-fits-all' approach to pest management. From experience with a wide variety of pest management operations within diverse communities, a pest management regime specifically developed for the Okataina Scenic Reserves is described. One that will contribute positively to water quality, the sustainability of forest ecology and to community engagement.

TRANSCRIPT
Kia ora no tatou nga mihi kia koutou katoa e tena hui. Thank you for that introduction. Having heard from Alastair Fairweather, DOC, and Dale Williams, the Bay of Plenty Regional Council, I have been asked to give you an independent perspective. I will give you my background so you can make up your own mind whether it is independent or not. I will talk about my perspective around stakeholder considerations and how the social science of pest control has a long way to go. We will look at some of the pest management considerations in this part of the world and the key local pest issues as I see them. I will conclude with a brief look at a pest control proposal that my colleague Nick Singers and I prepared for Nicky Douglas when she was here with DOC a couple of years ago.

I am Rotorua born and bred and went to Massey University where my academic training was in zoology and wildlife management. I did 20 years in the public service (NZFS/DOC) before it got too much for me and then I worked for Roger Lorigan at EPRO for a few years. He taught me a lot. Since then I have been working for myself and often work in the renewable energy industry for Genesis Energy, particularly around biosecurity, tuna which has become a new passion for me and whio (blue duck) which has always been a passion for me.

My first love is sika deer and probably always will be; I have been a student of sika deer for 30 years. But I do have a background in biodiversity, particularly forest ecology and more recently with the energy industry in fresh water ecology. I have had direct involvement in planning and managing more than 70 aerial operations all over New

Zealand. So I do know a little bit about what goes on out there. When I worked for Roger I managed 700,000 hectares of ground based pest control annually. We operationalised a deer repellent for 1080 baits which we tested over 3 different deer species and a whole lot of other critters like possums, rats and wallabies.

I project managed the eradication at Maungatautari and Wairakei sanctuaries and have done a lot of work with iwi and hapu groups in conservation and management planning. That level of pest management experience has given me a lot of interaction with various stakeholder groups and many and varied; conservationists, various iwi, hapu, whanau groups, hunters, researchers, farmers and land owners, anti-toxin lobby groups and then agency staff for a lot of different agencies (Councils, DOC, Ministry of Health, Food Safety Authority, Animal Welfare, etc.). There are a wide variety of perspectives, values and desired outcomes out there.

There is always a strong consensus on the need for pest control but very rarely is there a consensus on how we should do it, because there are a whole lot of different methods of control. They have all got advantages and disadvantages but there is no 'one size fits all' silver bullet. It simply does not happen like that. You cannot use a rat trap to catch a wallaby and you cannot use a Victor No. 1 to catch a wallaby. Bait stations are good for some species but wallabies do not like all bait stations. Night shooting is good on farmland but do it on Makatiti Dome and you will be struggling. **(Slide 1)**

Slide 1

That is a really important take home message, there is no silver bullet. It is about using a mix of tools to deliver the right outcome. The right method for a given operational area depends on a whole lot of things including what outcome is sought. Other considerations are the terrain and habitat, the size and scale, stakeholder and landowner requirements and the types of pest present as well as considering the past. What have these guys been exposed to previously in control operations?

It is the pests that are important here and there are plenty of them; wallabies, mustelids, possums, rats, cats, pigs, deer. **(Slide 2)** Which ones are the important ones?

Slide 2

That really depends on what is to be achieved. In my view the key management requirements we must have for a place like Okataina are the protection of those local iconic tree species like the pohutukawa, rata; mature forests as seed sources for wider recovery. **(Slide 3)**

Slide 3

It is also important to maintain the ecosystem services provided by the remaining keystone bird species like the bellbirds, tuis and kereru, those pollinators and seed dispersers. Without them the recovery of the Tarawera forests, impacted by fire and logging, will not occur. Forest succession following the Tarawera eruption means that the forests are young, they are even aged, and they are still developing. It is also obvious that the healing of all those slips that Willy Shaw showed us is critical to reduce sediment and phosphorus run-off. These are key management requirements in designing a pest management regime for a place like Okataina.

In my view these are the three key critters that we must look out for. **(Slide 5)** Possums are not only chewing at the totara, rata and the kamahi, they are also taking off the flowers and the seed sources for future recovery. If there are no berries for kereru to disperse then that seed dispersal ecosystem service has no foundation. Ship rats are devastating predators on those keystone bird species reducing their numbers, their productive output

of offspring. Every little seedling that eventuates from a seed or fruit pooped out by a kereru will not turn into a tree while there are dozens and dozens of wallabies nipping them all off. In my view these are three critters that we have got to address. Unfortunately wallabies, because of their subordinate behaviours, come third on the list when you put a device out there. They will not turn up until the rats and the possums are dealt to, so that creates operational headaches as Dale has already described.

Slide 5

Possums do a lot of habitat damage; they take a lot of forest resource like flowers and fruit as well as destroying the canopy. They are a predator on insects, bird's eggs, nestlings, reducing those ecosystem services. They are a competitor for our native wildlife taking food resources that other species would otherwise have.

Ship rats cause habitat damage by the destruction of fruit and seeds. They are a predator of insects, bird's eggs, nestlings and again the reduction in the ecosystem service and a competitor for native wildlife.

Wallabies cause habitat damage; they browse seedlings and destruct the understory of the forest. Most of the Okataina Reserve is below a metre high as many of you would have seen on the field trip on Wednesday. There are not even filmy ferns, it is just hollowed out. There is a lack of regeneration particularly around the slip scars from climatic events, but also the natural forest succession processes recovering from the Tarawera eruption.

What are the pest attributes? Possums are widespread at moderate density. There has not been a lot of pest control in that area since 1999 and 15 years is a long time in pest control. They will be an environmental equilibrium in balance with whatever resources the forest contains. They are vulnerable to most pest control methods. One of the things that makes possums so successful is their investigative behaviour, a willingness to try stuff out, and it is also their Achilles heel which makes them relatively easy to control. Populations take 5 years to recover after control.

Ship rats are very wide spread but fluctuate in density from one year to the next. When we have a mast[1] year of forest seeding and fruiting, rodent abundance booms. They can occur in very high densities when we have a big rimu or podocarp fruiting. They are vulnerable to most of the toxins we use and have preponderance for any toxins given them. They can be trapped but it needs a large fleet of traps during a mast year to make a difference. You need regular intensive control for rodents because they breed very prolifically, the average litter size is 6 or 7 and they can be breeding themselves at just 3 months of age, so they proliferate very quickly and come back very quickly.

Wallabies are currently at an environmental equilibrium with the forests out there. They have not been controlled for 15 years and they are spreading. My mum lives up in Tarawera and I am always getting hassled about the possums eating her roses. But when she tells me she has a funny looking wallaby kangaroo on her front lawn eating her grass, and she has never told me about it before, it tells me that things are changing. They have got limited vulnerability to many of our pest control techniques and that is an operational headache, but also it is subordinate behaviour. If you want to remove wallabies where there are possums and ship rats at any sort of a density you are up against it.

It has been many years since there has been any effective control. That previous control was small scale and localised with no repeat work done. There are large areas of adjoining habitat which remain untreated and will remain untreated, such as vast areas of forestry plantation to the east. Ongoing reinvasion from both sources is inevitable. It is not about eradicating; this is about starting on a journey that does not finish. If you are going to bite the bullet and undertake expenditure on pest control in the Okataina Reserve it will require sticking at it forever otherwise all the benefits unravel and it will be back to square one if it is stopped. I cannot emphasise that point enough, there must be sustained control for any sort of benefit; a long term commitment for decades to come to see outcomes achieved.

But there are some opportunities here. There are a lot of positive community initiatives and motivation in the Tarawera community with their pest control work and at Rotoiti. There are good physical boundaries. Dale showed you the effects that Lake Rotorua, the Kaituna River and the Tarawera River have for wallabies. They create nice geographical features to limit reinvasion if we get the geographic scale of our pest control right. The unknowns of course are things like pigs and deer. There are not large numbers of deer in this landscape but they do browse. Some will argue they are an analogue species for moas and that our forests without any browsers are not natural anyway, so who knows. But for me the three that we need to look after are possums, wallabies and ship rats.

The potential pest regime that Nick and I have considered is a combination of localised intensive control, targeting ship rats and possums to enhance key bird species sites supported by landscape scale pest control. Most of the localised control can be done at ground level and be community led involving stakeholders. If it is targeted on the high value mature forests which provide seed sources for keystone bird species that have those ecosystems services for dispersal then there is the opportunity to support the larger landscape. The big stuff, the 5,000, 10,000 hectare areas, by its very nature will have to be agency led which will need some sort of secure funding. The logistics of managing

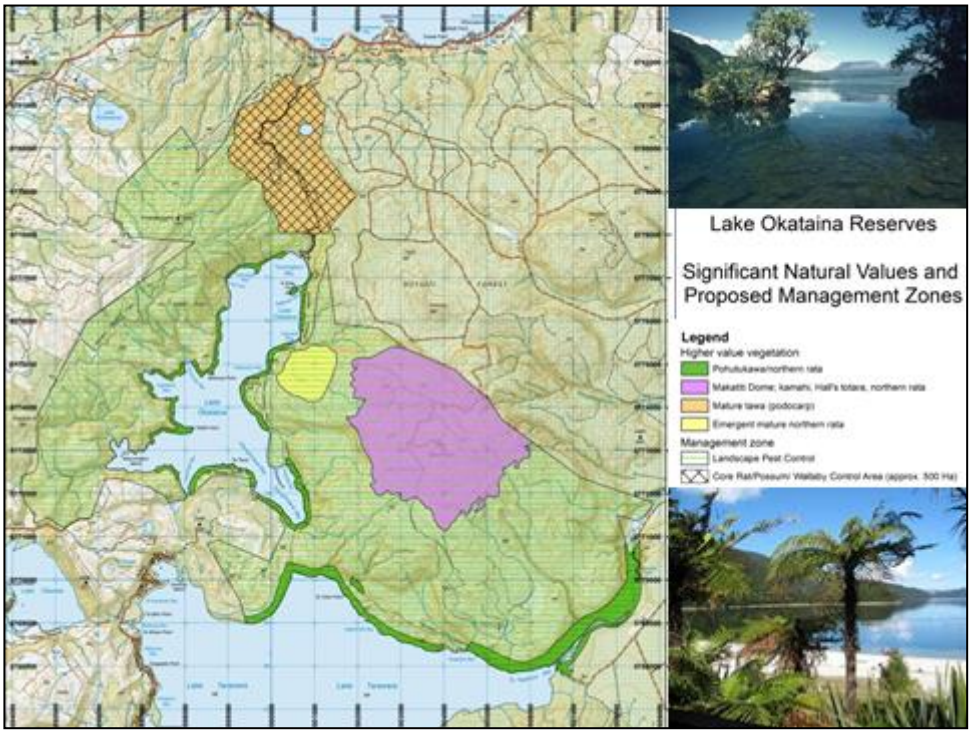
[1] mast year (noun)a phenomenon when the fruit (mast) produced by trees in a given year is exponentially higher than the average; by extension, a year in which vegetation produces a significant abundance of fruit. dictionary.reference.com/browse

possums and wallabies on large landscape scale, whether by aerial or ground means, requires a level of complexity that cannot be handled by community groups.

A pest management regime would require regular landscape scale pest control at 3 - 5 year cycles over a large area, supported by more intensive community led pest control in smaller localised areas of high quality habitat. For effective forest recovery control it would require 4 to 6 cycles, a 20 year time horizon, to get any outcomes. Are funding agencies and communities ready to take on that sort of an endeavour? It is a serious endeavour which, if you want to deal with, you need to go into it with your eyes open.

Slide 6 is a map of how a regime like this might be structured. Our thinking was that there is some very high quality tawa/podocarp forest which is relatively accessible (brown cross hatched) where there is an outdoor education camp. This is a sitter for some sort of community led ground based regime that is ongoing.

Slide 6



Here ship rats would always be suppressed, as would possums, so that birds like kereru and tui and bellbird could thrive in that environment, from where they can take the seed sources from those mature forests and spread them into the surrounding recovering landscape. There are some very important resources in places like Makatiti Dome (purple) and some of the pohutukawa (dark green) rata (yellow) forests, but as already discussed most of this is developing second growth forests (bright green) which have been impacted by the Tarawera eruption, fire and logging. We want to see a wider recovery of this area. An effective landscape scale pest control area might well be much wider and even have to involve the production forestry to the east where there is a sea of pests. If you want to create an island of very low pest density (and pest impact) it is vital to manage this sea of pests which will be a source of reinvasion forever.

We have good physical pest boundaries like the Tarawera River and lake shores and a very active community group at Tarawera who are doing great things with community led pest control bringing back birds to their settlement. This provides an opportunity for birds

to help repopulate the wider area with vast numbers of seeds. However, if you do not remove the wallabies out of this wider area those seeds will be nipped off as cotyledons[2] and none of them will turn into understory that will support the healing of those slip scars, the healing of that lake shore erosion and the recovery of the Tarawera eruption forests back to tall forest.

In summary, there is no 'one size that fits all' approach in pest management. It is about selecting the right tools for the right place, for the right reasons based on the sorts of outcomes that you are after. If you do not do that it is wasting your time even starting.

The most appropriate methods depend on the outcomes sought and the attributes of each operational area, stakeholder requirements and pests present, and again I cannot over emphasise that enough. For Okataina it is a combination of methods over a sustained period of time, localised community led pest control projects supported by landscape scale projects. We have a really good one at Turangi where Project Tongariro manages pests on Lake Rotopunamu over a 500 or 600 hectare scale. It is a magnificent place to go and see what New Zealand forests used to look like in terms of birds, but they would not be as successful if they were not supported by TB Free New Zealand landscape scale Tb vector control in the 20,000 hectares of forest all around it. It is the sort of example that Nick and I think has application here at Okataina, based around our experience at Mount Pihanga and Tongariro National Park.

The cool thing about that approach is that it provides an opportunity for stakeholder engagement and an active community like you have here. To me it is a bit of a no brainer and critical for sustainable outcomes.

[2] A **cotyledon** is a significant part of the embryo within the seed of a plant. Upon germination, the **cotyledon** may become the embryonic first leaves of a seedling.
http://en.wikipedia.org/wiki/Cotyledon

QUESTIONS

Ken Hughey, DOC: I am confused about the issues of water quality and biodiversity. If we achieve, for example, a 95% reduction in wallaby densities in these forests or get to the level required where seedlings survive would that achieve a water quality outcome? But if we only achieve a 50% reduction which might achieve a water quality outcome but unlikely to achieve a biodiversity outcome. We need to be clear about these questions and what we seek to achieve.

Dale Williams: BOPRC: The whole density thing is academic. Those 95% reductions mean diddly squat, the important slide was the next one, are you getting the forest regeneration? To do that you have to measure the forest. We believe that it is more important to know how many possums are left rather than how many have been killed. Our trail cameras may be giving us that for wallabies. We want to see very few wallabies in the cameras after our controls. To answer your question about achieving outcomes, you have to suck it and see, which is what Cam was saying, give it a go and find out.

Cam Speedy, Wildlife Management Associates: I will also make a comment about how low you can squeeze things down. I think back to the Pureora Forest operation in my last year at EPRO with 83,000 hectares and two pre-feeds before the operation, afterwards possums were very hard to find. People 20 years ago would never have thought they could get possums down that incredibly low. But with advances in technology you can, and I am confident that with trial and error and a bit of work you could get wallaby numbers down too. The challenges will be to understand the dispersal mechanisms and how quickly they come in from adjoining uncontrolled landscapes. So there is a lot of work to do in the wallaby space and having tools to measure abundance and density, but I am confident that we can come up with a regime on a landscape scale that would squeeze wallaby densities down to infinitesimally low levels. That would make a difference in the forest understory.

Alastair Fairweather, DOC: The only way to determine if the operation is a success is to monitor the outcomes; monitoring forest plant species, bird species and water quality. Only then will you know the effectiveness. I question whether water quality will be influenced by pest control. Numbers are quite low and there are other natural processes in effect that are probably more important in the long term.

Rob Allen, Landcare Research: We have been controlling pests in this country for many decades but can someone pull out a list of achievements from all that investment? I believe we are surprising lacking in that, but there are reasons for that. Whatever these benefits are, and we will come to them in a minute, were they possible and then, if you undertook an action, could it be achieved? I would say we are littered with the lack of demonstrable achievements. We need to go into these things very carefully; are the benefits possible and can we achieve our desirable outcomes?

I will give a few little examples. One of the long term pest controls in New Zealand is the control of red deer in the Murchison Mountains in the name of protecting takahe. That has been done for more than 30 years and good quantitative data has been collected on the vegetation. Recently there was a publication on that which struggled to demonstrate any recovery in the understory. That parallels Dale's presentation where they are struggling to detect a change in the forest understory with a mish mash of pest control at Okataina in the past.

That is one aspect. I was pleased that Alastair made comments about the pests. There is a biodiversity outcome there and we have been talking about the water quality outcome. In the fifties and sixties water quality was a major driving force of pest control. We gave up on it for a couple of decades and it is now coming back. But Alastair's specific words, and I will not hold him to this, were, 'Water quality impacts of pests is generally low'. There have been quite a number of studies and when you average across these studies there is a pattern, whether it be wallabies or deer. When I see the word 'pests' I think they mean 'across all pests'. We do not have data on those species because there would not be a quantitative study in New Zealand demonstrating a water quality impact of pests. I accept we can control pests dramatically, that is repeatedly demonstrated, but can we achieve the outcomes we are interested in after investing a lot of money in places and not achieving them?

To paint a picture of this introduced biota as always being bad is not entirely correct. In Banks Peninsula the best distributer of matai seedlings, which was widely distributed in the area, are now pigs. If we want our matai forests back and want pork should we be allowing the pigs? Are benefits possible and are they achievable?

Willie Shaw, Wildland Consultants: Monitoring is essential as Alastair said and the results will always surprise. There will be unexpected results from any monitoring to do with pest control, especially dealing with multi species groupings and varied vegetation and habitat cover.

Rowland Burdon, Royal Society of New Zealand (Rotorua Branch): Dale you mentioned that there were very successful poisoning operations in terms of % kill with wallabies but they were generally one-off operations in particular areas. My question is what is known about how follow up poisoning operations might decline in effectiveness?

Dale Williams, BOPRC: In terms of wallabies almost nothing is known because most of those operations were one-offs. Cam raised an important point about sustained control. There is no point in starting unless you intend to carry on. To me it was almost criminal that those operations were not carried on. We might be having quite a different presentation today.

I would like to take this opportunity to talk about eradication because that is a term I have heard a lot over the last 2 days. The scientists in the group understand what eradication is, but there may be a few people who do not realise there are very defined rules around eradication. Considering the wallaby distribution map I put up, we are trying to eradicate the isolated populations and ideally eradicate them completely.

The rules state that:

- your pest has to be vulnerable to your control technique
- you have to expose all your pests to the control technique
- you have to kill them faster than they can breed
- in the case of weeds you have to keep on killing the propagules as they pop up

Then there has to be either no or a very low chance of reinvasion.

Pest control falls into two camps. Site led control trys to get the benefit that you are after. When you are trying to limit dispersal or eradicate you do not care about a conservation outcome specifically in the site where you are killing the things. Targeting the animal we call pest led control. At the moment with wallabies our control is pest led. We are trying to

limit dispersal and eradicate those isolated populations. Our monitoring is based on finding the last individual.

Angus McKenzie, Latitude Planning Services: Thank you very much for that informative summary. I like what you were saying Cam around achievability and it being a long term game. You touched on the social science around pest control and mentioned that it has a long way to go. I wonder whether you could just explore that a little bit more and maybe outline a couple of successful approaches in that sphere.

Cam Speedy, Wildlife Management Associates: I am not sure I can because folks have a very different perspective on everything based on their own personal world view and there is no consensus around what is the best approach to controlling pests. Some people are happy with toxins and some are not, and that will always be the case. When working with communities, if we have a shared vision about what we are trying to achieve then we can work our way through the ins and outs of how to get there. But it is sharing the vision which is most important. I have got away from trying to work out the journey and just get everybody on board with what we are aiming for. I do not profess to be a social scientist, I just know that there is a lot of debate in New Zealand about pest control and how it is done and I think there always will be. But I think we should all focus more on a shared vision of what we want our place to be.

Hilary Prior, LWQS: Dale do you know why the Bay of Plenty Regional Council Draft Long Term Plan has a significant decrease in effort for wallaby control?

Dale Williams, BOPRC: No. I guess there are always limited resources. My slide said that we have not got enough runs on the board, we are losing stakeholder support and that might well be an example of exactly what is going on.

Theodore Kpodonu, Waikato University: Two quick questions. The first is that these animals have been around for about 100 years. From an ecological point of view are we seeing them as being integrated into the ecology of New Zealand? For instance Rob gave an example of peak dispersals of seeds of certain plants, so are we looking at them as just pests or are we looking at them as becoming an integrated part of the ecology of New Zealand? My second question is for any wildlife to have an impact on an ecosystem they should exceed a certain threshold. Do we have numbers of populations for the different animals for each catchment or we are just eliminating, eliminating, eliminating and do not have a threshold.

Dale Williams, BOPRC: I think the threshold question was the same question I asked - let's see. The first part was about what we call technically 'recombinant ecology'. Are these species now a part of New Zealand's heritage?

I guess they are, and some introduced species people rate highly, such as deer, which Cam mentioned as a deer hunter, and so am I. We live off sheep and beef which are introduced species as well. So it is a value judgement. In terms of being an integrated part of our ecosystem, Rob mentioned that we used to have a lot of native browsers and the argument is whether these modern introduced herbivores are simply replacing the extinct ones. It is one of those arguments that could go on forever. Looking at introduced species that we should consider bringing in, Rob's photograph of a bird that looked very much like a Cape Barren goose, why don't we bring that back? There was a duck that looked very much like the Australian Wood duck, why don't we bring that back? There is a sub species of the New Zealand quail that lives in Australia, why don't we bring that back? It would be something that might fit into our ecosystems a bit better than wallabies do.

Max Gibbs, NIWA: Would it be appropriate, rather than to eradicate wallabies, to convert Lake Okataina into a Maungatautari type situation where we exclude within a certain range from the lake the impact of wallabies. In other words the exclusion cages are 20 x 20 metre control plots within the forest, if we took that around the entire lake would that make a difference. Then the understory regeneration would reduce sediment run off which is the fine material taking phosphorus into the lake. It is lateral thinking, but would the cost be achievable and better spent that way?

Cam Speedy, Wildlife Management Associates: I will have a crack at that since I was involved with the Maungatautari pest eradication. The fence was $200 a metre to build, how many thousand hectares did you say the catchment was? 6,290, Maungatautari is 3,500 hectares more or less and it has cost in excess of $10 million so far. The regeneration in the forest understory is unbelievable, within the first 18 months all the slip scars and even the tracks that were put in the southern enclosure vegetated overwhelmingly. That would achieve exactly what you are talking about. There would be prolific regeneration at every square inch of the catchment. But at a catchment scale of 6,290 hectares I would really question the economic viability and the long term maintenance costs. Looking after a 40 kilometre Maungatautari is a huge undertaking and not without its problems. A fence would be twice or three times that around Okataina. But if there is the political will, and the finances available, it is achievable absolutely.

Dale Williams, BOPRC: On a smaller scale there is a peninsular in Lake Rotoiti that is an ideal case study. It would only cost about $200,000 to build a fence across the isthmus. It has wallabies, possums and rodents fringed by pohutukawa, very similar vegetation to Okataina but whether you could monitor the benefits to the lake from an operation that small would be anyone's guess.

Jacqui Aimers, Freelance Scientist: A question about dama wallabies. They are a nasty pest here but they are endangered in their natural range, virtually extinct in mainland Australia and there was a repatriation attempt made some years ago that had limited success. Is there any potential for some repatriation taking the pest back to South Australia and whether that would be a positive PR story that could counteract any negative PR with the extermination of a very cute pest?

Dale Williams, BOPRC: You are right. A decade ago there was a reasonably lucrative export going on. I suspect a lot were going to game parks and possibly the freaky pet trade in the States. About 40 animals went back to South Australia because the ones that came to New Zealand were from the Australian mainland and genetically they are already extinct. Dama wallabies still exist on the offshore islands of the southern coast but the ones we have are the mainland gene type. Recently we processed permission under the Biosecurity Act for wallabies to be exported to zoos in the States. They have got a genetic breeding programme and there were two shipments of about 40 animals. But one of our requirements was an indication from the Australian Government that they see these zoos supporting the conservation of their wallabies and we did not receive that. There is potential but it could be a double edged sword because it is back in the cute and cuddly thing.

Ken Hughey, DOC: Before we take another question I am reminded Max that there has been a request from Maungatautari for an additional injection of $600,000 per year to operate that sanctuary over and above the costs that they thought they had budgeted for. These mainland sanctuaries are huge investments and something the communities must enter into pretty carefully, but they do have a lot of benefits as you talked about.

Don Atkinson, LWQS: The last kill was about 15 years ago. Are we now at a sustainable population level or will it get worse if we do nothing?

Dale Williams, BOPRC: It has not been measured, but Cam inferred those wallabies will probably be back to some equilibrium. From what I understand the numbers are way lower than they were prior to those operations, they will probably never get back to those levels. They have already eaten themselves out of house and home, but they are spreading and that is our biggest concern. From a wildlife management background, when resources become limited it is one of the factors that drive dispersal.

Session Seven : Responsibilities and Funding

SESSION CHAIR – Ian McLean, LakesWater Quality Society

WATCHING FOR INVASIVE SPECIES: PUBLIC ENGAGEMENT

Tracey Burton
Freshwater Ecologist, NIWA Hamilton
Email: Tracey.burton@niwa.co.nz

Tracey is a scientist in NIWA's Freshwater Biosecurity team with more than 15 years' experience in undertaking and designing aquatic vegetation surveys, with a focus on the use of aquatic plants as indicators of lake ecological condition. In her role Tracey is also the regional co-ordinator of NIWA's education and public outreach activities and is currently exploring the potential for citizen-science volunteers and community groups to assist with the early detection of invasive aquatic species.

ABSTRACT
Invasive species continue to be one of the greatest threats to the Rotorua lakes and include not only water weeds and wallabies, but other organisms too. Invasive molluscs such as zebra and quagga mussels have the potential to cause wide spread devastation to our freshwater ecosystems and are just one example of other invasive aquatic species not yet found in our New Zealand lakes.

The management of invasive species is a shared problem that requires the cooperation and support of a diverse range of stakeholders, interest groups and members of the general public. The early detection of an invasive species is critical and may make the difference in being able to appropriately manage, control or eradiate a species before it has a chance to spread.

Anyone can help prevent the incursion and spread of invasive species into our lakes. In New Zealand, we can learn from the success of programmes in other countries where they are recruiting citizen scientists to look for anything new or unusual. Citizen science, broadly defined as the involvement of volunteers in research, provides a means of combining research activities with environmental education and public engagement in science. Volunteers are able to increase their knowledge and understanding of the environment, learn more about local issues of importance, and contribute to science based recommendations. In addition, observations collected by citizen scientists can provide valuable records and knowledge that otherwise wouldn't have been available.

TRANSCRIPT
Good afternoon, today I am going to talk about the importance of watching for invasive species, look briefly at what is here and what is not and look at ways in which the public may be able to help with watching for invasive species in their lakes.

Yesterday we looked closely at the weeds in the lakes and today have learnt much about the potential impacts of wallabies but we do not want to gloss over other invasive species that have the potential to pose a serious risk to the Rotorua region as well as the whole country. There are weeds not here yet that are much worse than the ones we have

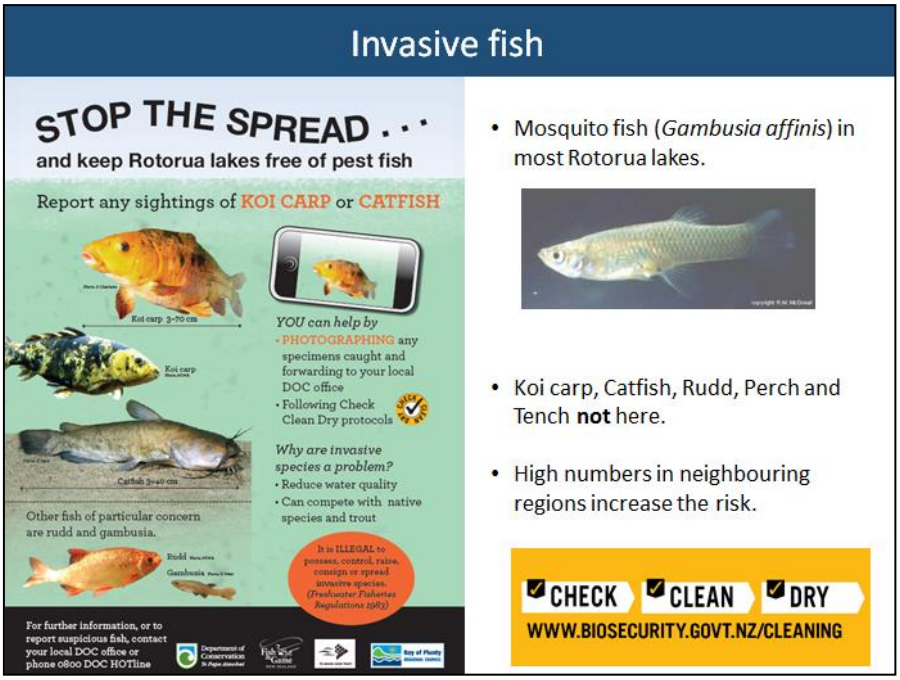
already. We also have concerns for the spread of invasive fish into the Rotorua lakes. Didymo is in the South Island. So we need to remain vigilant in watching for these invasive species that are already on our doorstep.

There are other invasive species not yet in New Zealand that we must also be on the lookout for. **(Slide 1)** Freshwater invasive snail species and other molluscs such as the zebra and quagga mussels have the potential to cause widespread devastation to our freshwater ecosystems should they make their way here.

Slide 1

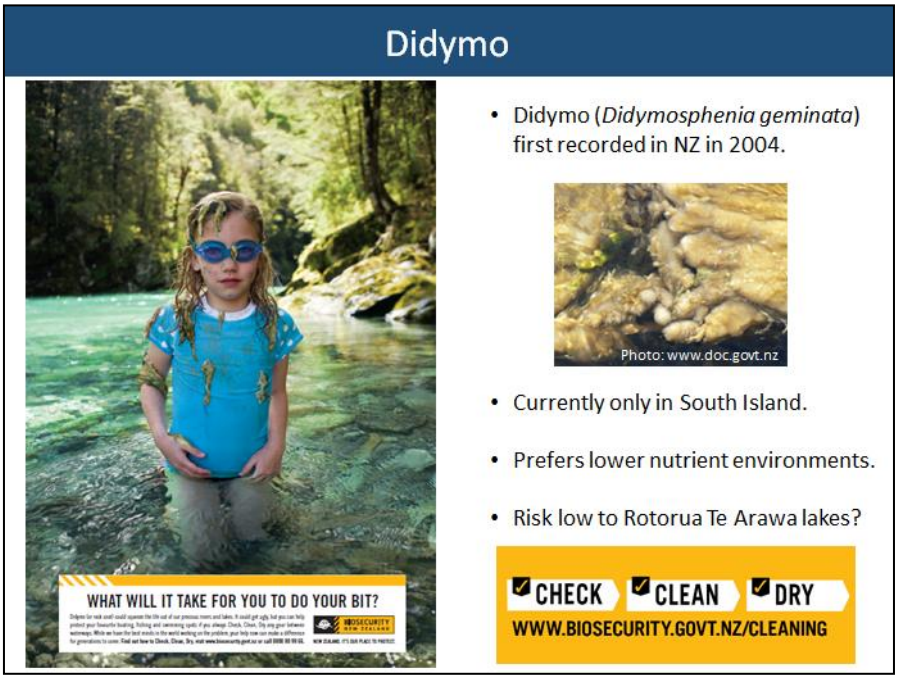
We do not have any of the major pest fish species in the Rotorua Lakes now but we do have the invasive mosquito fish. A programme this summer using students to carry out interviews around boat ramps focused on pest fish awareness and some suspicious fish sightings were reported. Luckily the only one that required validation was a goldfish found

Slide 2



on the edge of Rotoiti. However these reporting's should serve as a reminder that we need to watch out for invasive fish. Koi carp, catfish, rudd and perch **(Slide 2)** are well established in the Waikato Region and pose a great risk to these lakes. All lake users must remember the 'Check, Clean, Dry' messages that can help prevent the introduction or spread of pest fish and other invasive species into the lakes.

Slide 3



Didymo (rock snot) was first recorded in New Zealand in 2004 **(Slide 3)** and is still only in the South Island, likely because of its preference for lower nutrient environments and colder waters. There is research now suggesting that it may not pose a significant risk to the Rotorua Region should it make it up this far but the message is the same, 'Check, Clean, Dry'. Before didymo hit the South Island it was given little thought and its impacts were not appreciated until it arrived. The strong message from this is that we do not know the impacts of invasive species until they arrived so we always need to remain vigilant. It is easier to prevent the arrival of new species into a lake than to try and control or eradicate them once there.

The apple snail (top left) can literally grow to the size of a small apple and the ear pond snail pictured at the bottom is one that I have a personal interest in. These two snails are both available through the aquarium trade in New Zealand and at my local markets near Cambridge there is a man who sells bags of ear pond snails, 10 for $10, readily available. Despite their availability only one apple snail has been found outside of the trade, in the Waikato River in 2010. Following an extensive search of the river carried out by the University of Waikato no more were found. It was most likely released from someone's fish tank into the river and hopefully a one off.

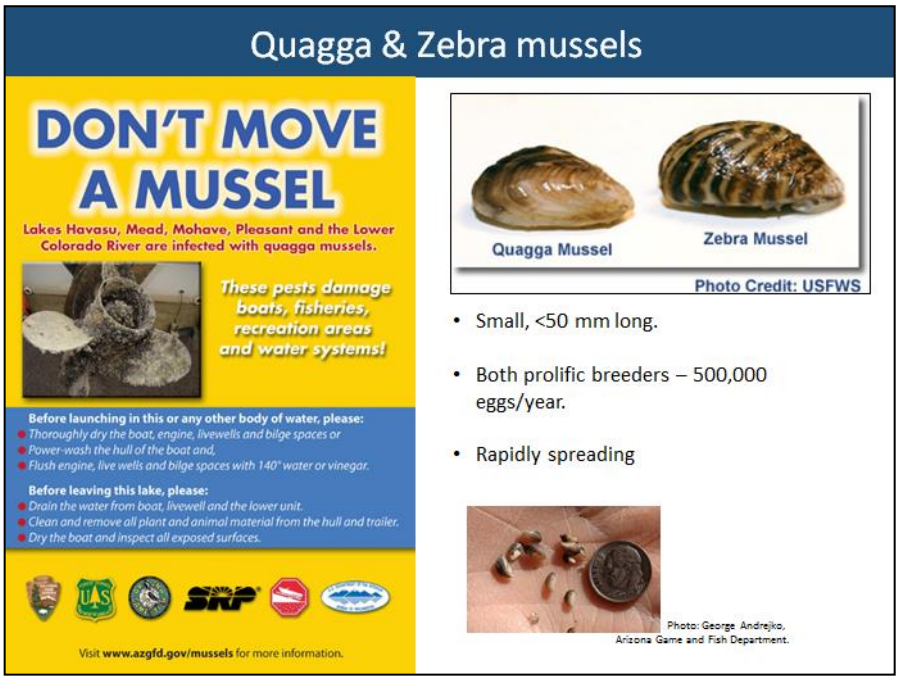
These invasive ear pond snails can grow to about 25 mm wide, about the size of a 50 cent piece, and were recorded for the first time by myself and John Clayton during a survey of Lake Rotomahana in 2011. Since then they have naturalised in Lake Pupuke (Auckland), Lake Roundabout (a small lake in the South Island), and four other Rotorua Te Arawa Lakes, Tarawera, Rotoehu, and this year for the first time in Lakes Rotoiti and Okaro.

We carry out aquatic plant surveys in these lakes with scuba gear once every two years so are confident that these snails were not previously there. They are moving quickly between lakes. In Lake Rotoehu, the sheer numbers of these snails present in one of the bays was alarming. If I had been a swimmer in that bay I would have been crunching at least three of these snails with each foot step. We do not know enough about these snails to assess the risks involved. There may also be potential human health impacts associated as they can be vectors of different parasites but we are not sure.

There is also the Malaysian Trumpet snail (left) which might not pose a significant threat to a lot of New Zealand lakes because it has temperature requirements. However because of the thermal inputs in some of the Rotorua lakes, they are already in the Golden Springs area, more work needs to be done to see what the potential risks could be.

In my opinion one of the worst invasive species not yet found in New Zealand are the freshwater zebra and quagga mussel. **Slide 4** at the top shows an adult quagga and zebra mussel which are smaller than our native mussels (kakahi), at less than 5cm long. Both alien mussels are prolific breeders. Adult mussels, some only as big as a grain of rice, have been known to produce between half a million and a million eggs each year. These snails are present in the United States and still making the news as they continue to spread. They were first reported in the Great Lakes in Northern America around 1988, and have since spread through many states. They were found in Lake Mead in Colorado for the first time in 2007 and in October 2014 quagga mussels were found in a reservoir in

Slide 4



the Heathrow area in London.

Slide 5

Slide 5 illustrates some of the problems resulting from these mussels which are of real concern. One problem is that while they are prolific breeders they are also great water filters. The immediate impact of abundant populations of these mussels is that water clarity improves. John Madsen talked about mussels in waterbodies causing a threefold increase in the water clarity which might be seen initially to be a great improvement. The problem is that they filter out the phytoplankton and suspended solids thereby interfering with the food web cycles. Suddenly the zooplankton and fish have nothing to eat. In the United States some fishing communities have completely collapsed as a result.

These mussels can fix on to any hard surface as can be seen in the photos above. Imagine the money involved in clearing mussels off hard surfaces: intake pipes, dams, harbours, jetties and other places. They have the potential to damage boats, propellers, anything that remains in the water for a long period of time. Boats are the main vector of spread between lakes.

Also disturbing is that because mussels fix onto any hard surface they could potentially attach to our native kakahi (freshwater mussels). Overseas they have been shown to climb on top of other species and push them into the sediment until they suffocate. The photo of a fresh water crayfish, looking very similar to our native koura, illustrates the disturbing consequence that they could be fouled by numerous small alien mussels; not very pleasant. But the problems created by these molluscs do not stop there. The once pristine sandy beaches surrounding lakes impacted by zebra and quagga mussels can become smothered in jagged smelly deposits of shells.

So weeds and wallabies are not the only thing that we should be on the lookout for when watching for invasive species in the Rotorua Lakes Region. Early detection is critical and can make the difference in being able to appropriately manage, control or eradicate a species before it has a chance to spread. We need to know where it is before we can do anything about it. Surveillance for invasive species is carried out by the Bay of Plenty Regional Council who are doing a great job. Last year they asked NIWA to look at their

surveillance practices and we concluded that they are doing everything right in terms of best practice and methods used. The study determined that the most successful methods for the early detection & delimitation of submerged invasive weed species continue to be in water visual methods using divers.

But it is not just a regional council or other authority's job to watch for invasive species. The management of invasive species is a shared problem that requires the cooperation and support of a diverse range of stakeholders, interest groups and members of the general public. Everyone has a role to play in preventing the incursion and spread of invasive species. Invasive species are spread predominantly by people; boaters, anglers, and even swimmers can unintentionally spread invasive species from one water body to another when invaders hitch a ride on their equipment. We have seen over the last couple of days the devastating consequences invasive weeds can have on the recreational, cultural and economic values. Fresh water systems are the most threatened globally and invasive species are the biggest threat to biodiversity loss in the Rotorua Lakes.

Anyone can help prevent the incursion and spread of invasive species into our lakes. A term loosely used at this symposium and gaining recognition around the world is citizen science. Citizen science can be defined as the involvement of volunteers in scientific research. It combines research activities with environmental education and public engagement in science. The main aim is to get any one interested from young children right through to those that are now retired to help answer real world questions about our environment and take ownership of the problem. Citizen science is not new, it has been happening since at least 1900s when community groups helped with bird counts.

Today's technological advances are increasing the popularity of citizen science around the world with tools such as GIS-enabled web applications that allow for the collection of large volumes data. Smart phones, which allow observations to be recorded and validated using photos and apps. There are online portals for free data sharing and a raft of free online resources which means setting up projects and getting information out is suddenly cheap and assessable for so many people.

The benefits for citizen science are numerous but most importantly it increases the community's awareness of local issues; advances their learning, knowledge and understanding of the issues and can change attitudes. It is a philosophy change on how people connect with the environment and take ownership, and gives them some responsibility for their patch. Volunteers can participate in making science based recommendations which is important because they want to be involved. However, a successful programme involving citizen science must be a two way thing; it is not just people giving the scientists lots of data. It should benefit both parties. Scientists can use citizen scientists to provide valuable records and knowledge that otherwise would not have been available while volunteers can receive feedback and the benefits of seeing their data and knowledge contributing to something positive – they can make a difference. Some of the examples of citizen science occurring around New Zealand are:

- *King Tides Auckland Project* – 'Snap the coast: see the future' - asks members of the public to upload photos to help researchers work out what many coastal areas will look like in the future and to plan accordingly.

- *Annual Garden Bird Survey* - is an initiative set up to monitor the distribution and population of common garden birds around New Zealand. www.landcarerresearch.co.nz

- *NIWA Snow Project* - asks volunteers in Christchurch to take regular measurements of snow fall and submit information via a phone app. www.niwa.co.nz

- NIWA Steam Water Quality Project - involves community volunteers in monitoring stream water quality and ecosystem health, in parallel to data collection by regional council staff.

Easily the biggest example of citizen science working in New Zealand was Nature Watch, a website run by the NZ Bio-Recording Network Trust which allows nature watchers to record and share information on birds, insects and plants. In the last 18 months over 85,000 photos have been uploaded with 5,000 observations from 785 observers. These types of initiatives are attracting great interest.

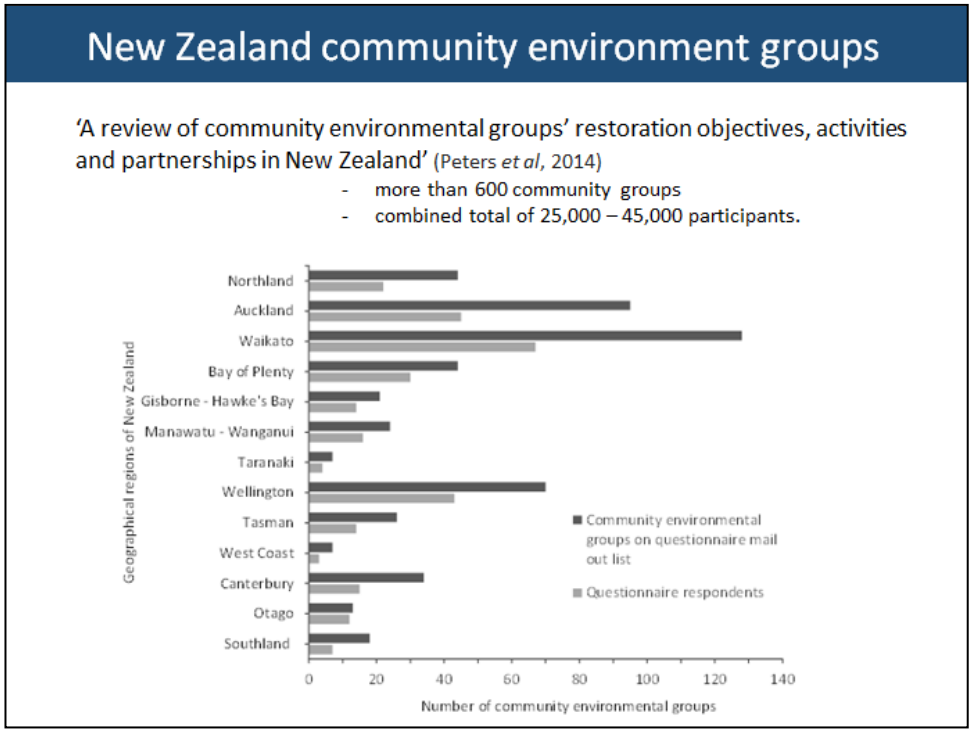
NatureWatchNZ www.naturewatch.org.nz

Another example that sits on the cuff of citizen science is Weedbusters which is a weeds awareness programme that aims to protect New Zealand's environment from increasing weed problems.

WEEDBUSTERS www.weedbusters.org.nz

Slide 6 and 7 show some results obtained from a review carried out by Monica Peters et.al. from the University of Waikato looking at community environmental groups in New Zealand. Her results showed that in 2014 we had more than 600 community groups active throughout New Zealand. Furthermore from questionnaires completed by 288 of these groups Monica's review was able to show the wide range of community activities that environmental groups are involved in. These types of activities also reflect the type of work being carried out by community groups in the Bay of Plenty Region.

Slide 6



Slide 7

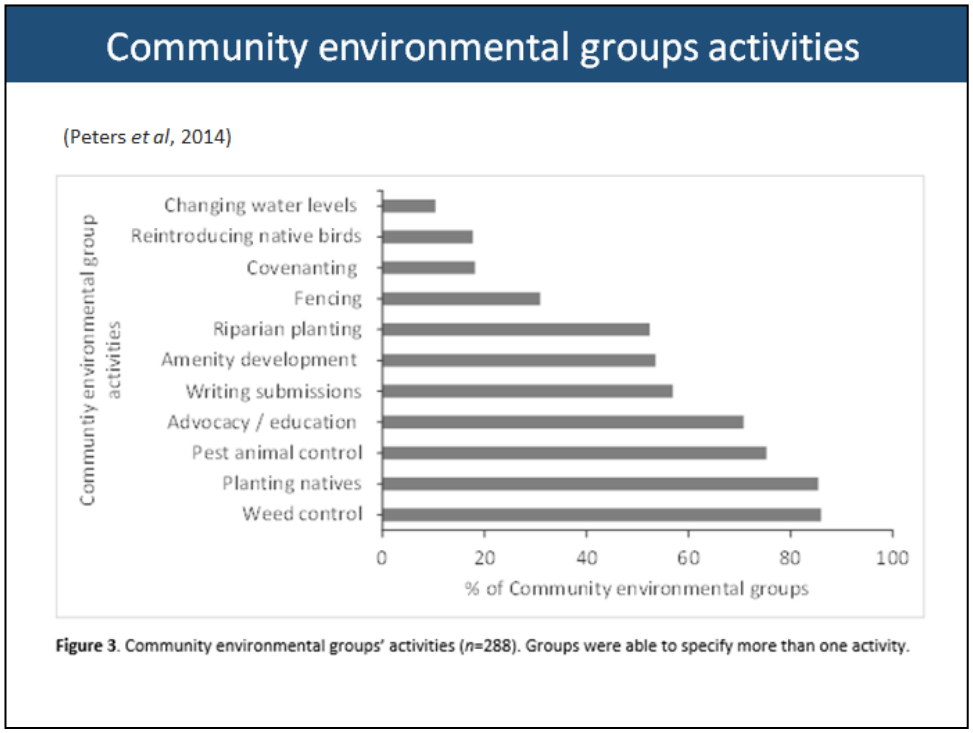


Figure 3. Community environmental groups' activities (*n*=288). Groups were able to specify more than one activity.

Most of the active groups listed with the Bay of Plenty Regional Council include:

- Tarawera rat control programme – increased dabchick and native bird populations
- Landcare Ōkāreka - pest plant and animal control programmes around the lakes to benefit native bird populations including the dab chick
- Tikitapu Forest and Bird – pest animal control
- Ōtautū Bay, Lake Rotoehu – rat control programme benefiting waterfowl including dabchick

I think these programmes show that we already have people within the region who are interested in helping with environmental issues and perhaps the same groups could be utilised to help in the war against invasive species. The more eyes watching for invasive species the better.

In New Zealand, we can also learn from the success of programmes overseas where they are recruiting citizen scientists to look for anything new or unusual. Some of my favourites include the 'Clean Boats Clean Waters' programme in Michigan, USA, which aims to prevent the spread of aquatic invasive species in Michigan lakes. With more than 11,000 inland lakes you can see why they need as many eyes and ears for information on new incursions as possible. This programme offers volunteers training to educate boaters about where they are most likely to find aquatic invasive species. Based on a roster system they are present at the lakes year round and educate lake users on how to inspect their boats and trailers and demonstrate cleaning techniques as well.

CLEAN BOATS CLEAN WATERS

http://www.uwsp.edu/cnr-ap/UWEXLakes/Pages/programs/cbcw/default.aspx

The Oregon Lake Watch Programme is another good example of where the public are able to help with the early detection of aquatic invasive species. Volunteers help with the detection of aquatic invasive species, the collection of long-term water quality data and encourage an appreciation of Oregon's Lakes. This programme has had some great success stories with the finding of three aquatic invasive plant species in 2013 as well as Chinese Mystery snails and Asian clams.

Oregon Lake Watch www.pdx.edu/oregon-lake-watch

Another great example of public engagement is the hydrilla hunt which happens in several states throughout the United States each year. Over a week volunteers, including school groups, help search local waterbodies to locate undiscovered Hydrilla infestations. They get in with their rakes, boats and underwater cameras all looking for hydrilla to map its distribution and presence. A webinar is used to instruct volunteers on the skills needed to identify hydrilla, what to do if they find a suspect plant, and how to record the areas that have been searched.

For example:

http://www.niipp.net/hydrilla

http://www.lakegeorgeassociation.org/what-we-do/Citizen-Science/LakeGeorgeHydrillaHunt.asp

Other great initiatives overseas include newsletters such as that put out by the US Fish and Wildlife Service called Citizen Science (www.fws.gov/pacific/iq/Spring2014). Others such as the Maine volunteer lake management programme (www.mainevlmp.org) offer a range of practical workshops including one on how to build a water scope, how to carry out surveys from a canoe and for carrying out courtesy boat inspectors. The Texas Invaders Programme (www.texasinvasives.org/invaders) is an innovative campaign where volunteers are trained to detect the arrival and dispersal of invasive species in their own local areas. Advances in technology have also seen a whole new wave of citizen scientist initiatives such as phone apps like that from the Invasive Species Strike Team (www.njisst.org) in New Jersey.

No matter where you look overseas the messages are the same as here. 'Stop Invasive Species from Spreading', 'Stop Aquatic Hitchhikers', 'Don't move a mussel', Stop Aquatic Aliens'. **(Slide 8)**

Slide 8

So we have established that the management of invasive species is a shared problem but what can 'you' do about it? What can our communities do about it?

The first thing is to know your enemy. We have to know what we are looking for and how to identify it before we can react and do anything about it. **(Slide 9)**

Slide 9

There are plenty of resources that can be used to find this information out. The New Zealand Freshwater Pest Identification Guide is available on the NIWA website (www.niwa.co.nz/freshwater-and-estuaries/management-tools). It has guides and fact sheets for all the invasive species of concern here and is a great place to start.

Know your lake by looking at the information available for each of the lakes on the NIWA LakeSPI (Lake Submerged Plant Indicators) reporting website (www.niwa.lakespi.co.nz). This site provides information on the types of submerged plants known to be in the lakes including invasive species so you can gain a better appreciation of what you might be looking for.

Watch for invasive species. If you know what invasive species look like that is great, but either way, always be on the lookout for anything different. Actively look, 'Oh, that looks a bit different', 'I haven't seen anything like that before', or 'That's a funny looking shell'. Spot things that are unusual and do not assume that somebody else will know about it. If you find anything suspicious contact the biosecurity officers at the regional council.

Help 'prevent the spread' is one of the most important things that anyone can do. The 'Check, Clean, Dry' message was originally promoted in New Zealand to help prevent the spread of didymo. More research is needed to validate this message for other aquatic pests in New Zealand but in general the principles are the same.

CHECK - Before leaving any lake or waterway always check your boats, (including the anchor wells and bilges) trailers, fishing gear and other equipment and machinery

CLEAN - Remove any weed or other debris and wash thoroughly all equipment (e.g. nets, machinery and footwear). Evidence supports the benefit of also using detergent or salt water mixes.

DRY - Once cleaned, dry completely inside and out then leave for at least a couple of days before moving onto a new waterbody.

Slide 10 shows operators of the Rotorua Duck tours checking for invasive weed species after visiting each of the lakes. You can see the guy up in the top corner is under the vehicle checking every little bit of space where weed could get caught. This is a great example of responsible eco-tourism in the region. The Rotorua Duck Tours were the first ones to detect the invasive weed hornwort in Lake Okareka.

Slide 10

In conclusion, we do need to remain vigilant against invasive species. It is not just weeds and wallabies that pose a risk to the Rotorua lakes. Management is a shared problem and we all have a part to play in the process. We already have community groups in the Rotorua region so there is an opportunity to harness their potential. We need to look at ways in which we can provide them with the knowledge to look for invasive species and be a part of the process. A successful citizen science programme needs to benefit both parties, it is not a one way process. Local residents and community groups have an important role to play in watching for invasive species. They are the ones on the front line, at the lakes on a regular basis, boating and fishing, swimming and walking around the edges. They need to know their enemy, what signs to look for and act on anything different or strange that they find.

I would like to thank my team at NIWA, particularly John, Paul, Mary and Rohan for their contribution to this talk. Thanks also to Stephanie Bathgate from the Bay of Plenty Regional Council who was a big help yesterday, and to the Lakes Water Quality Society. This has been a really valuable symposium, thank you.

STATUTORY RESPONSIBILITIES AND BARRIERS TO ACTION

Guy Salmon
Ecologic Foundation, Nelson
guy@ecologic.org.nz

Guy has worked as an environmental policy specialist in consulting, policy advice and research roles. He leads the Ecologic Foundation, a think tank which focuses on the challenge of integrating economic and environmental perspectives in decision-making. His research on environmental decision-making in the Nordic countries has contributed to the recent focus in New Zealand on collaborative policy-making. Guy is a member of the Land and Water Forum

ABSTRACT
Looking at the context of current policies and institutions, this presentation will explore possibilities for enhancing the effectiveness of control actions for lake weed and wallabies.

TRANSCRIPT
It is a great pleasure to be back with the LakesWater Quality Society which is an inspirational organisation for me; it would be wonderful to see some of its attributes picked up by environmental groups in other parts of the country because there is so much to be learnt from the success story here. The Society gave me quite a broad brief and essentially it is this. We want to step up to a new level of ambition and performance in controlling lake weed and wallabies and sort out the barriers to actually doing that. I have tried to boil this down into three questions.

The first is to look at the statutory responsibilities of all the different agencies in this area and ask if there are too many outfits, too many cooks spoiling the broth? Is co-ordination good or are things in a bit of a muddle?

Secondly, looking at the toolbox that we have to solve problems, the science and technology, are there gaps here? Is there a lack of energy and commitment behind it all?

Thirdly, are the communities themselves properly engaged with these issues? Or have they got the wrong mental picture about some of their problems, and for that reason have become complacent?

This is a big field to cover very quickly. I make some hasty judgements based on phone conversations with various people and a bit of knowledge of the area. But it is intended as a discussion starter.

Slide 1 shows the list of organisations, which have all sorts of statutory responsibilities. But it is worth saying that some of the most important influences are not statutory organisations. The LakesWater Quality Society or Professor David Hamilton (who is sort of an institution in his own right) should perhaps be on the list. Some of the statutory players are a little understated. The Te Arawa Lakes Trust has ownership of the lake beds, but that seems a bit of an understatement of its role in this community.

Slide 1

Another significant point is that there are some funny splits of responsibility. For instance, a weed is growing on a lake bed owned by one party, but the control of that weed in the water column belongs to another party and there are two different outfits involved with that control. One of them does harvesting and another does spraying - which looks like a real muddle.

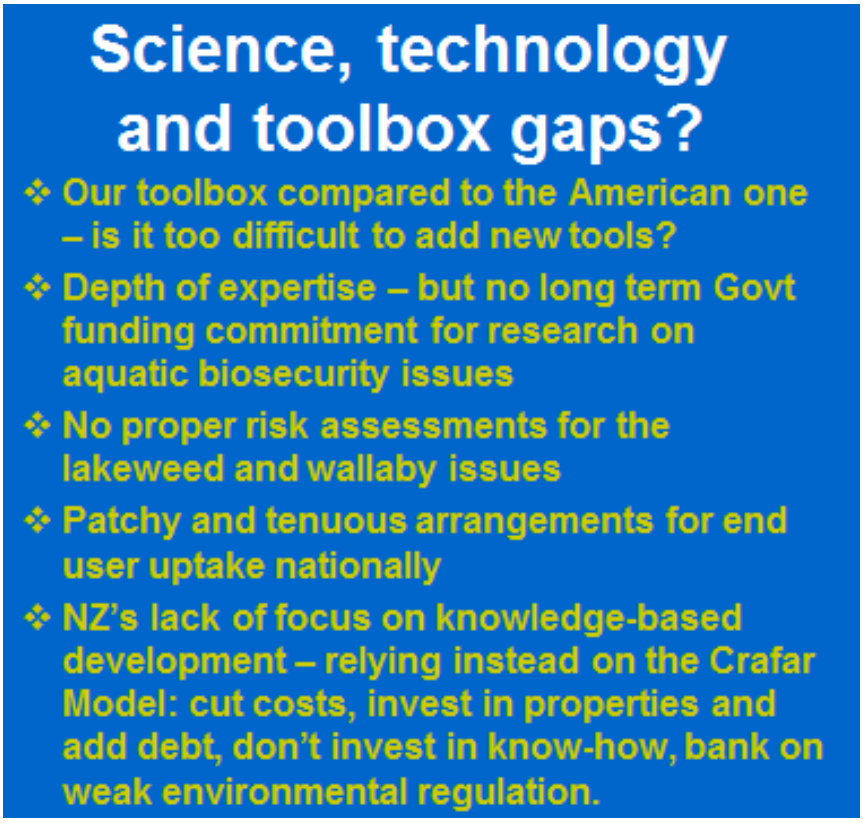
In phone discussions to suss out whether this works, I got the contrary impression to what I had expected. People told me that coordination was reasonably good with everyone more or less pulling their weight. 'This is not a muddle, we've all got clearly defined roles and it does work', they said. I gathered no evidence to make me feel it was not working. There appear to be no barriers to moving ahead on these issues that would be solved with New Zealand's favourite remedy of 'restructure everything'. Maybe we can just tune up what we have already and make it work better.

Then I looked at the science and technology and the toolbox that we have; those who have attended this Symposium would come away with a vivid sense of existing uncertainties and unresolved problems. But in a way that is not the question; the real question is do we have a science team, an establishment and a nexus with the policy community that is sufficiently strong and expert to solve those problems and narrow the uncertainties over the next few years. Overall my impression, a little bit qualified, is that we are strong in the science and technology area.

Having said this, we have all seen some excellent people producing excellent stuff. However there are still a few issues that we ought to think about. Clearly there is a difference between the list of chemicals, for instance, which is in the toolbox for use in New Zealand and the list for North America. Talking with people, I find that part of the reason is that it is quite difficult to get a new tool added to the toolbox in New Zealand.

Perhaps the procedure for doing this does not have a strong enough sense of the benefits of adding these things and is too focussed on the disadvantages or costs. This is an area with the Environmental Protection Authority, and perhaps it needs more attention.

Slide 2



Another disconcerting factor is that, while we have very good scientists in NIWA working on this, they do not have a permanent government funding commitment. They are operating off a cross subsidy within NIWA plus earning a bit of commercial money on the side. There is a certain insecurity about this scientific establishment and workforce. This signals lack of political commitment and recognition that this is a big, long term issue for New Zealand. We need to talk to the politicians. They need to know that this temporary way of funding is only just working OK, but we ought to put it on a permanent, long term basis and expand it.

Why do we find it difficult to get this long term commitment? Possibly part of this comes down to a lack of robust risk assessments. One of the striking things about the United States Environmental Protection Agency is the way they do enormous risk assessments to understand the situation. They ask, 'if this trend continued uncontrolled or if this invasive species arrived in the country, what sort of scenarios could we construct and what are the cost implications of reversing or controlling it?' Considering the issues of the lake weed and the wallabies, we do not have proper risk assessments for either of them.

Supposing that the wallabies spread across the Rangitaiki River and into the Ureweras or the Mamakus and Kaimais and progressed up those chains of mountains. Do we know what would then happen? Do we know what the cost would be in terms of environmental damage? Do we know what the cost would be in terms of trying to reverse that problem? Are we putting sufficient weight on the risks of wallabies continuing to spread? The same kinds of questions can be asked about lake weed. As a South Islander I am very

conscious of the fact that we are not yet grappling with some North Island pests but they could easily get there.

I believe that this lack of awareness of risk, and lack of propensity to properly study risk and look at risk scenarios, is underpinning a failure of national commitment to put adequate funding into biosecurity research, in particular aquatic biosecurity research. This is a problem that needs to be looked at in the large picture.

When I was a director of Landcare Research for 6 years in the early to mid 1990's one of our rather dubious duties was to reduce the science research effort in soil conservation; this happened because the funding was cut off. When pressed for reasons why the funders said, 'Well, nobody is taking up this science. You have produced all sorts of solutions which farmers could use to stop their soil eroding on the 5 million hectares of North Island soft rock hill country but nobody much is using it. Regional Councils don't seem to be interested in taking the lead on this work, so why are we funding the science?'

That is a problem for science in the biosecurity field. We rely very much on the regional councils to use this science, but the uptake is quite patchy. There are some councils like the Bay of Plenty - blessed with an extremely profitable port investment - which is able to do things that other regional councils cannot do. Then there are some quite poorly-funded regional councils that nonetheless are very aware of aquatic biosecurity issues, like Northland. The great majority of councils however, are just not using this science, and they need to be galvanised. They are the same councils that need to be galvanised on almost every other environmental issue as well.

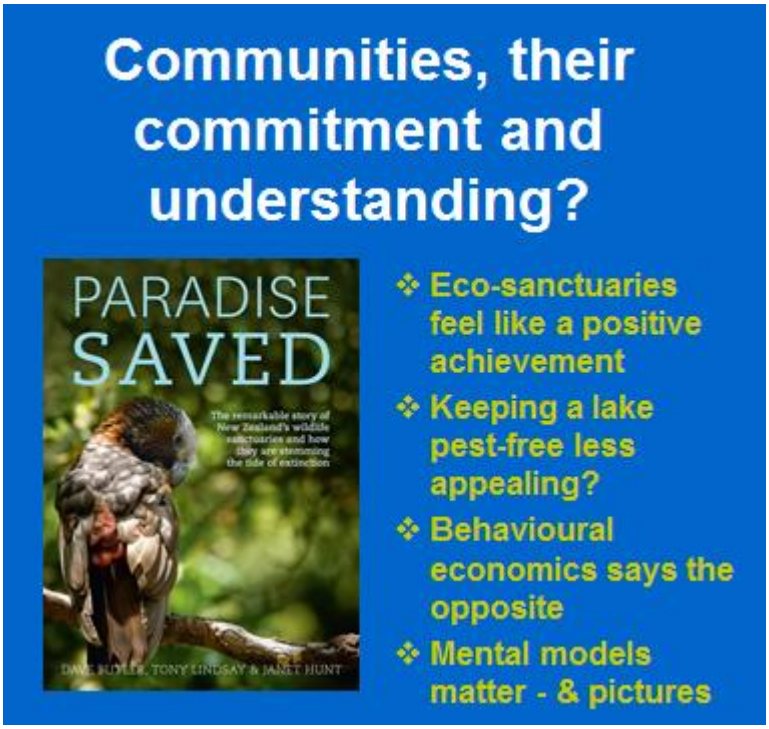
So there is a problem out there which can be driven partly by local environmental activism, gingering up the councils, and perhaps partly by more national policy statements and national environmental standards out of central government, which would force the regional councils to do more about these issues. Until we strengthen the regional councils and their role as our main environmental managers we are always going to have insecurity around the funding of the science and technology tool kit and the workforce in this area.

That leads me to my last point on this slide, which is perhaps a little general for this meeting, but it is something we need to think about. As a society we undervalue knowledge generally, and it is increasingly obvious that we are differing more and more from other small wealthy countries in the OECD in this regard. Looking at comparable countries like Finland, Singapore or Israel, they spend 2, 3 or 4 times as much as a percentage of their GDP on research and development as we do.

New Zealand has become trapped in a way of thinking about our national development which I call the Crafar model. Thus it is all about cutting costs, investing in more properties, building up more debt, non-investment in knowhow, and dependence on weak environmental regulation; we know where all that got the Crafars. We should not follow that model. There are better models out there, and taking a closer look at Singapore, Denmark or Finland we could learn something that is important about knowledge-based development. That is a lesson we can learn and it would benefit a whole lot of other things like the problems discussed in this Symposium.

My third question asks how committed are the communities to these problems? What is their understanding of the issues? Have they got some mental models which are not helpful and can we change those, how can we engage with them?

Slide 3



I was struck recently by the book *Paradise Saved*[1], which is a premature title unfortunately, but a lovely vision. It is a story of more than 350 community initiated eco-sanctuaries that have been established around New Zealand by local groups; it is amazing how this really has taken off in the last decade. People are aware of some of the high profile projects like the Maungatautari Sanctuary but there are so many others and it is such a popular thing for people and communities to do. When talking with these people, they feel so positive about their achievements; putting up a fence, running a trap line, bringing a whole lot of birds back into the community.

But thinking about the slightly different issue of biosecurity, it is the other way round: prevention of a bad thing happening, and the realisation of how important it is that the asset is not lost. So this question about communicating a clear vision about the risks that we run, building some mental awareness in the community, is really important.

Behavioural economics has important things to tell us about this. There is experimental evidence to show that people are much more concerned about losing something they already have, and much less concerned about getting something additional. In a sense, the huge enthusiasm for eco-sanctuaries is probably just the tip of an iceberg of enthusiasm in the community for protecting assets like lakes, for instance. We need to seriously consider the work that Mary de Winton presented to us today about myths held in the community. It is a big part of the challenge ahead: how to turn around the mental models held within our communities.

The members of the Land and Water Forum have pioneered and achieved respectability and a revival of collaborative problem solving methods in this country. At the national level, it is part of a wider movement, very strong in the United States, which might be called 'place based community management'. Where the risks to a resource like a lake are recognised and the local community springs into action to protect it. There is a terrific

[1] Butler, D., Lindsay, T. and Hunt, J., 2014. *Paradise Saved: The Remarkable Story of New Zealand's Wildlife Sanctuaries and How They Are Stemming the Tide of Extinction,* Random House, NZ

amount to be gained by tapping the willingness of communities to be mobilised to do constructive things in the space. We now see a number of examples in New Zealand which tells us something about the possible potential.

I live in a little place on the coast not far from Nelson where there is a marine reserve; we have to deal with people who come into it and grab the abundant fish. If they come in a boat, DOC's hotline gets plenty of calls from people with binoculars identifying the boat. If they start fishing off the shore, locals talk to them and tell them, 'Look you can't fish here this is a marine reserve'.

There is a strong community sense which could also work in the Rotorua area for people arriving with a boat with weed hanging off it. If weed was a threat in the area where I live, the community would be down there stopping people launching boats and looking closely at their trailers. This community engagement is something to foster a lot more.

I was working a year ago with a community group in the Mackenzie Basin and there was an important issue which needed outside funding to solve it. A member of the group was the operator of the local ski field and he said, 'I'm going to set the ball rolling on this by giving all my customers an opportunity to make a donation towards the Save the Mackenzie Fund. We can get the private sector mobilised to put money into this and attract some co-funding from the Department of Conservation.' It is now gathering momentum and shows there are opportunities to tap into community groups as well.

We still face the fact that new weeds are going into lakes and wallabies are spreading. There is a long way to go in building up the community awareness, tapping sources of funding and building the contribution which the community can make to address these problems. That is a key way forward. The Bay of Plenty Regional Council are currently writing their 10 Year Plan and new Pest Management Plan. The Rotorua District Council and Department of Conversation could contribute and perhaps fund some facilitators to work with communities or co-fund initiatives which communities themselves want to start.

I come back to the reality that we are in an era in which there are so many threats: water quality decline, climate change, invasive species. We are at a stage in history where every environmental asset that we have in this country needs a community group alongside to look after it. We need to take that challenge seriously, empower those community groups, give them the knowhow and guidance they need and help them go forward.

THE ROLE OF A WEED MANAGEMENT AGENCY – A SMART APPROACH TO DELIVERING INNOVATIVE BIOSECURITY SERVICES

David Mole
Senior Portfolio Manager (Biosecurity), LINZ, Wellington
dmole@linz.govt.nz

Dave has been the Senior Portfolio Manager (Biosecurity) at Land Information New Zealand (LINZ) since 2012, moving into this position from a policy role at LINZ, which also had a biosecurity component. Dave has spent his career in a variety of technical and management roles at LINZ and its predecessor departments, specialising in the geospatial areas of topographic mapping and hydrographic charting, which LINZ took over from the Navy in 1996.

ABSTRACT
Over the past year, Land Information New Zealand (LINZ) has taken a new approach to biosecurity as a result of significant external factors and a new, organisation-wide 10 year vision. We have reviewed our biosecurity aims and goals, and re-examined the tools and processes that determine our ability to fulfil these overarching outcomes and objectives.

Our new thinking about biosecurity has been informed by what we call SMART procurement, and this approach has encouraged innovation, ensured a better focus on outcomes, and laid the foundations for a truly strategic partnership with our suppliers. This presentation will outline our SMART philosophy, and offer some thoughts on its benefits over traditional models of biosecurity management, focusing in particular on our aquatic weed control work.

TRANSCRIPT
Thank you for the introduction, I should point out that I am not a practitioner. I picked up the biosecurity portfolio about 6 years ago and found it fascinating. Through that time I have been involved with new legislation with the Biosecurity Act and an opportunity came up to cross the fence into operations and I have been in this position for the last 2½ years.

I would also like to applaud the two previous speakers who were brilliant. I was concerned initially that what I will talk about may have cross over, but thankfully not. I echo and reinforce what they talked about. I will take a different tact and talk about the significant transformation within LINZ over the last 12-24 months; a snapshot looking at the past, the present and future direction of LINZ biosecurity. In my area we hope to take more of a leadership role. We have introduced a new business model which will hopefully provoke some thinking amongst the agencies here that can be applied to your type of work.

The Role of a Weed Management Agency
I would like to begin with a bit of context and look at the big picture**. (Slide 1)** We all play a part in enhancing or maintaining those biodiversity values that we hold so dear, unique New Zealand values which enhance our environment for recreation, economic purposes, cultural identity and of course the health of the environment. When I first came into the job I wanted to see where LINZ biosecurity saw itself at the time, its position and looking forward. How did LINZ want to position itself in the future?

Slide 1

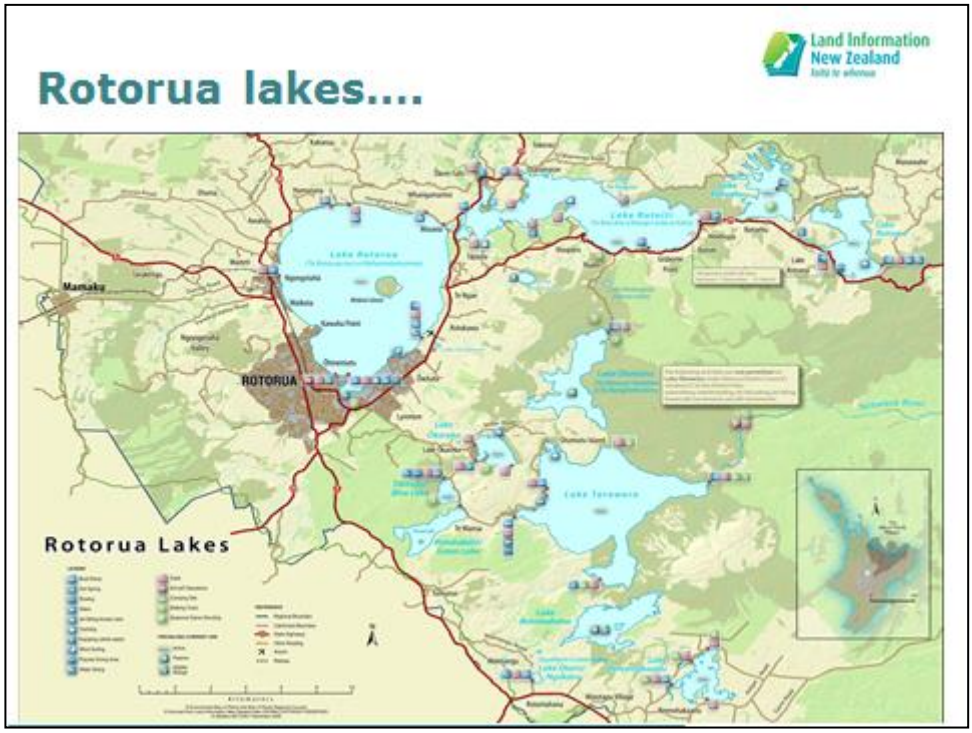
LINZ's Role as a Weed Management Agency

On behalf of the Crown governed by the Land Act 1948, LINZ manages roughly 8% of New Zealand land which equates to about 3 million hectares. This includes some of the iconic high country pastoral leased farms and a number of iconic lakes, most of which are in the South Island, such Lakes Pukaki, Benmore, Whakatipu and Wanaka. **(Slide 2)**

Slide 2

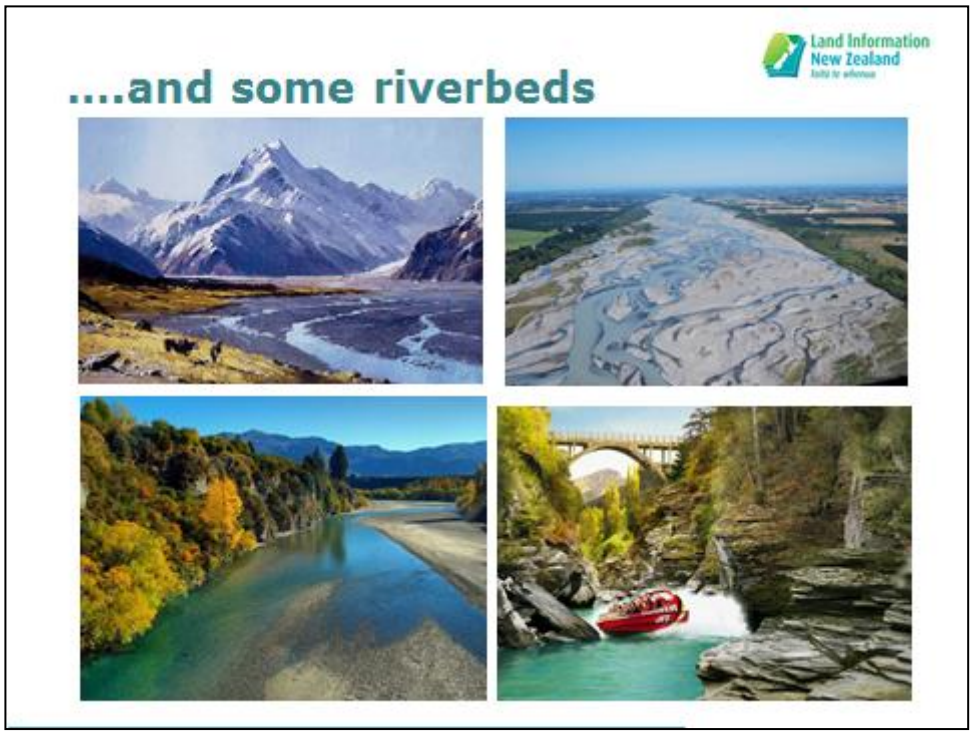
We have a special role with the Rotorua Lakes since the Te Arawa settlement in 2006. **(Slide 3)** We co-manage these lakes and I will describe that later on.

Slide 3



We manage some of the rivers shown in **Slide 4.** Top left is part of the Tasman River with Mount Cook in the background, Waimakariri on the top right and the Shotover.

Slide 4



LINZ's Biosecurity Programme

Among LINZ's management activities is its biosecurity programme. We have an annual appropriation of about $1.5 million, which is ring fenced, and together with partner contributions it is about $2 million a year we spend, half of which goes on aquatic weed control. That leaves another million dollars to spread, and the big ticket items are wilding pines which is very topical at the moment and our old favourite gorse and broom and to a lesser degree rabbits. **(Slide 5)**

Slide 5

We prioritise funding at two levels:

- Compliance or acting as a responsible land owner
  - Relevant standards and legislation
  - Compliance with Regional pest management strategies
  - Act as a responsible land owner and good neighbour
- At a site level
  - Site value + risk of spread + cost benefit
- Types of programmes
  - Eradication/exclusion
  - Progressive containment
  - Sustained containment

We need to be compliant and work under the Biosecurity Act and other relevant legislation. We also work closely with the Regional Pest Management Strategies to ensure there is compliance, but just as importantly LINZ consider ourselves a responsible land owner and good neighbour. There will be more about this good neighbourliness when the new legislation comes in shortly, but that is another story.

At a lower level we look regionally and establish plans on the principles behind site value, the risk of spread and the cost benefit. That is how we would approach a programme and that then translates to the type of programme to employ. Some examples are eradiation and exclusion, such as at Lake Whakatipu which is considered weed free at this stage so

we would just undertake a monitoring programme. If we find the occasional weed then it is removed.

A good example of progressive containment is in Lake Wanaka where we are completing a 10 year strategy plan and it has worked very well. NIWA are reviewing that plan for another 10 years. We have progressively rolled that weed back and it is almost near the Wanaka township. Anything north of the containment line is now classed at eradication or exclusion and suction-dredged or hand-picked.

We cannot say the same for Lake Dunstan at the other end of the Clutha River which flows out of Wanaka and into Dunstan. There we are obliged to undertake a sustained control and concentrate on the high value which is all we can do because it is not going to go away until the problem upstream is fixed. There is an additional site led programme, we have one or two but they are just sites.

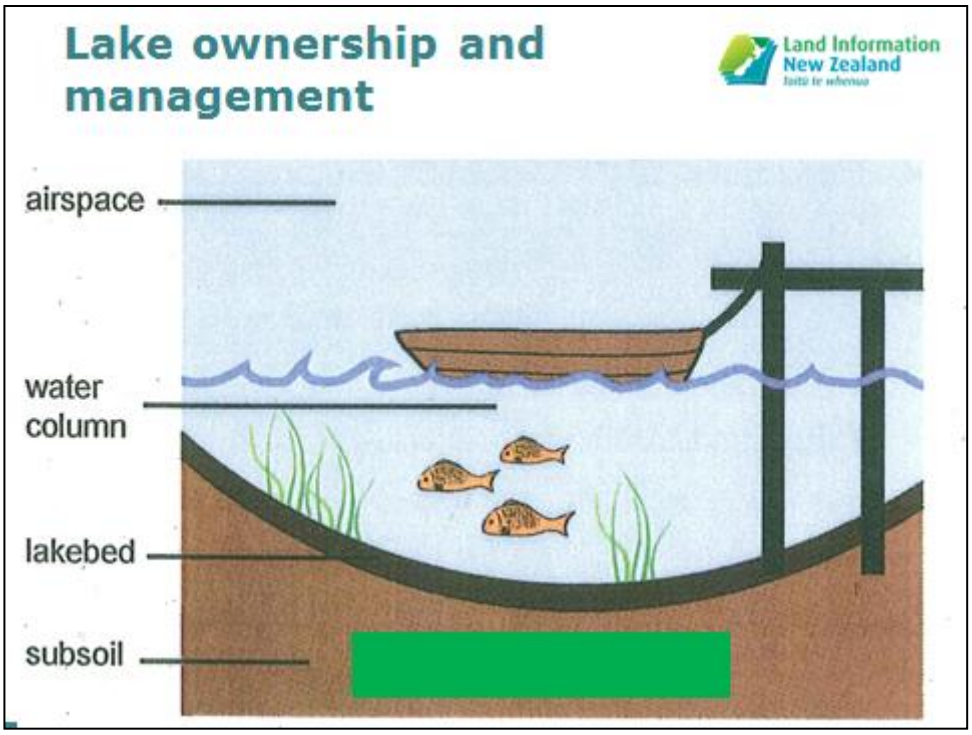
How We Operate

Up until recently LINZ has used a traditional outsource and contract model. In 2009 we contracted Boffa Miskell that is an environmental consultancy company based in Christchurch with offices in Wellington, Tauranga and Auckland. They are my operational arm and consult and develop together the annual work programmes, run the contracts use sub-contractors, do post-control audits, etc.

Let's talk about lakes. We use traditional herbicide control methods, diquat and endothall. It comes down to what is most appropriate and cost effective, diver-based control, weed harvesting or weed cordons. We would consider alternative biocontrol methods such as the use of grass carp, provided they were ultimately viable.

Lake Ownership and Management

Slide 6



Ownership or management of lakes is complicated and it took a while to get my head around it. For Crown owned lakes LINZ owns the stratum which consists of the subsoil, the lake bed, the space where the water is and the air**. (Slide 6)** But of course there are other organisations and interested parties involved that make up the successful achievement of our business requirements and goals. **(Slice 7)**

Slide 7

For instance the Regional Council has an interest in the water column and the District Council has an interest in the structures around it. DOC looks after margin strips and biodiversity values, Fish and Game for the fish and game. The difference with the Rotorua Lakes is that from 2006 the lake bed and subsoil was handed to Te Arawa and we retained the stratum for above the lake bed to the air, and the weeds, but the rest stays the same.

Success Relies on Working with Others

There has been a lot of talk over the last couple of days of collaboration and the need for team work and I can only reinforce that going forward. Success relies on working with others and I treat this on two levels. On a national scale it is very important LINZ and most of you here work with MPI and other Crown agencies like DOC in the overarching policy and governance roles.

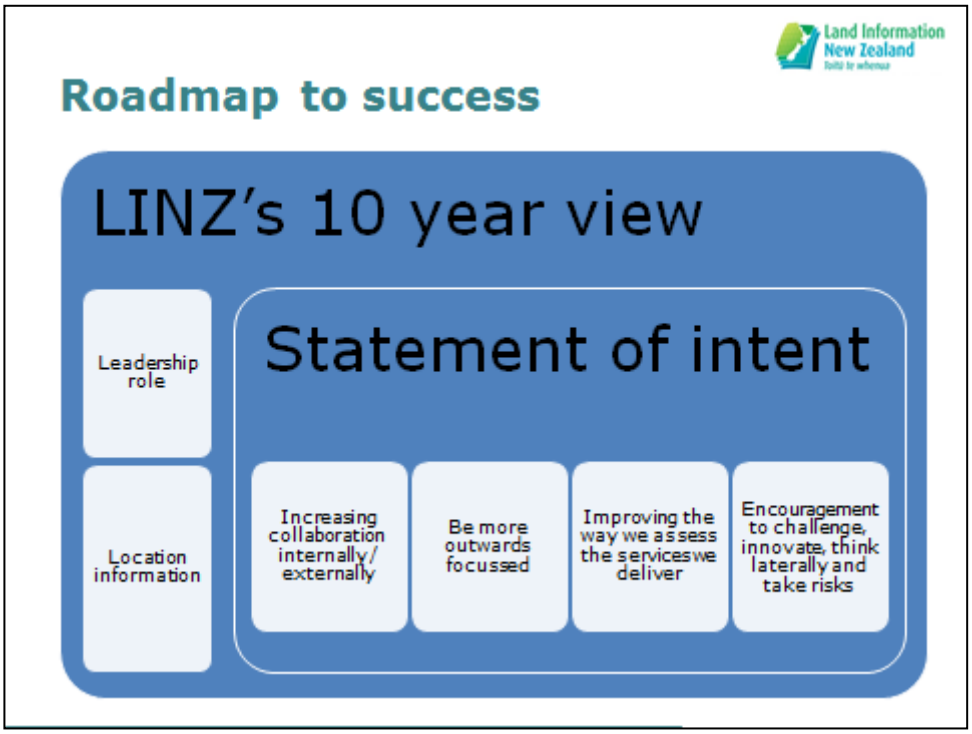
At a regional level we can establish relationships or partnerships to achieve our business goals. Lake Benmore, for example, there is a partnership with Meridian Energy. They have their own drivers for hydro-electricity and we have ours, but jointly fund an annual programme and have a strategy going forward. In Rotorua we have the Aquatic Pest Co-ordinating Group (Aptag) which consists of LINZ, Regional Council, District Council, Te Arawa, Fish and Game and DOC and together there is joint funding, the bulk is for weed management, mostly LINZ but Bay of Plenty do contribute.

Wanaka is probably the most successful lake we have with all the same stakeholders as well as the Guardians of the Lake which is like a Trust. But the plan that we have in place

there has been a real success story. If we could adopt that type of model going forward here it would be great, because the success over the last 10 years has been so noticeable.

Future Role of LINZ as a Weed Management Agency

Slide 8



In mid-2013 LINZ and the whole system went through a huge transition. **(Slide 8)** Within LINZ a new chief executive brought fresh ideas and a 10 year vision called 'The Power of Where' which is a powerful value proposition. This vision promotes leadership, the first key word. LINZ's Statement of Intent also contains 4 clear messages:

- to promote collaboration
- to be more outwards focussed
- to effectively improve our services
- to challenge ourselves to be innovative and take risks

Historically, reasons for not doing things rather than reasons for doing things existed, but we have changed that paradigm to challenge ourselves and go forward and 'just do it'.

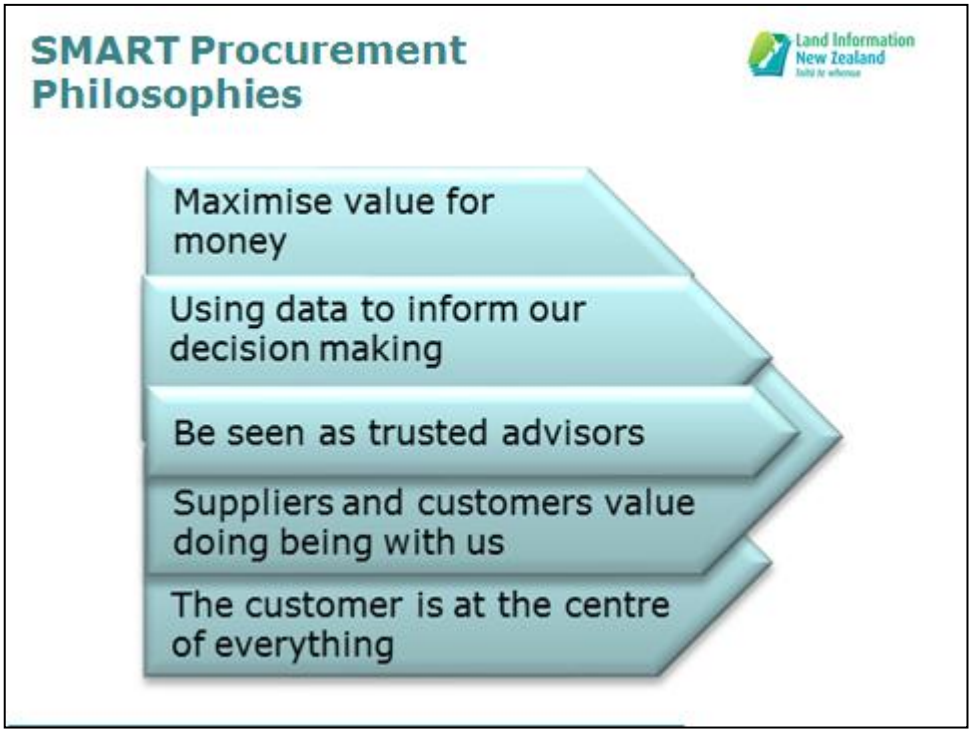
At that same time the contract with Boffa Miskell was about to expire. For the previous five years they had performed very well, establishing relationships with our stakeholders and maintaining them extraordinarily well. There were also external things happening as we came out of a recession. There was a zero budget and we had to do the best we could with what we had which was not much. Importantly there were changes to legislation based around a complete review of the biosecurity system undertaken by MPI which started around 2009 and is still rolling out. It is huge culminating with the national plan of action which has effectively replaced the biosecurity strategy of 2003.

There were some extenuating factors in terms of a supplier and a direction for LINZ biosecurity going forward. Taking all these things into consideration, internal factors and our new direction for LINZ plus the externalities, we came up with three key drivers:

- It had to be outcome focussed to think longer term, more sustainable and do the best we can with what we have and aligning with stakeholders
- It was about legislation and compliance to protect LINZ's interest
- To provide a better public service and value for money, common sense to be smarter.

LINZ has adopted SMART procurement philosophies. **(Slide 9)** SMART is an acronym used in many ways, I am not sure what SMART stands for in this case but these are the principles behind our SMART philosophy. What I have learnt over the last 12 months is that things that I previously thought not possible can be done and very easily.

Slide 9



On 1 July 2014 LINZ entered a 10 year strategic partnership with Boffa Miskell that was the first of its kind, certainly for LINZ and Boffa, and probably the first of the kind across government because it is a true partnership. MBIE are treating this partnership as a case study and there is interest in this particular model going forward. It is a true partnership. What was a 62 page very prescriptive contract is now 2 pages and suits the outcomes that we want. Previously, like most contracts, it was so prescribed that you tell the contractor how to do their jobs. In this case you know there are controls in place like health and safety, which fulfils that prescription.

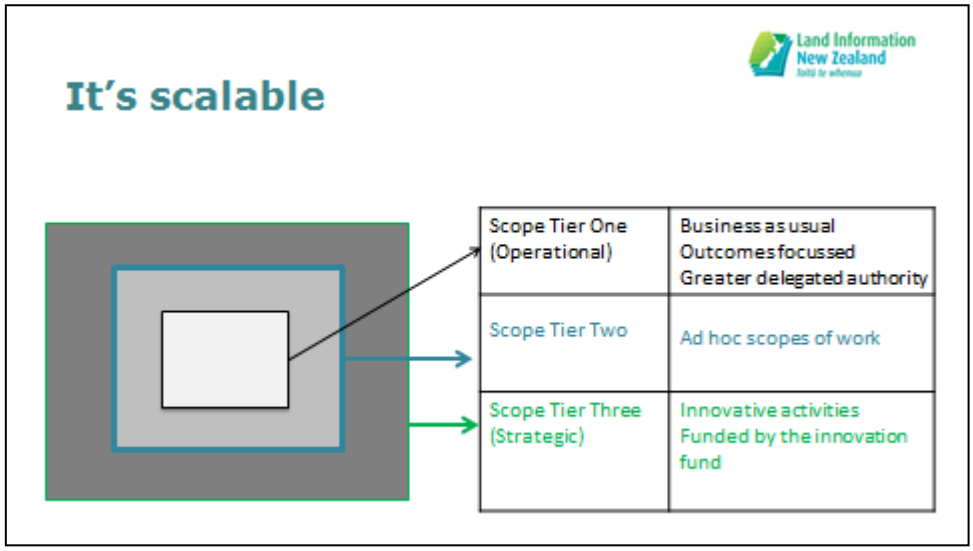
Both parties are working towards a mutual goal striving for mutual gain:

- vested in each other's business
- committed to learning from each other
- measures consider how successful the partnership is, not how well the work is done
- innovation underpins our purpose

In a similar vein we have an MOU between the two agencies and have established a governance board, and it's important to note the individual make-up of that Board. On the LINZ side there are three, myself as the business owner, a representative from Policy to ensure that we are not pushing too far outside our remit and to make us aware of relevant legislation and strategies that might be appropriate for the partnership going forward. The third is the Procurement Manager who understands the business and provides an effective procurement system and process.

This business model is future proof. It promotes collaboration and ensures alignment with our stakeholder's outcomes and objectives. It shares technology with our stakeholders and also resources and information. In terms of measuring our success, we have a list of no more than five or six key success indicators (KSIs) such as partnership effectiveness and relationship health. We measure the performance of the partnership as opposed to the performance of the services. The KSIs are based around risk, such as preserving the reputation of both chief executives and the minister, operational health and safety, and success factors around the delivery of strategies and programmes. These are measured annually and have targets. There is a matrix on the health of the partnership, where we started from and where we want to be and individuals mark off where we are. Where we are not measuring up we can identify those areas and take remedial action.

Slide 10



This model is also scalable and **Slide 10** shows the makeup of the partnership. Tier 1 is business as usual, our core business, the annual programme and the expert advice, relationship management, everything to do with our key goals. Tier 2 promotes ourselves as a centre of expertise to provide advice and pick up biosecurity work where it seems beneficial or more effective for us to do so, whether that is from another business group within LINZ or an external stakeholder. An example could be that if down the track LINZ would pick up the properties in the red zone area of Christchurch. Currently it would be a Tier 2 that would come with a resource and eventually it might come to Tier 1 as business as usual.

Tier 3 is the exciting fun part. We have established an innovation fund where both parties put in a significant amount annually, capped at $60,000 at the moment, for more effective and efficient business functions. Now we have an innovation register, a log, where the board consider ideas. The fund is for innovative tools and investment in research education or if a programme is failing somewhere we have the capability to pump it back

into a programme. There is growing capability in the sector. We can think outside the square and come up with these innovative ideas on how and where to succeed.

The first purchase has been a drone and this has taken on a life of its own with the amount of interest not only by colleagues and other business groups, but external parties. We talked to MPI, the Police and everyone is talking about drones. We have purchased it for our own business requirements for surveillance or monitoring areas that we cannot access currently or with the use of a helicopter. A helicopter costs $2,000 an hour, this just needs someone to drive it.

LINZ is the national mapping agency and home to a lot of public spatial information, which is made available - but can it be made available in a more accessible form. There are a couple of tools here which have wider applications using and sharing location information. We have recently introduced a new service called LINZMaps which is not available externally but will be shortly. It is a visualisation tool, web based and takes information largely the same layers as on LDS and puts it in a web view and we can add as many new layers as you like.

A prime purpose of this service is when we do work with our stakeholders - you external stakeholders - so we are all looking at the same information. We can take layers from you and collectively make informed decisions. One project I am involved in is the National Wilding Pines Strategy and LINZ is leading that with mapping and monitoring which is quite an exciting venture.

In summary it is all about collaboration and working together. We can make some improvements. Guy Salmon certainly mentioned a couple of opportunities going forward but without that cooperation we will not succeed. Cooperation and collaboration lead to more effective, more efficient decision making and more efficient processes. Partnerships such as the formal type we have adopted can only be of benefit where we are aligned and share the same vision, objectives and business requirements, become a centre of expertise, and last but not least to apply innovation which can really be fun!.

Everything leads back to the first slide where we all contribute equally to the bigger picture, New Zealand lakes and maintaining those values, thank you very much.

RESPONSIBILITIES AND FUNDING – CONSENTING PATHWAYS AND OPTIONS

Angus McKenzie (MNZPI, MRTPI)
Principal Planner, Latitude Planning Services, Hamilton
angus@latitudeplanning.co.nz

Angus is a Senior Planner with over 15 years of consultancy and local government experience. He is an accomplished resource management practitioner and has provided environmental management advice to a wide variety of private, local government and central government clients. Angus has significant experience in the development and implementation of biosecurity programmes and projects. His diverse skill set has seen them involved in a range of collaborative biosecurity projects to navigate legislative frameworks to improve the efficiency, including a national business case for simplifying the regulation of aerial 1080, a national permit for aquatic pest plant control and comprehensive consents for biosecurity programmes.

ABSTRACT
This presentation will outline the regulatory framework for biosecurity programmes within the Rotorua Lakes and explore a range of potential options for tackling the framework, drawing on my experiences with collaborative comprehensive consenting and national policy tools. Examples to be discussed will include:

- National aquatic weed consent. A multi-agency reassessment that has expanded the aquatic weed toolkit under HSNO and provided efficiencies through reducing administration costs.

- Comprehensive consenting in the Waikato region. Programme level consents for the Waikato Regional Council, their effectiveness, outcomes and relevance to the Rotorua Lakes context.

These examples showcase a range of alternative responses to regulatory requirements that have resulted in positive outcomes for the agencies involved and could provide a framework for the Rotorua Lakes programmes.

TRANSCRIPT
Kia ora koutou and thank you for the opportunity to speak, it is a real privilege with all the expertise that we have here today. I have seen some detailed presentations and great high level stuff, notably Guy Salmon's presentation just now which was very interesting. I am also interested in finding out more about the partnership approach that LINZ is taking. That is a great initiative and represents forward thinking regarding where we might take biosecurity.

I have also enjoyed the number of heritage buildings that we have been in at this Symposium. I have a bit of a heritage bent and think that back wall that we look at might be the exterior of an old building. This convention centre is a great example of what can be achieved and the Blue Baths last night is a wonderful example of the heritage we have in this country.

I am a planner by background sadly, but I am proud of that and in the last 5 years have become involved in the biosecurity area and I am very passionate about it. I am sure this passion is shared within this room. It is an area where we can collectively make some of

the biggest environmental gains for this generation and those to come. I applaud the work of those people who do it on a day to day basis at grassroots level. It is a challenging and at times very uncertain field. It is also an area of extensive scope for those a bit younger than me and notably in the cross over between planning and biosecurity.

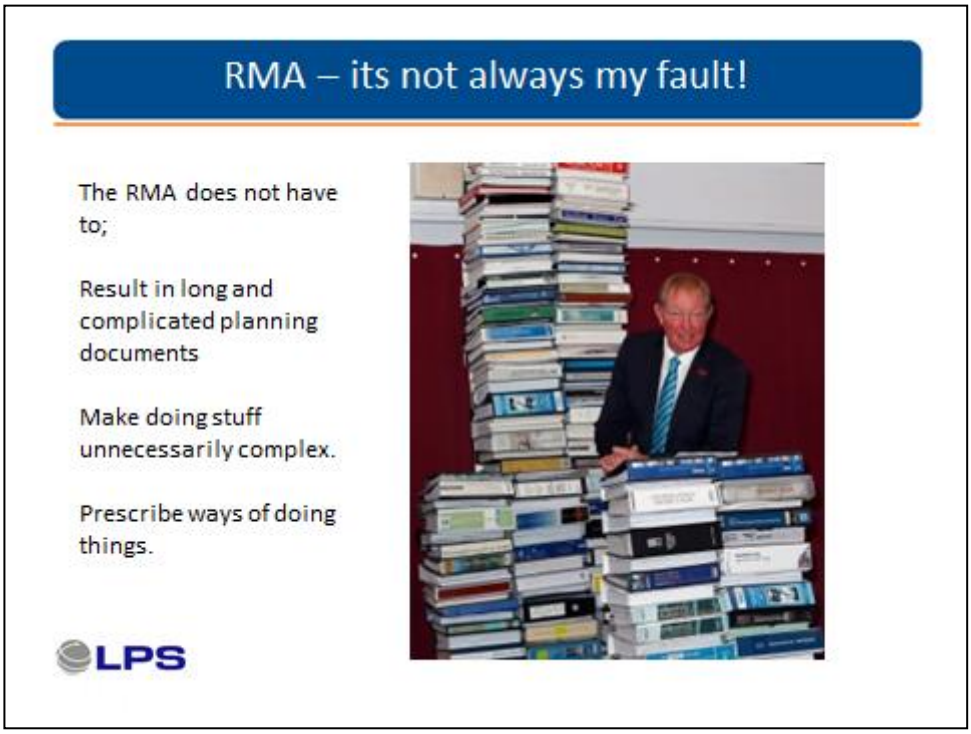
I want to cover my views on how the planning world is implementing that wonderful piece of legislation called the RMA, and how we are going in respect of biosecurity. I will look at some of the key drivers to improve the implementation around the RMA. I do not profess to know in detail the planning context for the Rotorua Lakes but I will talk briefly on where I consider some of the consenting hurdles lie. There have been some interesting questions around this issue during the Symposium. I would also like to take you through a couple of consenting example in the Waikato Region that we have worked on as a possible tool to apply here. I will touch on some work that we did nationally with NIWA, and particularly Paul Champion, to expand the biosecurity toolkit and make more tools available. I will conclude with the benefits and explore some of the downsides of these approaches and the potential applicability to the Lakes' Programme.

Before I start I want to touch on a theme that has come through for me, and I know this amazing community group has done so much work in the last 15 years to get to this point. As the Hollies once wrote, 'The road is long and with many a winding turn'.

The road is long,
With many winding turns,
That leads us to who knows where,
Who knows where.

So we have to keep at it and this has resonated with me at this symposium. We need to carry on and we need strong leadership, we do not want to end up where England ended recently. AB de Villiers showed some good leadership, and Mr McCullum, and we do not want to end up on the Boeing 747 bound for Heathrow. So let's keep going.

Slide 1



I do want to acknowledge Hon Dr Smith. I thought his address yesterday was excellent and I am pleased he is the Minister in that portfolio with the background and experience and a really good grasp of regional issues, which I have not seen before in that portfolio before. **(Slide 1)** There are some major issues on the district side of planning and particularly in relating to housing. I am not sure that the wholesale changes to the RMA are the way to go, but I do agree it needs some tweaking. I was interested to hear the Minister's thinking about better co-ordination of funding with the regional planning as that is a need I have come across as well. We would love to see further work to co-ordinate and focus funding.

The RMA is just a tool, it does not result in long complicated planning documents, it does not make doing stuff unnecessarily complex. At a recent planning conference, a clause one of the planners from Northland highlighted was that you do not actually have to have any rules in regional or district plans, you can rely on policies and objectives. There is a lot of focus and angst around rules in planning but the RMA does not encumber this on planning, it is just the way it is being implemented at the moment. The RMA is not overly prescriptive; it has in fact a large amount of flexibility. In my view a lot of issues are created by a lack of quality implementation and are the reason planning is a dirty word.

There are some key drivers that have been around for the last 5 years for improving that implementation, increased need for co-governance and structures that you are well aware of in this community. Government is always calling for better integration between land use and infrastructure planning, not inundating our roads with commercial and housing developments and making sure we look across legislation more and the juncture of the RMA and Biosecurity Act is an example of this.

A number of cross boundary jurisdiction issues have also been touched on at this symposium as well as good partnerships happening with the Waikato Regional Council, the Bay of Plenty Regional Council, LINZ and DOC and other partners.

A tight fiscal environment still exists within the Government realm and in my view this will continue into the future. We must look for efficiencies and try to squeeze more from less. There are perceived barriers to service delivery so making our RMA more straightforward would deliver to communities what we have signed up for under our pest management strategies and various other plans.

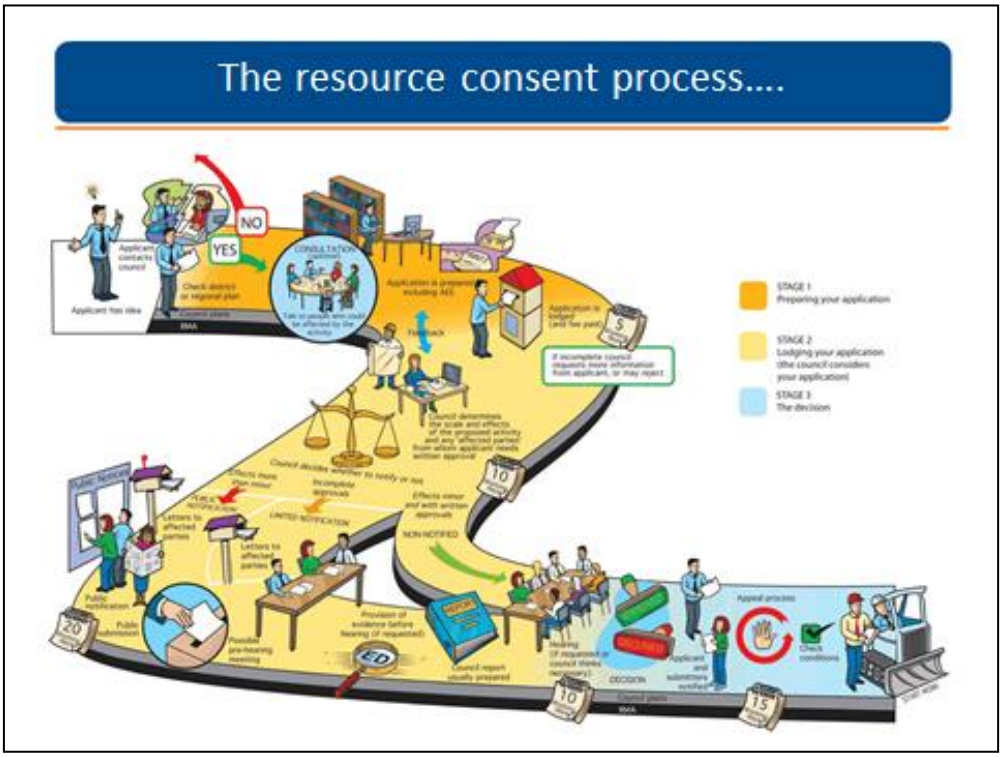
In terms of integration in the biosecurity space, the National Plan of Action talks about:

- better and more effective tools.
- developing, maintaining and registering physical controls and monitoring tools
- best practice guidelines for use
- provision of accessible info to Iwi, industry and public, strengthening collaboration

Moving now to the consenting requirements for the Lakes. In most regions animal pest and weed control programmes require two types of permit - one is on the RMA side and generally on the Hazardous Substances and New Organisms Act (HSNO) as well. The Bay of Plenty Regional Plan requires consents for aquatic weed work and consents for aerial toxic agent operations as well. EPA permissions are also required, although they are at times already in place, and I will touch on that later**.**

Slide 2 sets out the Resource Consent process. I have counted 25 steps. It snakes and ladders and can go any which way. My view at a programme level is – why therefore would you want to do it over and over and over again, operation by operation? Why would you want to focus on one particular herbicide for one particular site? If the context is appropriate, and that is critical, do it once, do it right, and look at a comprehensive approach to consenting.

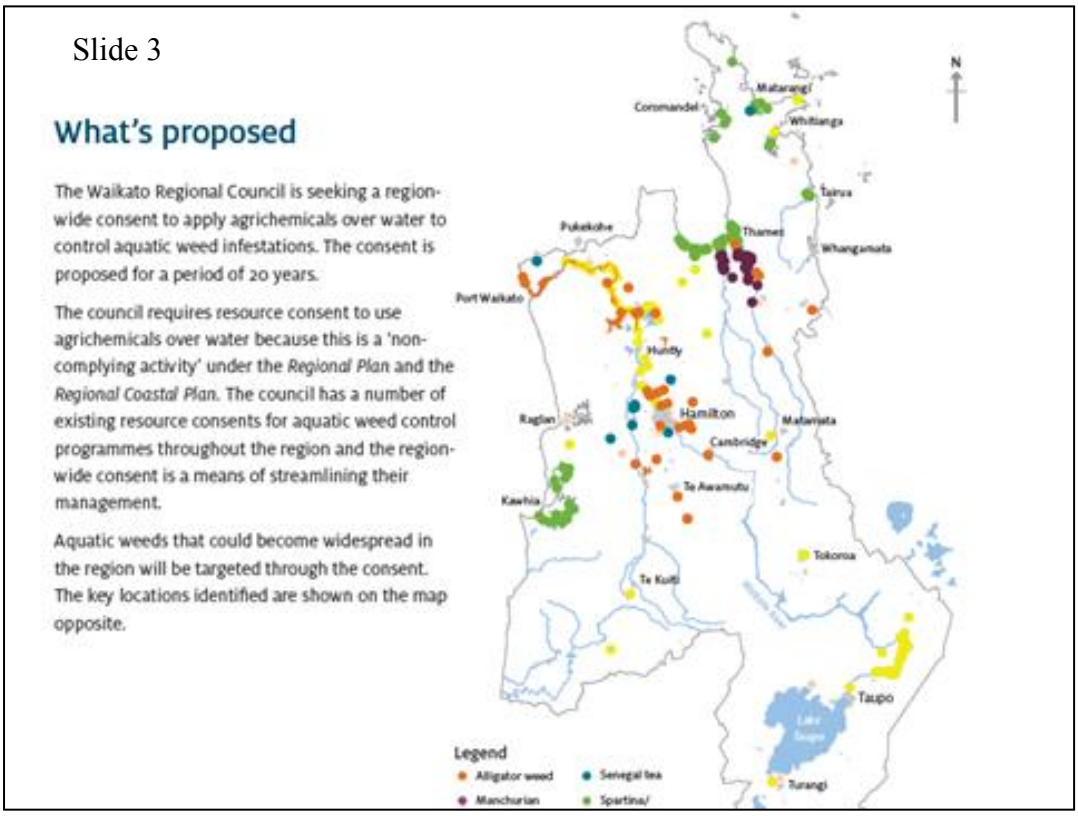
Slide 2



What are comprehensive resource consents? They generally cover a wide geographic area. They can go region wide or district wide. They can be programme level and generally on a wide geographic area for a long term. The RMA allows regional consents to be granted for a 35 year period and these consents can incorporate multiple activities, for example weed management activities alongside animal control activities. You need to think about these consents at a programme level.

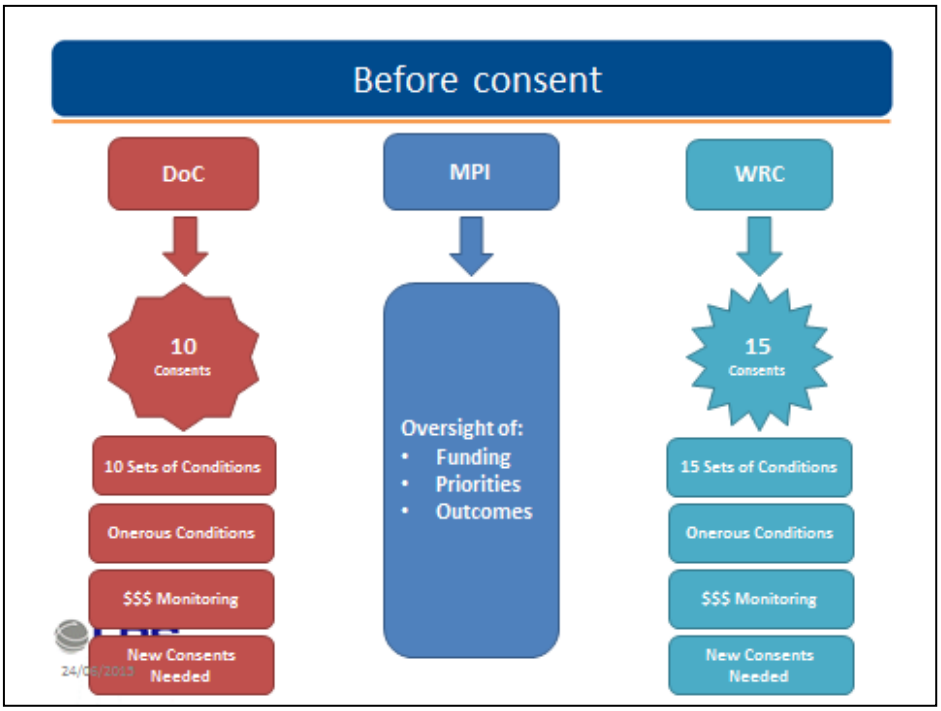
I should acknowledge Wendy Mead who was a great driver for the Waikato Region wide consent that worked on all the RPMS priority aquatic weeds there. Consent was required for application of herbicide over water under the Regional Plan. The objective was a 'single long term comprehensive consent for aquatic weed control in the Waikato Region'. It was a multi-party application. MPI were applicants together with the Department of Conservation and the Waikato Regional Council. This shows that you can bring applicants together within a consent, even diverse groups with different drivers.

Slide 3 is an extract from a piece of consultation and gives a picture of how we communicated. Conceptually it is difficult to get one's head around, but we showed the history of the control in the Waikato for the last 10 years. It is not everywhere, there are sites we manage and it is a dynamic thing so we need flexibility within the tool. Conceptually it can be done.



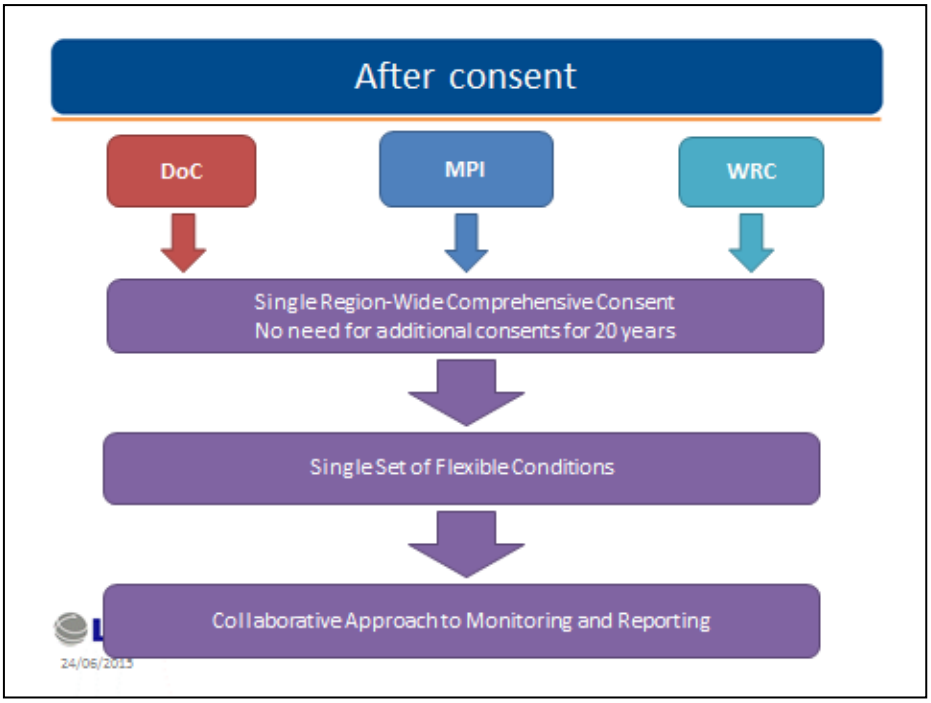
Before the consent there were three agencies operating under different consent frameworks. DOC had around 10 separate consents, meaning 10 sets of conditions to comply with, 10 lots of monitoring, and more money spent on monitoring. **(Slide 4)** MPI had the oversight role in this case. WRC had around 15 to 20 consents, with all the sets of conditions and monitoring requirements and an ongoing need to get consent on a site by site basis.

Slide 4



After the comprehensive consultation there was one consent for a 20 year period for the whole region with a single set of flexible conditions. **(Slide 5)** You may not agree with that Wendy, but from a planning perspective it was a pretty good deal. There has also been a collaborative approach to monitoring and reporting thereafter and this has led to roll out of national monitoring programme.

Slide 5

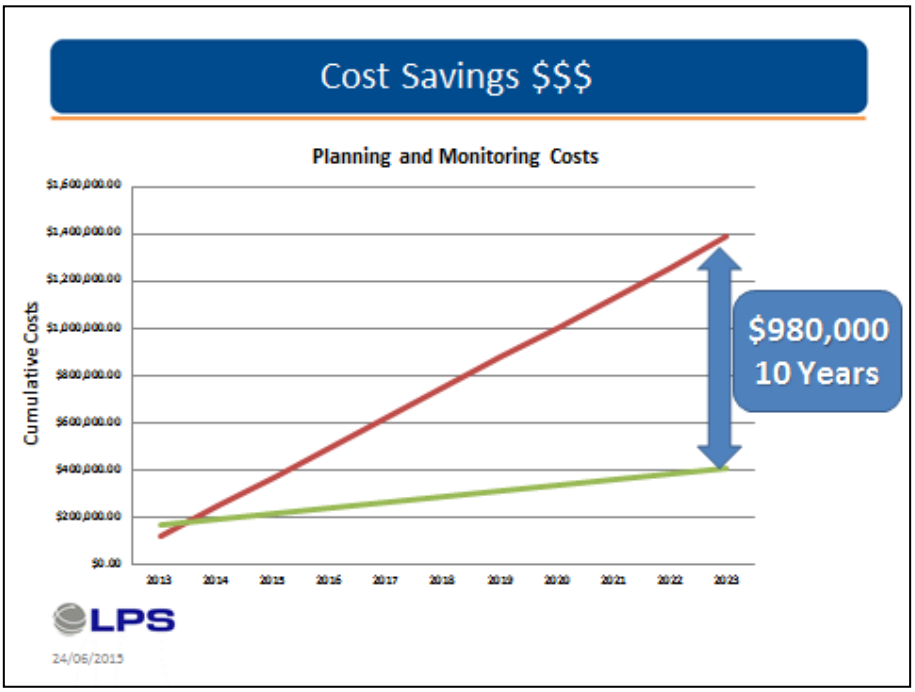


There were a number of benefits to this approach. We were able to access the extensive consultation networks of these applicants. DOC and WRC have a long history of good consultation in the Waikato. It provided a forum for those parties to come together and talk about their shared operations and what they were doing. We were able to use technical

information efficiently as well, using NIWA for that single assessment of environmental effects. The process benefits meant that the joint applicants rather than the submitters in the process addressed the issues up front not during the process to resolve issues within that process.

Slide 6 shows the cost savings for another comprehensive consent investigation we have undertaken for the New Zealand Transport Agency. NZTA hold around 450 consents in the Waikato. We looked at some rationalisation around that by reducing to about 8 to 10 consents. There were quite considerable cost savings if we can.

Slide 6



What are the downsides to a comprehensive approach? The biggest risk is that not all key stakeholders grasp the concept and/or get their head around the scale. Most notably this relates to the consent authority planner - you have to get that planner on board. It takes time and resource upfront to get everyone on that same page and generally you need more time, but the long term gain is what you are after. There is a need to develop robust and workable conditions for operations in the future that will balance of management environmental effects. Allow for that future input and review that gives the community some certainty if things change. Resource up front pre-application discussions, consult widely and get the strategy together before pursuing any of these pathways.

You have a great strategic story here that could be used for a similar approach. Why are we here, why do we need to spray, why are we even doing this? Put it in strategic terms and filter it down to the detail. Assume you are going to be notified and assume that you may go to the Environment Court. Clearly you need to allow time for that. Work up conditions and get them in early so that you can influence the process as well. 70%-80% of that effort is upfront before you get into the actual consent process.

We have also worked with NIWA on the National Aquatic Weed Permit through the Environmental Protection Agency. Paul Champion schooled me on the weeds in the photos below for a few years now, Alligator weed is on the left and the other picture is in Northland with its wonderful riparian margin of Manchurian wild rice. That entire green margin along the river is an invasive pest.

This national consent was a much more collaborative framework, 15 Regional Councils were involved alongside other parties such as DOC and MPI. The consent was about securing approval for the use of herbicides over water under HSNO. All 4 herbicides are critical tools in the management programmes alongside other methods.

The table below shows the plant species managed nationally. The process allowed a stocktake of this information which has led to more national monitoring and national

Pest Plant Species	Freshwater Presence	Marine Presence	Eradication Areas
Alligator Weed	Yes	No	Bay of Plenty, Horizons, Waikato
Californian Bulrush	Yes	Yes	Horizons
Fringed Water Lily	Yes	No	Nationally eradicated
Manchurian Wild Rice	Yes	No	NIPR species, eradication targeted at all sites outside Kaipara Containment Zone
Marshwort	Yes	No	Auckland, Waikato, Bay of Plenty, Nelson-Tasman, Canterbury
Monkey Musk	Yes	No	Northland
Phragmites	Yes	No	NIPR species, national eradication targeted
Purple Loosestrife	Yes	No	Northland, Auckland, Waikato, Bay of Plenty, Horizons, Greater Wellington, Nelson-Tasman, Canterbury, Southland
Saltwater Paspalum	Yes	Yes	Waikato
Sagittaria	Yes	No	Auckland, Waikato
Salvinia	Yes	No	NIPR species, national eradication targeted
Senegal Tea	Yes	No	Northland, Auckland, Waikato, Bay of Plenty, Taranaki, Horizons, Nelson-Tasman, Marlborough, Canterbury
Spartina	No	Yes	Northland, Auckland, Bay of Plenty, Waikato, Gisborne, Horizons, Nelson-Tasman, Marlborough, West Coast, Canterbury, Otago, Southland
Water Hyacinth	Yes	No	NIPR species, national eradication targeted
Water Poppy	Yes	No	Auckland, Bay of Plenty, Northland
Yellow Flag Iris	Yes	Yes	Northland, Waikato

approval subject to conditions. I viewed the project as a tool kit expansion, previously we did not have the appropriate approvals for those herbicides, but the permit opened access to the tool kit and introduced a couple tools more into the mix.

The costs were shared and cost savings were achieved by sharing the burden. When looking at biosecurity tool kit expansions a collaborative approach is vital, particularly in terms of tackling the EPA. At this point I would like to acknowledge the Regional Council biosecurity managers for taking the lead on this project. This is an excellent forum for tackling these more strategic national issues and the EPA were very supportive of this approach. The permit has since led to a national monitoring programme for aquatic weed management which we are working on with the EPA at the moment.

Where to from here for the Lakes? My observations from these two days, and I do not confess to know masses of detail, but I have been learning the whole time. It seems you have the structures in place, a good strategic story and solid governance structure to run a high level consent for the tools required in the programme. You have a programme history, have built community trust and relationships, but the tool kit is a little limited by the RMA.

There is potential for large scale animal pest control in the future and could definitely look at some integrated consenting arrangement around that. This would provide a vehicle and opportunity to integrate across the two programmes of water quality and the aquatic weed management programme. Tackle it strategically and look at a joint consent and policy approach.

Thank you very much.

QUESTIONS

Craig Morley, Waiariki Institute: My question is regarding the citizen science. I find there is a dilution of work as a result of this? In other words we are not getting graduates employed. I saw a newspaper article in the Herald on Monday with a whole class from Massey University with Honours Degrees in Environmental Planning and Environmental Management; none of whom have jobs. Now the issue that I have with citizen science is - are we diluting prospects for these guys to get jobs and funding because it is going into citizen science for agencies?

Tracey Burton, NIWA: Yes, that is a really good question. I do not think we are. The type of science, observations and data that people collect, is not a double up. We ask for extra information that we would not usually employ to collect anyway because that funding is simply not there and they are not on the front line. We are not taking other people's jobs but those people would be prime candidates to tackle awareness programmes should funding become available. I did not mention with citizen science before that it is not a silver bullet. A good citizen science programme takes a lot of planning and plenty of involvement. These people need to be given the knowledge, training and ongoing support so it is not something you can up and walk away. An expert must be involved and of course that comes at a cost. I do not believe that we would take anyone's jobs.

David Hamilton, Waikato University: I have a question for Guy in relation to your evaluation of councils. You identified funding as an issue to uptake for science. From my personal experience working with councils and also presenting to councillors, to what extent is the backing of councillors and their staff a factor in funding that uptake of science.

Guy Salmon, Ecologic Foundation: Yes that is a real issue and there are a lot of issues around the governance of councils which I could talk about for some time. Since regional councils were established in 1989 their performance has been quite disappointing and patchy. Nowhere do you see that more dramatically than in the water quality area where the regional councils' jurisdiction was established about the beginning of the dairy boom and we had huge expansion of intensive land use impacting on water quality. Nothing was done in almost all the regions during the 25 year period that followed. In a series of interviews and studies of regional councils I tried to understand why that happened and it is partly in the composition of the councils as they are elected.

There are two sectors of the community that are perhaps a little further advanced in their concern and awareness of environmental issues and the sort of people who are members of environmental groups like Forest and Bird or Fish and Game, recreational groups on the one hand and on the other Iwi. When you look at the membership of regional councils those two are quite under represented compared to the population basis or in the national parliament. It has to do with the system by which councillors in every region are elected, except the Bay of Plenty. The composition of the councils tends to have an over-representation of primary sector interests compared to the rest of the community. That is not entirely surprising because the decisions the councils make have a large concentrated impact on the primary sector. For urban people perhaps they do not feel quite as passionate about following what councils are up to. In Environment Canterbury for example over the last 25 years they have handed out water permits valued around $5 billion but most people are not aware of that, They think it is just a bit of administrative paperwork being done and there are some quite strong incentives for some sections of the community to pay more attention to the regional council elections than others do.

This was an issue discussed at the Land and Water Forum and while there was no support for changing from elective regional councils there was a strong feeling that there ought to be. The regional councillors themselves ought to be supplemented by some appointed representatives who would reflect the interests of Iwi and environmental interests and provide what might be called a governance component to the council. In other words bring to the table people whose focus is on looking at what the statute says, what is supposed to be done and make sure it is done. Not the continual drift around which is unfortunately so often the pattern.

I am afraid that is a longer answer than I should have given but I wanted to say that I believe the governance of regional councils is a big issue. The Land and Water Forum has recommended some changes but so far nothing has happened and unless it does we cannot expect a higher level of performance.

Dale Williams, BOPRC: Guy in your presentation you commented on the lack of risk assessments. You will be pleased to know that Bruce Warberton from Landcare Research has just been contracted to carry out a risk assessment of both the Dama wallabies and the Bennetts wallabies to look at what the potential implications are if we do nothing about preventing the further spread of those species.

Te Taru White, Pukahukiwi Kaokaoroa Inc.: Kia ora, a question to David Mole. I applaud the notion of collaboration and cooperation because as a land owner it is increasingly frustrating to look back at all the bureaucracies, energy and resources that have been soaked up in that space when looking for delivery at the coal face. It is tough when funding is restricted and everything else. I saw the new framework for LINZ and the comments you made and thought I have probably seen some of those words 10 years ago. I wonder what is going to be different to make this happen instead of being in silo - really cooperating and collaborating together.

David Mole, LINZ: The short answer is watch this space and I will deliver on my word. This partnership is not just me, we have it with another agency and have invested in each other's business and really believe in this. I dare say it does come down to individuals but by and large this is a new direction. Before, LINZ was under the radar and decisions were based on 'not to do things' as opposed to 'doing things'. We are now front footing this, being proactive and want to be leaders in the space. It comes down to personal aspiration and seeing tangible achievements.

Warren Webber, LWQS: David, as a community member I have observed what has happened with the weed spraying programme, particularly around the Lake Rotoiti area. My impression has been that it is grossly underfunded, under resourced and we struggle to get the work done that as a community we see is required. When I saw your funding slide earlier with $2 million per annum, of which only half goes to aquatic weed control, it struck me as being a huge underfunded proposition. Would you like to comment on that?

David Mole, LINZ: I agree. I would like to defend the programme that we do have in the Rotorua Lakes. I think it is effective but going back to that prioritisation and the types of programmes we employ, effectively for these lakes we employ a sustained containment programme. We could make improvements and we talked about strategy. Once again it comes down to collaboration and firmer partnerships. There are ways of becoming beneficiaries of more funding. Money is tight and there is no question about that and I concede that in order to get new funding there has to be a problem. It is more reactive than proactive. But things can be done and I certainly see opportunities. From what I have heard over the last couple of hours, and the report from yesterday, there are opportunities

in Rotorua to press things this way and perhaps get more definitive plans in place. A business case, if you like, for the lakes going forward which would attract new funding.

Nick Miller, LWQS: I would like to commend Tracey on her advocacy of what she called citizen science. We all need to remember that there are a lot of very famous scientists who were really citizen scientists, or amateur scientists, such as Newton, Darwin and numerous other illustrious people. There is no way they could they have been called professional scientists. I am sure amongst the membership of the LWQS and at this symposium where we have the professional scientists I suspect there are a good few amateur or citizen scientists as well. For many decades one of the world's leading scientific periodicals produced a column every month called 'The Amateur Scientist'. No longer produced alas which may reflect current views.

CLOSING COMMENTS

I have to say that this has been one of our best symposiums. The quality of delivery and ideas and the way you as presenters put your case with excellent slides demonstrates the depth of thought that went into the issues that have been widely traversed. I must compliment you on the clear delivery of scientific messages to the community by keeping the message relatively simple. 'Keep it simple stupid' for the layman. I have the same issue in board reporting. If you can get the message across simply it is amazing how you get the community engaged.

So I congratulate all the speakers and will not go through each one individually in giving a summary. We have a wonderful science community here and our society is there to promote and encourage your work and convince the politicians wherever we can that more money needs to go into science to achieve the challenges of the future.

We will put all presentations and comments from this symposium into a proceedings. We have found these to be invaluable and the hard copy in demand. They capture all those messages which would otherwise be forgotten and it will be an excellent reference on lake weed and wallabies for all stakeholders. If you want one, contact Ann. It is a big challenge for her now because she is going to take the information off the tapes and get it to book format, which takes about 3 months, but we feel it is well worth it.

I cannot go away without making a few observations. Yesterday it was clear to us that we need to have lake plans for each lake for invasive species. We have done nutrient plans for the lakes and were able to get the community and politicians engaged and that is why we have been successful as a community as we have had science behind us the whole way. It is clear that is the model that Central Government and Nick Smith all like to see. So if we are going to get anything done we need to put it into a plan actively worked through will all stakeholders including the scientists, socialise the plan, hear what the community's goals are, make sure we have the science, decide what action is required and who is responsible and obviously the funding. That was a really important point brought home for me yesterday on dealing with our invasive weeds.

There is no question from what we have heard the last two days that we need to focus on funding. There is clearly not enough in the LINZ budget of $2million for all New Zealand for our invasive pests and weeds. So setting ourselves a plan and working altogether to achieve the outcomes that we want though a business case to the councils and central government is our challenge.

Another big message that came though is that our tool box is lacking. Endothall obviously was one which was talked about as a success story with hornwort and had an impressive record. Are we as stakeholders working together to get the appropriate consents for spraying invasive weeds?

Another key point was that exotic weeds can grow in any water quality conditions; they are not a function of good or bad water quality. It was a very solid message that Mary gave us enabling us to separate them in our minds. Two further messages were to keep invasive species out so we do not have to deal with them at all. But when they do come into lakes or waterways move on them fast and deal to them, rather than wait and see.

We learned today that forests are very complex. I enjoyed the Okataina papers and presentations; it has made it a lot more complex subject than what I thought before I came

this morning unfortunately. There are many factors that influence a forest, we understand that. We have not done any studies measuring the effects of browsing animals on water quality. I presume at some stage that will be looked at.

There is no question that sediment comes from bank erosion, landslides and storms yet exclusion plots did show that wallabies and deer do have an effect. Lake Okataina has shown signs of increasing phosphorus in recent years and a pristine lake at risk. There is no question that we should be get more action around and in that lake. Following the precautionary principles it is dangerous to simply do nothing, we need research urgently.

We heard about practical ways to reduce wallaby populations and at moderate cost. But we need to deal with the other pests, possums and rats, as well as they are all part of the cycle. The urgency and concern for wallabies is that they are very close to the main ranges and have a forest path up to the Coromandel.

We can all play our part as front line workers in keeping out alien invaders. The use of apps gives a far greater opportunity to get the community involved and modern technology allows us to take photographs to identify invasive species just by pointing your cell phone and it will come back and tell you there is a problem and we need to act. I do think that many in our community do not have a strong environmental view on the threats to the environment and the use of apps may well be an opportunity.

Perhaps every environmental asset needs a community group to take care of it. The Minister said that environmental reporting is coming around the corner. LWQS has always believed that we should have environmental reporting. By measuring the environmental impacts it would highlight the problems in the environment to the community.

Thank you speakers for giving us those messages, and many others, which will be recorded in the proceedings for posterity. Thank you for your attendance and all the time that you put into your speeches. For the chairs, thank you very much for giving your personal time and effort to conduct the meetings. I thought they all went very well; we stayed by and large within time and it was a very efficient meeting. For my committee, Ian, Don, Warren, Jim, Marcel and Ann, thank you for your support and all the meetings we had in planning. It takes an enormous amount of time in planning these symposia but it is very much appreciated.

Thank you Hilary, Diane, Ann and Brian for your support as ‘go to’ people to make each session run smoothly. Just a note for those speakers who seek reimbursement of expenses or costs, talk to Marcel before you leave and get his address to send your costs to him.

Thank you John Madsen very much for coming to New Zealand and sharing your thoughts. I know you had to get permission from the US Government to come. I hope you have a very good weekend fishing with Rohan on Lake Tarawera, but I can tell you Lake Rotoiti has much bigger fish, but anyway you prove us wrong. On Monday you are going to see the Bay of Plenty Regional Council and then we will take you to see Chris Battershill, Bay of Plenty Regional Council Chair in Coastal Science, based in Tauranga. I am told there is a very heavy weather event coming through so it may be that we will drive you up to Auckland so that the US Government cannot accuse us of trying to kidnap you.

John Green
Chair, LakesWater Quality Society