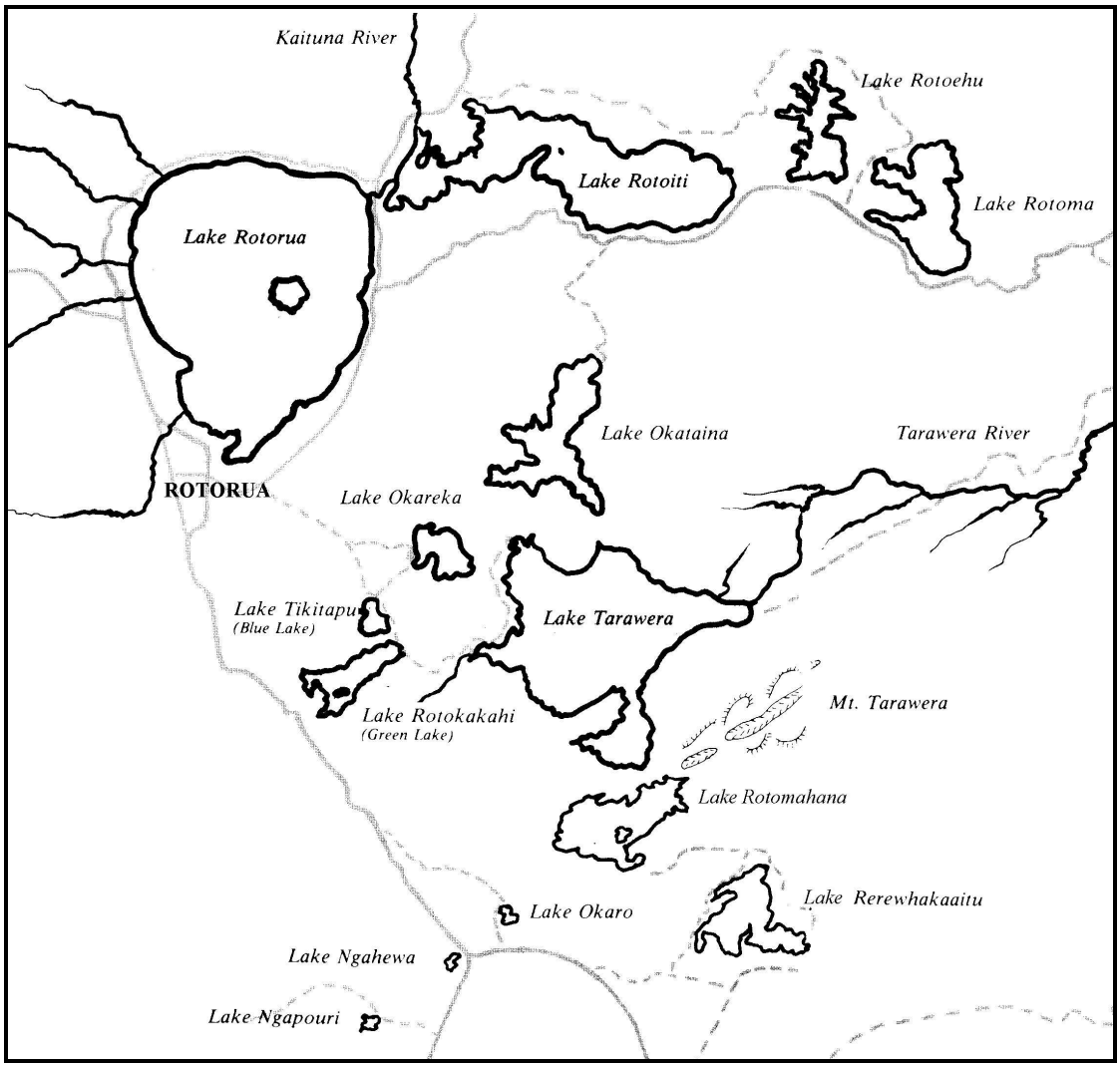
Proceedings

ROTORUA LAKES 2008

Nutrient Sensitive Zones – Nitrogen and Phosphorus, Lakes and Waterways



PROCEEDINGS

ROTORUA LAKES 2008

Nutrient Sensitive Zones – Nitrogen and Phosphorus, Lakes and Waterways

12 –13 August 2008
Heritage Hotel, Rotorua

Jointly hosted by

Lakes WATER QUALITY Society

and

the Royal Society of New Zealand

The Royal Society of New Zealand
(Rotorua Branch)

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Editor's Note

Material for the Symposium Proceedings has mostly been received as fully transcribed audio tapes and PowerPoint files. The editors have then endeavoured to edit the spoken word to a written word format and included graphs and pictures from the PowerPoint slides, with discretion, in the body of each presentation. Where possible, slides that contained only words were incorporated into the document text. Not all slides were included. These slides are in PDF files on a CD at the back of these Proceedings. Some of the papers were sent to the original presenter for clarification in the editing or meaning, particularly in the scientific and economic areas. Two papers were available as formal written papers. Simon Berry's presentation is the original legal document which he talked to at the Symposium and has been included without any extra transcription and additions.

Audience questions and presenter's answers have been included. A full transcript of the Forum sessions has been supplied, with minimal editing in the interests of clarity. These are a little more difficult to transcribe and there may be some errors or misinterpretation in the editing.

Poster presentations have been included in the Proceedings.

I would like to thank all the presenters who have kindly helped me with editing. It is a mammoth task. In the interests of expediency and accuracy I very much appreciated their support. I would also like to thank my co-editors, particularly Elizabeth Miller, who have spent hours of their time looking for the minutiae in spelling, grammar and format. It is a laborious task.

Ann Green

Disclaimer: These Proceedings report the formal presentations and open forum sessions of the Symposium, which was designed to encourage open discussion amongst those managing, studying, or with an interest in the Rotorua Lakes. The information is **not** intended to substitute for official policy statements from parent organisations.

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Warren Webber
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John Green
Chair, LakesWater Quality Society Inc.

This Symposium, ***Rotorua Lakes 2008*** was the sixth event of its kind jointly hosted by LakesWater Quality Society and the Royal Society of New Zealand (Rotorua Branch). The theme was ***Nutrient Sensitive Zones – Nitrogen and Phosphorus, Lakes and Waterways.*** The background to the Symposium was the increasing pressure on fresh water resources from the primary production sector, particularly dairying, and the damage to ecological, recreational and cultural values of freshwater environments. Many areas within New Zealand are highly sensitive to nutrient discharges, and our pristine rivers and lakes which have long been the show case to the rest of the world are showing significant signs of deterioration.

Earlier Symposia showed that the water quality deterioration is due to high levels of nitrogen and phosphorus contamination. With the causes of this pollution known, ***Rotorua Lakes 2008*** focussed on the policy tools and framework to manage it. The Resource Management Act has been used by Councils to regulate point discharges of pollutions but it has not been effectively used to regulate diffuse or non-point discharges.

The Symposium explored three questions:

- Whether the RMA is adequate to deal with diffuse discharges of pollutants
- Whether special Nutrient Sensitive Zones need to be created to manage sensitive lake and waterway environments
- What an effective National Freshwater Policy statement under the RMA should look like

The Symposium was designed to bring together the lessons learned in Europe, USA and Australia. The Symposium format again provided an invaluable forum for bringing expertise, practical observation and policy makers together to achieve the best outcome to complex and difficult problems.

There were 20 papers presented to the Symposium and these Proceedings record all presentations. Amongst these the Minister for the Environment, Hon. Trevor Mallard, in giving the opening address, clearly articulated the need for Central Government to show leadership on freshwater management in New Zealand. Professor Erik Jeppesen from Denmark, who is a world leader on nutrients in lakes and catchments, demonstrated the European experience of managing restoration of heavily polluted freshwater resources. The key point made was that the act of pollution must be internalised and borne by the polluter before normalised behaviour is achieved.

On behalf of LWQS, I extend our sincere thanks to all those who prepared and presented papers, to the Chairpersons – Professor Warwick Silvester, Paul Dell, Dr Toby Curtis, EBOP Chair John Cronin, Dr Jan Wright, John Kneebone, Ian McLean and the Rt. Hon. Simon Upton. Our special thanks go to Simon Moore for his excellent summing up.

The time and energy required to prepare and conduct these Symposia is high. My special thanks go to our sub-committee of Brentleigh Bond, Ann Green, Lyn East, Don Atkinson, Ian McLean, Jim Howland, Warren Webber and Sally Brock.

May these Proceedings give you inspiration for the future of our freshwater resources in New Zealand.

ROTORUA LAKES 2008

NUTRIENT SENSITIVE ZONES – NITROGEN AND PHOSPHORUS, LAKES AND WATERWAYS

INTRODUCTION

John Green
Chair, LakesWater Quality Society Inc.

Welcome everybody. Mayor Kevin Winters, the Honourable Trevor Mallard – Minister for the Environment, the Honourable Steve Chadwick – Minister of Conservation and our local MP, John Cronin - Chairman of Environment Bay of Plenty, Mr Toby Curtis – Chairman of Te Arawa Lakes Trust, Regional Councillors, District Councillors, Professor David Hamilton, Professor Erik Jeppesen, Speakers and our Chairs, distinguished guests, ladies and gentlemen.

Welcome to LakesWater Quality Society's Sixth Symposium. Many of you have travelled a long distance and we appreciate your being here. On behalf of our Society, and the Royal Society New Zealand, Rotorua Branch, we are going to be your hosts for the next two days and will enjoy it. We have a wonderful line up of speakers to address the question of *Nutrient Sensitive Zones* and the part and context such zones play in a National Policy Statement on Freshwater Management. We seek to educate, to participate and debate. We respect diversity of views and we look to find pathways through conflicting positions.

To give our opening address our first speaker needs little introduction. He is a very experienced politician with twenty-one years in Parliament and the last nine years as a member of Cabinet. He has a strong track record of taking on difficult challenges and getting things done. He was appointed Minister for the Environment in October 2007 and in May of this year announced a Government grant of over $72 million towards our much needed Rotorua Lakes Restoration Programme. This initiative has been gratefully acknowledged by the Rotorua region. In July this year the Minister established the process for the proposed National Policy Statement on Freshwater Management. He is here to speak to us today on this subject. Would you please welcome the Honourable Trevor Mallard.

Session One – European and New Zealand Perspectives

SESSION CHAIR: John Green

OPENING ADDRESS

GOVERNMENT POLICY ON FRESHWATER MANAGEMENT IN NEW ZEALAND

Hon. Trevor Mallard
Minister for the Environment

TRANSCRIPT

Thanks, John, for the invitation to be here. Your Worship – good to see you. My colleague Steve Chadwick who, I think, did not need to be the Minister of Conservation to push hard on these issues, although I might say that in the decision-making around the quantum for the Rotorua lakes, having someone inside the Cabinet was very useful. It was one of those occasions that I have seen as Associate Minister of Finance, where the envelope was pushed. I think that might be a good way of putting it. The reason for that was that Steve was there advocating and actually in the end it was a really good decision because what we got was something that has the potential to work in the long-term, rather than being a very *ad hoc* position going forward. For too long environment and conservation issues have been broken up too much rather than being solid.

Thank you very much for inviting me to be here. Water is a precious resource. I think that around the world it is seen more and more as being the precious resource. As far as Kiwis are concerned it is fundamental to our lifestyle. It is crucial for economic development and the country's beauty, health and cleanliness are a key to our national identity. We actually care about water, it is part of our way of life, our way of being – more than in many other countries – and it is vital. We trade on our clean green image and tourists love that. The fact that we do have clean water offers us competitive advantages.

It certainly offers lots of advantage in the agriculture area. What we are finding is that around the world countries are clamouring for eco-friendly products and services and having quality water is a big part of that. But while we can continue to take pride in some of the world's cleanest and most beautiful rivers and lakes, the most recent *State of the Environment Report* shows that the quality of our fresh water is increasingly under pressure from intensifying land use both in urban and rural areas, and the nature of the pollution is changing. Previously it was very much from point sources like discharges out of pipes, and that has decreased. But now there is an increase in diffused pollution entering our waterways from fertilisers and pesticides, from oils and nutrients, and from livestock effluent. These diffused discharges are associated with increasingly intensive land use, both in urban, and particularly in rural, environments. Because they are diffused they are much harder to contain.

The current state of the Rotorua lakes is a clear example of damage that urbanisation and rural land use intensification can cause to water bodies. The lakes are clearly very important both to tourism and recreation and they are very important to Tangata Whenua. However several of the lakes have suffered serious water quality problems for decades. High nutrient levels have resulted in seriously degraded water quality as well as algal blooms which reduce oxygen levels in the water and are threatening the other life in the lake. Our research has shown that pollution mostly comes from intensive farming and from sewerage discharge.

The Government has been involved with the Rotorua Lakes Strategy Group, made up of Environment Bay of Plenty, Rotorua District Council and the Te Arawa Lakes Trust, to

assist in the restoration of the lakes. While I might have got a little bit of credit for the announcement, although in fact the Prime Minister made it, the Government will contribute $72.1 million to the clean-up project. What it does is involve *inter alia* the construction or extension of sewerage works to the unserviced communities, treatment or diversion of nutrient-rich streams, capping lake sediments to stop nutrients coming up from lake beds, the construction of wetlands, land management changes to reduce nutrient inputs from surrounding land, and harvest and disposal of weeds. That is important here, just as the work that is occurring over probably a longer period at Taupo is important for Taupo and the Waikato.

Fixing water bodies on a case by case basis is not the long term answer. That is why the Government is undertaking the S*ustainable Water Programme of Action* to improve the management of our fresh water resources and to protect them in the future. It is an attempt to build a strategic and nationwide consistent approach to water management and is about ensuring efficient, fair and sustainable use of our fresh water while we protect it from contamination.

An important aim for the *Programme* is managing the undesirable effects of land use on water quality. That is something which is going to end up being quite controversial over a period of time because for a long time farmers, in particular, have had an understanding that what they did on their land, as long as it was not directly absolutely poisonous, was very much their business. The idea of reduced nutrient-leaching and reduced run-off is something that was not really heavily contemplated by many farmers up until quite recent times.

There is going to be a lot of debate and discussion and a balancing of rights going on. But what is clear is that people who have had rights, both to take, to use and to also effectively pollute, are going to lose those rights over a period of time. Working through that is going to be an interesting exercise.

So far though under the *Sustainable Programme* we have completed a National Environment Standard for the Protection of Human Drinking Water which came into effect in June and it requires Councils to consider the activities on drinking water sources in their decision-making, thereby reducing the risk of contamination. We are getting very close to finalising the standard for the measurement of water take, which will require consent holders to measure and report on how much water they use.

Frankly, when I came across that one, I thought, why do we not do that already? But we do not and it is something which is important. It will not mean that every little take will have to be measured, but things which are significant will have to be measured, and it will be something which will come into effect over a five year period on consent renewal.

There is a standard on ecological flows and water levels currently undergoing public consultation, and submissions on that close on 29th August. This proposed standard provides methods for determining water levels that are required to preserve the life-supporting capacity of our water bodies. I want to really emphasise that it is about the ecological flow in water levels. What will come later is one on environmental flow and that will take into account more cultural and recreational aspects of water flow. Ecological is pretty clearly about the ecology, and what is required to not make things worse as far as that is concerned.

We have also got a recent discussion document out for a proposed national environment standard for on-site wastewater systems which requires standards for on-site treatment systems. This will certainly help avoid water pollution from inadequate treatment or septic tank failures. The submissions on that close on 26th September. These National Environmental Standards will result in greater consistency in decision making.

The cornerstone of the *Sustainable Water Programme of Action* is the proposed National Policy Statement for Freshwater Management which I announced last month. That has gone off to a Board of Inquiry which will shortly publicly notify the proposed NPS and seek submissions. I want to emphasise that for all of its work the Board is independent. It will hear submissions; it will effect the National Policy Statement as proposed; it will look at a way of bringing this into effect, and will provide me with a report which may include written changes. The proposed National Policy Statement will lead to improvements in the management of land use effect on water by tying together the policies on water quality, water quantity, land use and development. I have to emphasise how important it is that everyone in this room has a read of it, as this will be the basis of the National Policy framework. It will guide Local Government decision-making on our water resources into the future.

This emerging regulatory regime of the National Policy Statement and the relevant National Environmental Standards, is complemented by the Dairying & Clean Streams Accord. It is industry-led, voluntary and developed to set targets relating to the physical protection of water bodies. The Accord has improved the understanding of the impact of dairying on water quality and the initiatives that are required to reduce them. This includes keeping cattle out of waterways, treating farm effluent and managing the use of fertiliser and other nutrients. I expect the pastoral industry to work pro-actively to stop degrading water quality through nutrient use. I think the vast majority of farmers, as they are briefed on the economics of that, will do it.

What has been very clear when farmers have entered into nutrient budgeting exercises, and I am going back into memory now, is that somewhere between $11,000-$13,000 per farm average reduction in nutrients applied when proper budgeting was done. What we are finding is that on average farmers are putting too much nutrients on for the economics of their particular farm. So there is an economic reason as well as an environmental reason for farmers to reduce existing nutrient use on farms.

I think also some social change is beginning to happen in the farming community. The farmer who lets the other farmers down is not acceptable now in the way they might have been in the past. People are working a pretty tight balance between what can be done voluntarily and what can be done by regulation. Anyone who stimulates more regulation than necessary by their bad behaviour is not likely to be popular with their neighbours, and so the acceptability of their behaviour lessens.

Whilst I can never interfere in matters of prosecution as far as Regional Councils are concerned, I would certainly encourage Regional Councils to use their powers to prosecute, and to prosecute individuals as well as farming companies. It is important that this is done because there is a danger that if just the farming companies or partnerships are prosecuted, it is treated as a bit of a cost of doing business. Whereas if an individual is prosecuted and is faced with a conviction as an individual and in the most serious cases the possibility of a jail sentence, it tends to create a bit more focus than paying a fine which might be regarded by companies as just another expense.
There have been a couple of prosecutions – one really interesting one in the Waikato resulted in someone getting six weeks in jail for, I think, probably the third or fourth offence of burning stuff in a way that was not approved. That is a lesson to people on how seriously these matters are taken now. So I congratulate local authorities who do take legal action.

In summary we need to remember that water is not a resource of infinite purity and supply; we need to take quality and conservation seriously. I think it is a problem that we all share and we have got to continue to share, by a mix of attitudinal change, good leadership and regulatory change. Then we can have a sustainable waterway. But

understanding the issues and building a consensus around what has to be done is very much the responsibility of groups like yours and seminars like this. Because to get it right we have to understand and we need a shared understanding, and that I am sure is the purpose of this Symposium.

Thank you very much.

QUESTIONS

Gary Taylor, Environmental Defence Society: My question is about the National Policy Statement on Freshwater. I guess the problem with it is that it sets up a bureaucratic process rather than setting national goals. I wonder if the Board of Inquiry's terms of reference are going to be sufficiently broad for it to fix that and to change the emphasis, and in particular whether the terms of reference will be sufficiently broad to enable the Board to infiltrate some national goals directly into regional policy statements via Section 55.

Hon. Trevor Mallard: Well, the short answer is that the Board is invited as part of its terms of reference to consider using Section 55 to bring all or part of the National Policy Statement into effect or to make recommendations to that effect. So the answer is yes, if the Board can be convinced of both the setting of tighter national goals and the method of bringing it into effect.

Gary Taylor, Environmental Defence Society: When will the terms of reference be publicly available?

Hon. Trevor Mallard: It is the Board's responsibility now to notify the National Policy Statement technically. They will be doing that over the next two or three weeks I think, and the terms of reference will be available at that time. It is slightly tricky – it is not quite a judicial situation now, there was even a little bit of tension around me releasing it rather than them notifying it.

Melissa Robson, GHD Limited: Just a comment really – you made a couple of comments about the change in communities which would lend itself to people maybe adopting measures to reduce the pollution because of neighbourhood interactions, and also about the economic benefits of reducing diffused water pollution from agriculture. I think in reality it's a little bit blue chip in that with increasing land corporatisation especially in New Zealand and big farming partnerships, that really desensitises farmers from their individual communities. Also, on the economic benefits of reducing the diffused water pollution from agriculture, you might save $100 or $1000 a year in terms of effluents, but it might cost $100,000 to actually build a decent effluent system. So the question is about whether any Government money is being put into influencing actual measures on the ground on farms?

Hon. Trevor Mallard: Clearly there is a lot of work in co-operation with Fonterra, in particular, going on around the Clean Streams Accord – there is a relationship between Fonterra, local authorities and Central Government; a lot of work is going on there. I don't know if I agree with you on the effect of increasing corporatisation in the dairy industry on pollution and attitudes to pollution. In fact, and I can say this from being a half-owner of a very large dairying company Landcorp, that has twice now in my time been prosecuted for pollution, the attitude from the owners and management to that is one which is very, very negative.

The problem that I see with corporatisation is often one of labour supply in getting quality trained people into the jobs for corporate. I think that the issue there is what might be described as accidents as opposed to ongoing ordinary business-type pollution which comes as a result of a lack of training. Overall Fonterra have certainly got the message

that business depends on a clean green image. The test for them will be when are they going to be prepared to stop receiving the milk from a farmer who pollutes? Part of that will be in working in co-operation with other dairy companies to ensure that the milk is not picked up by someone else when that occurs. The dairy company is actually the organisation with the most interest in and the best tools for ensuring clean farming.

Raewyn Peart, Environmental Defence Society: I want to ask a question more about the economic rather than environmental behaviour. At the moment the economic signals are resulting in a changing land use from forestry, sheep and cattle to dairy, and that's essentially because the environmental costs of dairying are not being factored into those economic decisions, both in terms of the cost of pollution and also in terms of the use of water through irrigation systems that is not charged for. What is the Government's thinking, or what is the likely policy in terms of incorporating those costs into the economic decision-making so that we get rational land use**?**

Hon. Trevor Mallard: Well, as a country we have had a history of capitalising the profits and socialising the losses, that is effectively the way that we have worked in New Zealand across quite a big range of issues including environmental topics. I think the Emissions Trading Scheme will be something that will begin to tip the balance in that area and change the economics of conversion pretty substantially, and I think that is important.

On the question of water, there is an enormous issue that at some stage we have to work through, and that is the question of ownership of water. We have not addressed that in New Zealand. We have a pretty important complication around the Treaty of Waitangi and what it says, and we have a lot of people who have existing rights. So working that issue through is going to be a major challenge for us and it is going to have to involve a lot more bringing together of the understanding of the importance of water and methods of allocating. In the end we are going to get through. The fact that we have not done it has caused enormous problems. If you look at Canterbury for example, despite Environment Canterbury having had sixteen years now to do their plan, they have not done one, and over the years they have continued to allocate water, more water in fact than they have actually got. That can not continue. But sorting through allocation and ownership issues is going to be one of the bigger challenges that we are going to have as a society. Fish is simple compared to water.

Don Atkinson, LakesWater Quality Society: I would like to know whether you think the National Policy Statement will in actual fact encompass the whole of New Zealand in one standard or whether you will see regions effectively with unique attributes being considered separately?

Hon. Trevor Mallard: I think they will be considered separately. At the moment you can not have the same water standards for Otago rivers and the lower Waikato. Even over, say, a two hundred year period you might aspire to but you are not going to be successful in getting your lower Waikato standards to the standards of Otago rivers. I would want to be very careful about setting any standards around the lowest common denominator or even an average. There are going to have to be, in my opinion, some regional targets. But I think what I am already doing is probably straying into the business of the Board of Enquiry who I am sure will have a lot of debate within themselves and groups in front of them on that issue.

There will also be some time issues. I have used 2035 as a date for swimability in the areas which are identified, but there are some areas around here and a number of areas in my electorate that you can not hope to get the swim law standard by then. The other point that I am sure everyone else will not know, is that it is going to be probably sixty years before the work around Taupo actually begins to bite and it is going to take fifty or sixty years after that before the nutrient levels actually start dropping in the lake because

of the time it takes the run-off to work through. It is very hard to get a National Standard that works to produce a considerable improvement for most places at a particular time. I do not want to go to the lowest common denominator approach.

Mike Barton, Taupo Lake Care Inc: Taupo Lake Care is the organisation that has represented farmers for the last eight years in the negotiations with Environment Waikato over Variation 5. A question about Landcorp. Landcorp decided that it was not economic to continue farming in the catchment once this legislation came into being and therefore sold all its farms in the catchment. Does the Government imagine that Landcorp would continue to do the same in other nutrient sensitive zones?

Hon. Trevor Mallard: It is probably more a question to the Minister for State-Owned Enterprises so I will pop that hat on. The answer is probably yes. Landcorp's role is to be an efficient and leading farm developer in farming and it is not designed to protect iconic areas, to hold on to its land forever. If you go back in history to the Lands and Survey Department, an organisation that was designed to bring blocks pretty much up to a certain level and to on-sell them. Now it does that a lot more slowly than it used to, but that is still its core business. I think we will see a continuation of farm trading on the part of Landcorp and that will involve them identifying where they can make further progress on the development of their farms and make them more profitable. But in some cases where they feel there is not long-term profitability in the value of the land then they are likely to sell them. That again is the decision of the Board of Landcorp in each case, and I will never get involved in saying sell this one or hold on to that one, other than some very carefully identified particular cases which are mainly those that are held for longer term Treaty settlements.

John Green, Chair, LWQS

Thank you very much, Minister, for coming. We really appreciate it. Your efforts so far have proven that the Government is certainly wanting to resolve critical issues around this district and the Taupo district. I am pleased to say that we have a very strong level of expertise through the Rotorua Lakes Strategy Committee and we have very committed staff in the Regional and District Councils. I think we should be very proud of this.

EUROPEAN CASE STUDY

European policy measures to reduce nutrient loadings from catchments to freshwaters and groundwater and their effects – using agricultural Denmark as a key example

Dr Erik Jeppesen
and Brian Kronvang
National Environmental Research Institute,
Aarhus University, Vejlosovej 25, DK-8600 Silkeborg, Denmark.

Erik lives in Denmark and works for the National Environmental Research Institute. He is regarded as a world leader in nutrients in lakes catchments. His major research interest is in aquatic ecology with special emphasis on the biological structures and interactions with the nutrient dynamics and climate of lakes. Lake restoration, lake re-establishment, palaeoecology and eco-system modelling are also of particular interest.

ABSTRACT

Agricultural nutrient (N, P) losses are of great and increasing relative importance for the nutrient concentrations in most European surface water bodies but the quantity of nutrients lost from agricultural areas in European catchments vary at least one order of magnitude (e.g. for P from <100 g ha^{-1} to > 1600 g ha^{-1}) depending not least of intensity and type of agriculture. High nutrient loading has major implications on the ecological state of receiving ecosystems including lakes. Using Denmark as a key example we will discuss the effect of various policy measures implemented to reduce loading and run runoff nutrients from the farm to the catchment scale and the implication for nutrient concentrations and ecological state in freshwaters. We will further highlight the European scale initiatives to combat eutrophication (Water Framework Directive), loss of biodiversity (Habitat Directive) and deterioration of drinking water (Nitrate Directive). We also discuss the benefits of a number of targeted mitigation measures that can be adopted to combat N and P-losses from agricultural areas in river basins. These include soil tillage changes; treatment of soils with iron to reduce P-transport from source areas to surface waters, constructed wetlands and establishment of buffer zones and restoration of river/floodplain systems allowing for natural inundation of riparian areas and higher water residence time leading to higher retention and loss (N) of nutrients. We will also discuss factors and mechanisms that may delay and/or counteract the responses of mitigation measures for combating nutrient losses from agricultural areas at the catchment level. Finally we will discuss how climate change may affect the loading from agricultural land and the lake ecosystem state in different climate zones.

TRANSCRIPT

Editor's note: This presentation has a large number of PowerPoint slides and only some have been inserted. The full version is on a CD in the back of these Proceedings.

Firstly, thank you for the invitation. I think there are two reasons why I was invited to this conference. I worked in New Zealand some years ago, for five months, I admit, but I managed to look at twenty five lakes in the South Island together with Stuart Mitchell and Carolyn Burns, so I know a little bit about New Zealand lakes. The more important reason why I was invited here, I think, is that I come from a smelly country. It smells of money, not so much any longer, but it smells of ammonia to a large extent. It could be worse because in Holland you can smell it in the air when you are flying into the country.

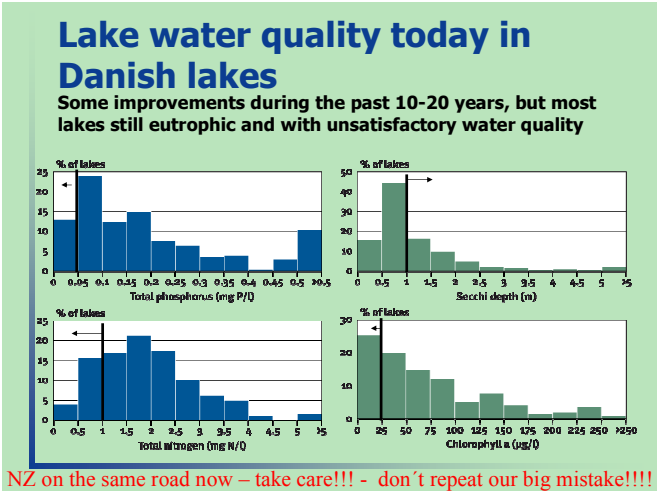


Figure 1

In Denmark, we have five million people and great sewage treatment from the small villages to the big cities, but we produce more than twenty million pigs and have lots of cattle and they all go around without underpants. The consequences of that are blue-green algae, you have it here also, but come to Denmark and see how it could be. Or you could have filamentous algae; they are all the rage in some places. If you look at the nutrient levels in *Figure 1*, you will be quite surprised compared to most of your systems here. You can see that very few of the lakes have phosphorus concentrations below 50 mcg/litre, very few of the lakes have nitrogen concentrations below 1 mg/litre, very few of the lakes have chlorophyll levels below 25 mcg/litre, and the water transparency is very low in most of these lakes.

New Zealand is on this road also. You are increasing every year the amount of nutrients you add to the fields because you are changing from more sustainable farming with sheep to dairy cattle and this will increase and increase, because as you will see in a minute how much nutrients we have in the farm landscape - you are far away from our level today but you will go fast in that direction because cows smell of money in New Zealand nowadays. Do not repeat our mistakes because you will eventually have a lot to do to clean up afterwards. That is the costly experience and life in Denmark now.

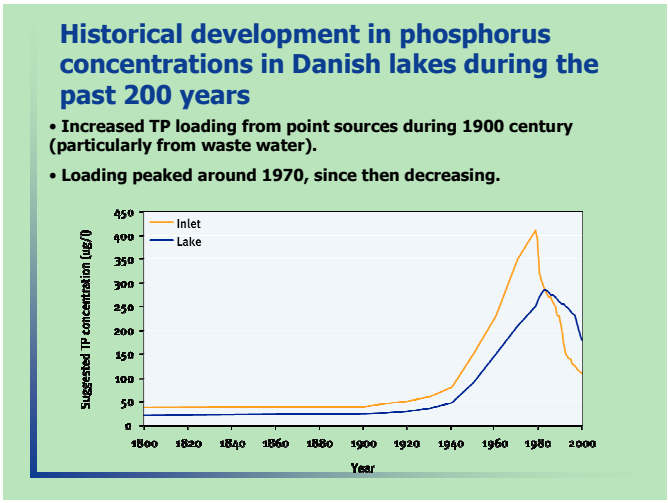


Figure 2

Figure 3 shows the increase in Denmark in loading during the last century and in the beginning it was because of sewage and agriculture and later mainly agriculture. We realised that it was bad in the mid 1970's in Europe and we started reducing the loading, especially from sewage and later on from agriculture. But what you also can see from this figure is the concentration in the lake is declining much slower than the reduction in loading, and this is because of internal loading and biological changes that are impacting on it.

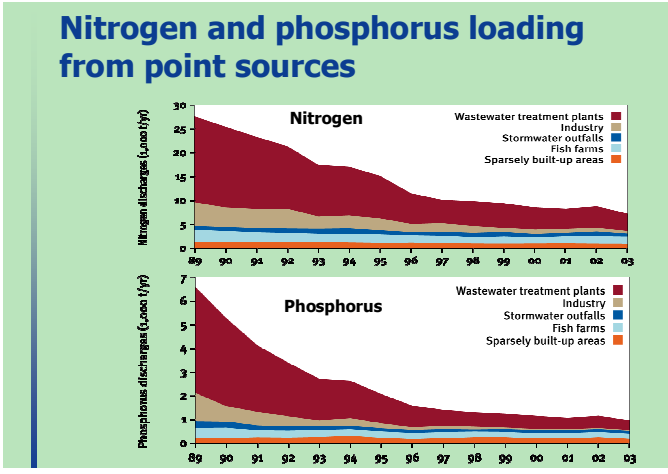


Figure 3

We are doing a lot to reduce the loading from sewage and have done since the mid 70's. If we take the figures in *Figure 3*, we have reduced total nitrogen from sewage by 81% and total phosphorus from the point sources by 93%. However, we are now facing a problem with diffused pollution, which is a key issue; it is because of increased fertilising of the land and the changing landscape by farming diversification.

I will first talk about the European perspective and concentrate on the non point pollution because it is what we are talking about at this Symposium. I will then discuss mitigation methods. Finally, I will come up with some perspectives that may be relevant for you.

The EU have a number of legislations, the **Nitrate Directive** from 1991 did not really address surface water, it was mainly about drinking water because the EU was very concerned about the increasing nitrate concentration in the ground water used for drinking water. We also have the **Habitat Directive** from 1998 which was mainly about biodiversity and to protect species and ecosystems, and finally a very comprehensive **Water Framework Directive** (WFD) which we all work with at the moment.

The requirement of the WFD is to secure at least good ecological status in all natural bodies and good ecological potential in all the modified water bodies, by 2015; and that will be a hard job for us in Denmark because we are dealing with green lakes. I will come back to that also in more detail. The concern about nitrate in the ground water was already clear in the late 1980's and you can see in *Figure 4* we have a very high loading of nitrogen in many European countries, especially from the catchments in lowland areas and with high precipitation/runoff. We are dealing with up to 170kg per hectare and even higher in some places. *(Figure 5)*

In *Figure 6* we have the nitrogen balance for the system. This is the surplus you have on the field when you have removed the crops. In some areas especially in Belgium, Denmark, Holland and parts of France, we have more than 200kg per hectare of surplus nitrogen in addition to what you harvest with the crops. If we take Denmark as an example and look at the balance, we have natural systems out here to the right and you can see we have an additional 15kg per hectare and a large proportion ends up in the ground water. But with the agricultural systems on sandy soil we have fertiliser of 74kg per hectare, 133 from manure and we end up with 248 that you add and of which 105kg enter the root zone and a large proportion goes into the ground water, about 90%. On clay soils it is a little bit less, 193kg per hectare you add and 53% pass the root zones and goes into the ground water. So with poorer soils a lot of nitrate goes into the ground water, and in the ground water concentration there are many areas that pass 25mg nitrate per litre.

The EU says it is a "good" standard below 25mg per litre, but above that it is critical and above 50 it may be harmful. Many ground waters have more than 50mg nitrate per litre, some even 100mg per litre. It is not only now in intensive wet cultivated areas in the north, it is also down in Spain in the dry areas where you also get extremely high concentrations in the ground water. You can also see there are many areas where there are more than 50mg per litre in the drinking water.

Figure 4

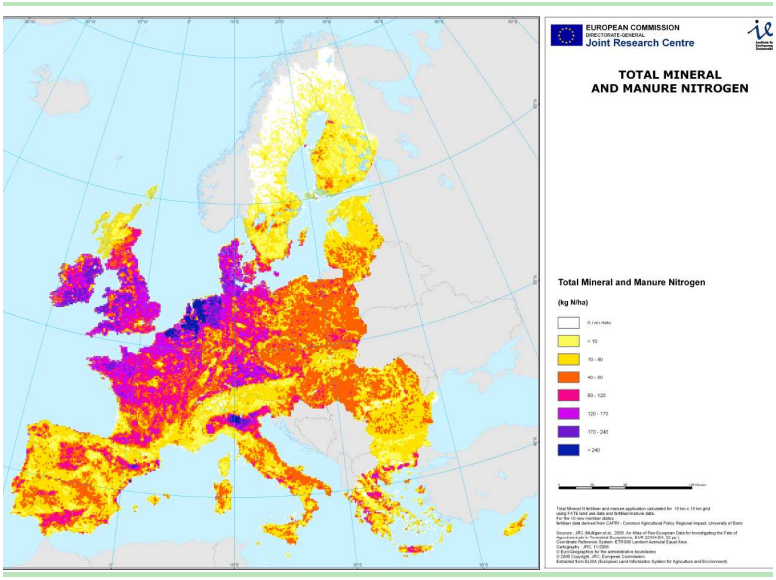


Figure 5

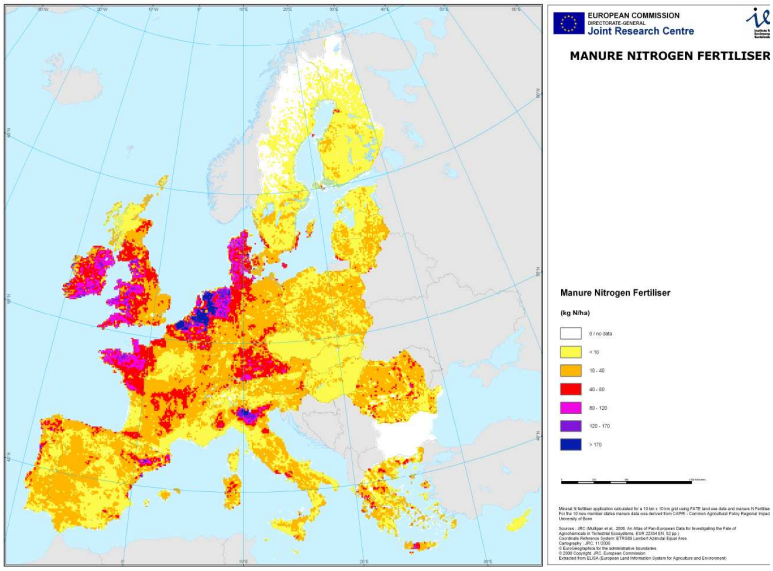
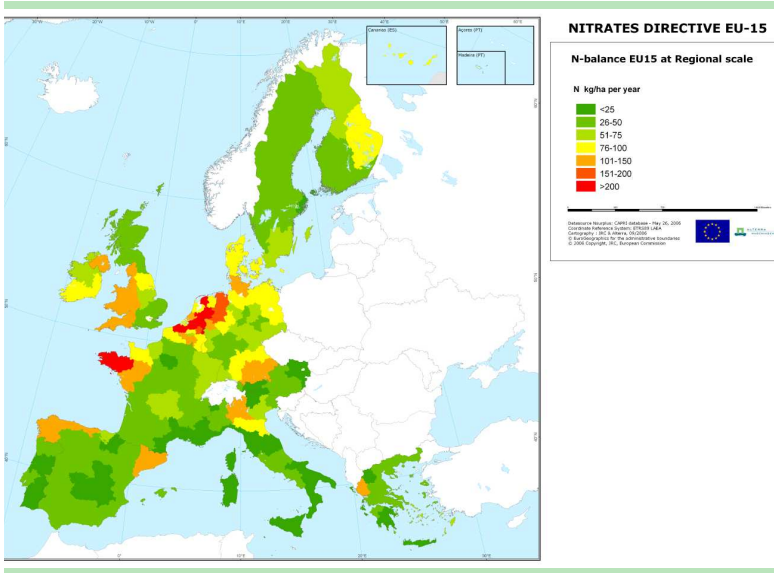


Figure 6



It is compulsory now to improve conditions in nitrate sensitive zones and these areas are growing in size and numbers. However, we are on the way to improving the conditions in many of the systems.

You can see when they are blue and a little bit yellow there is an improvement in the ground water concentrations, but you can also see that there are many that are yellow and here we have large increases in ground water concentrations. Even though you are reducing the loading to these systems now, it is difficult to obtain immediate improvements because of the build up which is a time bomb from the past – the accumulated nitrate is gradually coming down to the ground water. You will face that here in New Zealand also. You can see the surface water is not as bad as the ground water but there are many areas with very high concentrations of nitrate in the surface waters. Also there are high values in some areas and really strong increases in other areas. In other places in Europe you also see increases – especially in the Eastern European countries that earlier did not have funding to for fertilisation of the land. Another problem that we deal with in Europe is ammonia release, and in some areas (and why Holland is so smelly) the ammonia emissions are 100kg per hectare and part of this is precipitated on land with adverse consequences for the ecosystems.

Figure 7 shows that some countries are doing a lot to reduce it now. We also have a phosphorus problem; we have a very high loading again in the same areas where we have a high nitrogen loading, over 40kg per hectare. The highest surplus of loading in the areas where there are cattle and pigs. This is also a concern of the EU and one of the reasons for establishing the European Water Framework Directive (WFD). According to the WFD we have to protect, enhance and restore all water bodies of surface water to get good quality within fifteen years, and this is a comprehensive task. What is good quality? – It deviates only slightly from an undisturbed state; it is being negotiated at present, so not finally settled. A lot of variables have to be followed to test for the ecological state of the systems. For instance, for lakes that we are talking about at this conference, fish, phytoplankton, cyan bacteria, other algae, invertebrates, macrophytes, nutrients and water transparency are included in surveys and then thresholds set for each of these variables for good quality status, to obtain a combined score for the system.

You are increasing the loading now from farmlands in New Zealand and I hear arguments like those we faced in the 80's. We had very, very heated debate in Denmark, and the city said the farmer was responsible, the farmer said the city was responsible. The President of the Farmers Union at that time was asked about leaching from the soil and he said no and got very, very angry – a farmer is not adding one single gram more N and P than the plants take up or he would be stupid; that is what we were dealing with at that time, but of course we know better now. I think you have the same conflict in New Zealand now. The discussion is not an issue anymore in Denmark because we have intensive monitoring showing facts about leaching from the soil. The farmers now even request monitoring, to show that they are doing a good job. The programme is very comprehensive and you should learn from it – you have programmes here and there, but we have a national programme covering the entire country. We have monitoring stations in streams, lakes and wetlands and comprehensive studies of transport of nutrients in selected catchments.

Figure 7

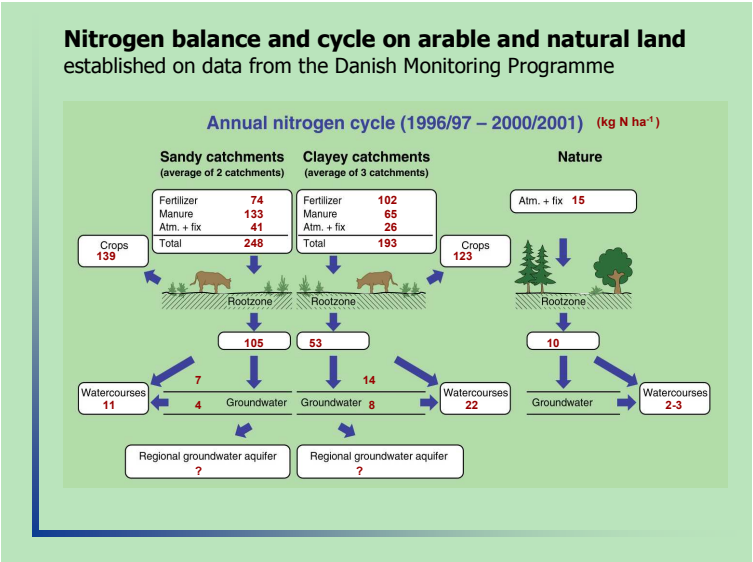


Figure 8

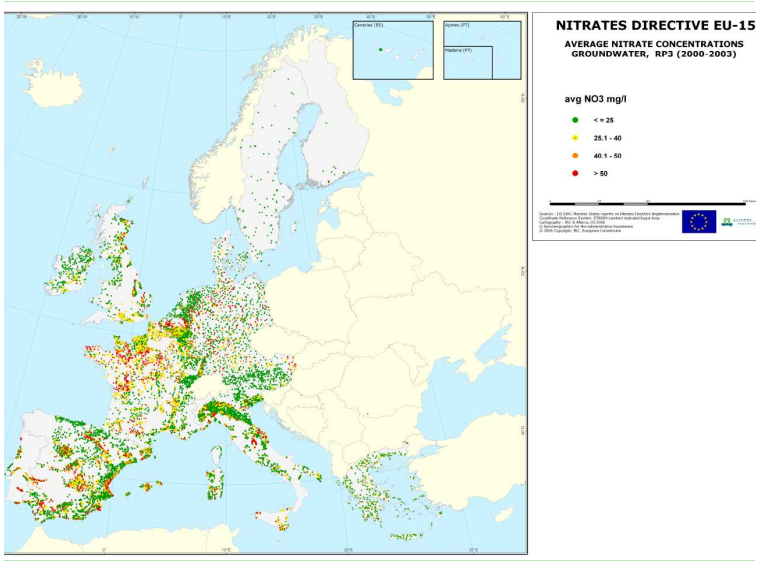
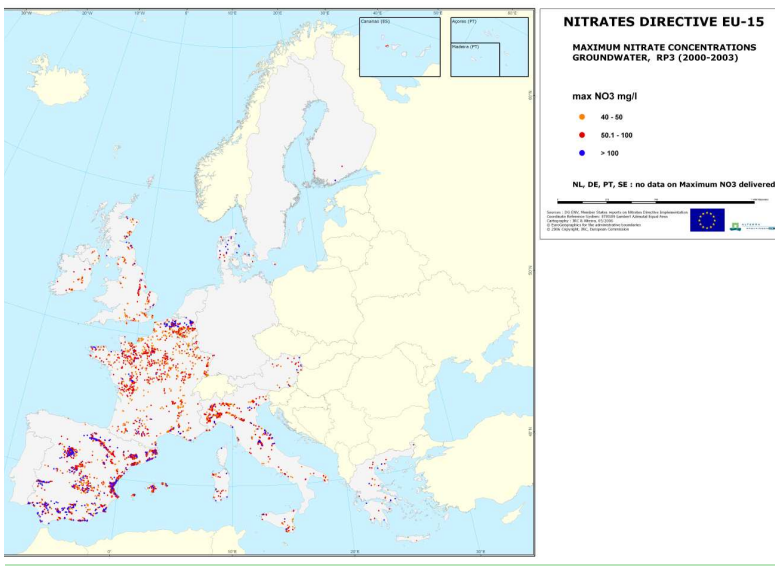


Figure 9



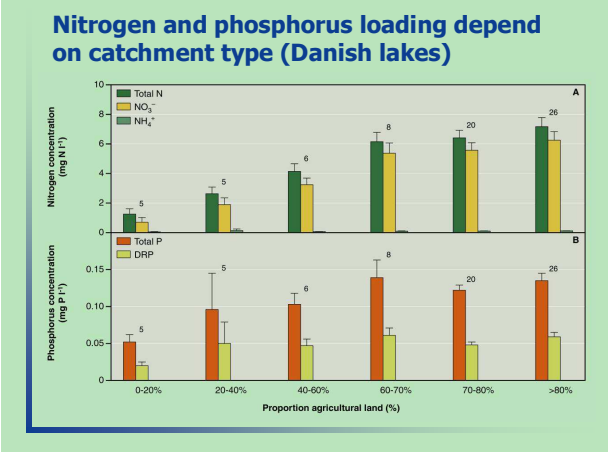


Figure 10

Both nitrogen and phosphorus affect lake water quality. There is a lot of evidence for that. *(Figure 10)* Some lakes have relatively low phosphorus compared to nitrogen and they become phosphorus limited; in other areas there is less nitrogen per unit of phosphorus and therefore they become nitrogen limited; and experiments have shown that also. Why can nitrogen be limited when you have such a high loading of nitrogen to these systems? You can see it here in the data from Danish Lakes. *(Figure 11)* Although there are high concentrations in the beginning of the year, nitrate runs out in the summer season. During this part of the season there is more phosphorus because it is released from the sediment. So we have a situation where nitrogen might become limited in late summer when the algae are most abundant. Therefore you can have nitrogen limitation, despite an annual average of very high nitrate concentration.

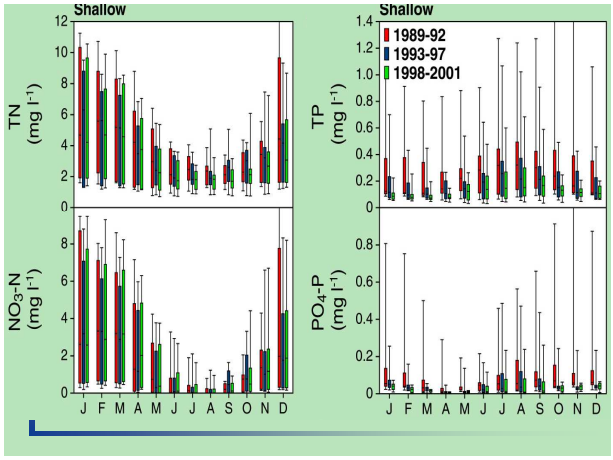


Figure 11

We also see another effect of nitrate related to the macrophytes. *(Figure 12)* Macrophytes play a key role in maintaining clear water conditions in shallow lakes. They lose some, if not all, of those macrophytes when they pass 1-2 mg of total nitrogen per litre, and we have many of these systems in Denmark now. This also shows that nitrogen plays a role in these systems. *Figure 12* shows that in another way when you have nitrogen and phosphorus together in a 3D plot macrophytes disappear above 1-2mg total nitrogen per litre even at relatively low phosphorus concentrations. It is likely that the reason is the periphyton is on top of the plants and also phytoplankton and these algae then out shade the plants from the system. So nitrogen plays a role, phosphorus plays a role – don't discuss that – it's not worth it.

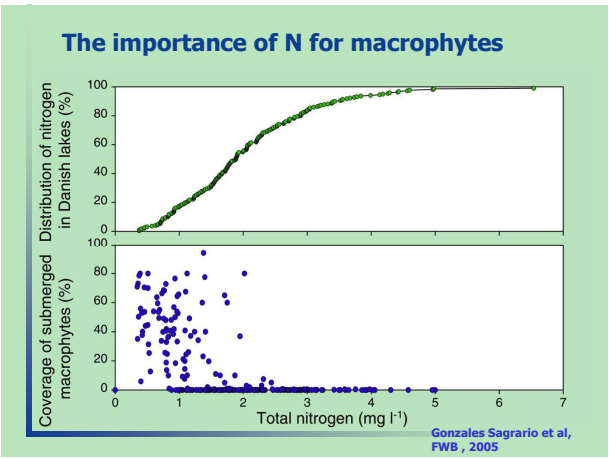


Figure 12

The action plans in Denmark try to resolve all this high loading from agriculture. There have been several plans and adjustments to a lot of plans because we did not achieve the needed improvement in the beginning. The reason the process of action plans started in 1985 was dead lobsters in a coastal sea area of Denmark and high oxygen depletion. We then got the first Aquatic Environment Plan, followed by a number of other plans and now we have the EU Water Framework Directive. I will go very briefly through them just to show some of the changes we have in perception and the actions taken.

- **NPo Action Plan - 1985.**
- **Action Plan for the Aquatic Environment I - 1987.**
- **Action Plan for Sustainable Agriculture, 1991 and 1996.**
- **Action Plan for the Aquatic Environment II - 1998**
- **Action Plan for the Aquatic Environment III – 2004**
- **Water Framework Directive – 2009-2015**

Table 1 – Summary of the Danish measurers imposed to reduce nitrogen losses from agriculture

Danish policy actions	Policy measures imposed
1985: NPo Action Plan to reduce N- and P-pollution	• Minimum 6 months slurry storage capacity • Ban on slurry spreading between harvest and 15 October on soil destined for spring cropping • Maximum stock density equivalent to 2 LU ha^{-1}. (1 livestock unit = 1 LU corresponds to one large dairy cow) • Various measures to reduce runoff from silage clamps and manure heap • A floating barrier (natural crust or artificial cover) mandatory on slurry tanks
1987: The First Action Plan for the Aquatic Environment (AP-I), aiming to halve N-losses and reduce P-losses by 80%	• Minimum 9 months slurry storage capacity • Ban on slurry spreading from harvest to 1 November on soil destined for spring crops • Mandatory fertilizer and crop rotation plans • Minimum proportion of area to be planted with winter crops • Mandatory incorporation of manure within 12 h of spreading
1991: Action Plan for a Sustainable Agriculture, aiming to reduce N-losses from agricultural fields by 100 × 10^6 kg N	• Ban on slurry spreading from harvest until 1 February, except on grass and winter rape • Obligatory fertilizer budgets • Maximum limits on the plant-available N applied to different crops, equal to the economic optimum. The economic optimum is calculated annually, taking into account the mineral N in the soil (from a comprehensive soil sampling system) • Statutory norms for the proportion of manure N assumed to be plant-available (Pig slurry: 60%, cattle slurry: 55%, deep litter: 25%, other types: 50%)

We started with a relatively unambitious plan, six months slurry storage capacity to avoid spreading the manure at the time when the crops did not need it, and not at a time when it was raining in Denmark and just running out. Farmers were no longer allowed to spread manure between harvest and 15th October which is autumn. It was not very ambitious because it was in the spring when the crops start growing. Then we put in the Livestock Identity Agreement with two livestock per hectare. Farmers had to prove that they had enough land in other places in the country so they could say that they had two livestock/cows per hectare. Many of them bought or rented land to fulfil this goal. The floating barrier was mandatory on the slurries.

The next plan demanded a nine months slurry storage capacity - no spreading of manure before 1st November. Then we had the Fertiliser & Crop Rotation Plan. It also included a plan for manure spreading - manure should be in the ground within twelve hours of spreading it. The next plan was no spreading of manure before 1st February. This was the right thing, because farmers had enough storage capacity to spread the manure when the crops needed it. Then we get the Obligatory Fertiliser Plans. As the Minister said in the talk before me, we introduced an economic optimal fertilisation plan – but this is far from a reasonable fertilisation plan from a nutrient loss point of view as farmers clearly add extra to maximize their outcome. There was discussion about what the manure was worth as fertiliser. Tests showed a value of the manure compared to fertilisers and this lead to reduction in artificial fertilisation. Then we got a new plan as the targets were not fulfilled.

1998: Second action plan

- Subsidies to establish 16,000 ha wetlands, designed to reduce nitrate leaching through denitrification and reduced demand for fertilizer
- Subsidies to enable reduced nutrient inputs to up to 88,000 ha of areas designated as being specially sensitive with regards the environment
- An expectation that animal feeding practice would be improved to reduce N excretion
- A reduction of the stock density maximum to 1.7 LU ha^{-1}
- Subsidies to encourage the conversion of 170,000 ha to organic agriculture
- The statutory norms for the proportion of manure N assumed to be plant-available were increased from 1999 (pig slurry: 65%, cattle slurry: 60%, deep litter: 35%, other types: 55%)
- Maximum limits on the application of plant-available N to crops reduced to 10% below the economic optimum
- Mandatory 6% of the area with cereals, legumes and oil crops to be planted with catch crops
- Subsidies to encourage afforestation on up to 20,000 ha

In 1998 we started to take actions in the catchment itself by establishing wetlands to remove nutrients and also to reduce input from the areas that were sensitive, and it included subsidies. Then the stock density allowed was reduced from 2 to 1.7 livestock per ha. We are also doing more organic agriculture; 170,000 hectares is now organic agriculture. Then the norms for the value of the manure increased as scientific work indicated that this was the case. Then we moved away from economical optimal fertilisation to 10% below economical optimum.

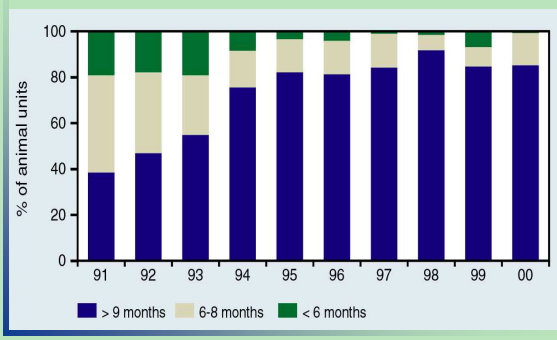
2000: AP-II Midterm Evaluation and Enforcement	• Increased economic incentives to establish wetlands • The N assumed to be retained by catch crops must be included in the fertilizer plans • Further tightening of the statutory norms for the proportion of assumed plant-available N in manure. From 2001; pig slurry: 70%, cattle slurry: 65%, deep litter: 40%, other types: 60%; from 2002 pig slurry: 75%, cattle slurry: 70%, deep litter: 45%, other types: 65% • Reduced fertilization norms to grassland and restrictions on additional N-application to bread wheat
2001: Ammonia Action Plan	• Subsidies to encourage good manure handling in animal housing and improved housing design • Mandatory covering of all dung heaps • Ban on slurry application by broadcast spreader • Slurry spread on bare soil must be incorporated within 6 h • Ban on the treatment of straw with ammonia to improve its quality as an animal feed • Options for planning authorities to restrict agricultural expansion near sensitive ecosystems

Then in 2000 they got tougher by putting more and more restriction on farming practices. The next plan was from 2004 – we now have more wetlands and 10m buffer zones along the streams; we want to go up to 50m but this may come in the next plan. Then we started to have taxes on P fertilisers for the first time. The farmers do not like that at all. Nitrogen taxation may be next if the reduction target is not achieved. No doubt that is the best way, but it is very difficult to convince farmers that we should put a tax on artificial fertilisers. There needs to be a protection zone around sensitive areas, and also tell the farmers that there will be a new revelation in 2008 and another in 2011 and further plans if the targets are not met.

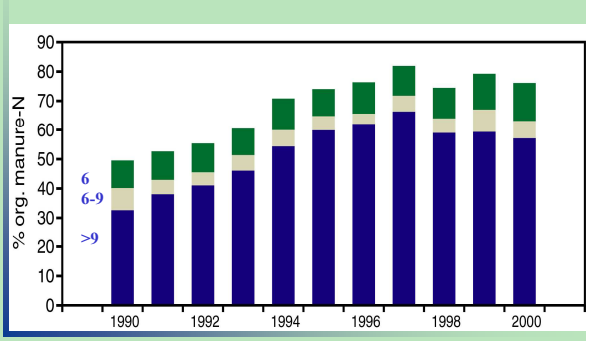
2004: The Third Action Plan for the Aquatic Environment (AP-III). AP-III is very closely related to the EU-Water Framework Directive and the EU Habitat Directive. N-leaching must be reduced by further 13% by 2015	• Further tightening of the request for catch crops
The agricultural P-balance of 32.7 × 10^6 kg $year^{-1}$ must be halved by 2015. (First AP that regulate P handling in agriculture) General reduction objectives will be laid down. In addition, regional objectives will be set for individual water bodies and natural habitats	• Further increase in the statutory norms for the proportion of manure N assumed to be plant-available based on research • Establishment of further wetland areas (ca. 4,000 ha) • Afforestation is assumed on 20,000–25,000 ha • Establishment of 50,000 ha of buffer zones along streams and around lakes before 2015 to reduce discharge of P • Improved utilization of N and P in feed is assumed to reduce losses of N and agricultural surplus of P • A tax of DKK. 4 kg^{-1} mineral P in feed • Protection zones of 300 m around ammonia sensitive habitats such as raised bogs, lobelia lakes and heats larger than 10 ha • Strengthening of organic farming • Evaluations of the effect of AP-III will be carried out in 2008 and 2011 • Based on the evaluations further initiatives will be implemented if necessary

As you can see below storage capacity for slurry increased dramatically over the time period. So the farmers did what they were supposed to do and the percentage of manure used is much higher now. The consumption of artificial fertiliser in Denmark shows a dramatic reduction – we are back to the level in the 50-70´s for nitrogen and even further back for phosphorus. So it works, but it only works when you add national regulations. You can see phosphorus loading has been reduced markedly.

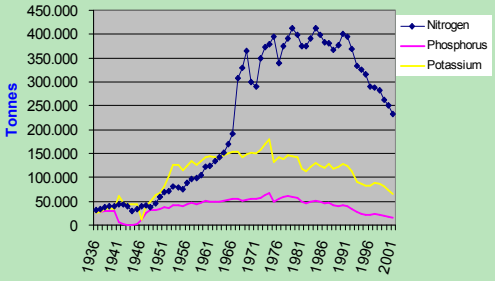
Storage capacity for slurry



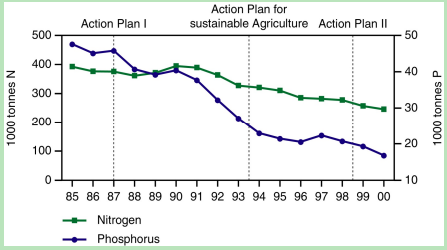
Spring application of organic manure



Consumption of fertilisers in Denmark 1935 - 2001



Consumption of nitrogen and phosphorus fertilisers in Denmark during three Action Plans, 1985-2000



There were different responses depending on the action plans that we had. The first action plan helped a little but not much, the next one mainly affected phosphorus but not nitrogen, now we have a big effect on nitrogen with the next one, and so on. So there have been dramatic reductions. As you can see below, chemical fertiliser had a 50% reduction and surplus in the soil is now reduced to 31%, which is still very high.

	1989	2003	Change
Chemical fertilizer	395.000 t	196.000 t	50%
Animal manure	244.000 t	237.000 t	3%
Surplus	375.000 t	247.000 t	31%

Trends in the nitrogen balance in Danish agriculture

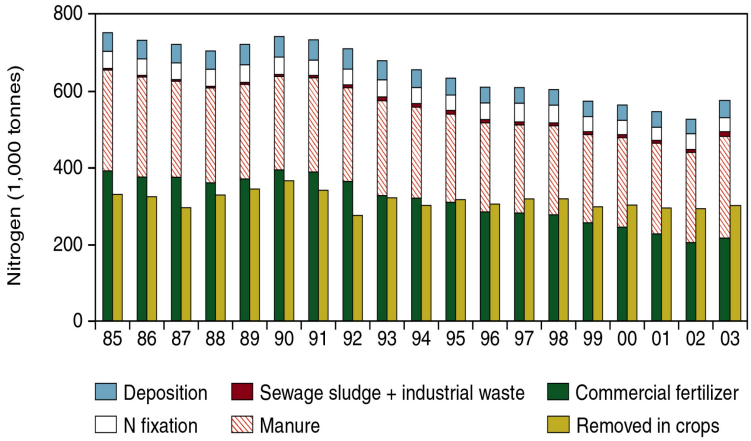


Figure 13

Trends in the phosphorus balance in Danish agriculture

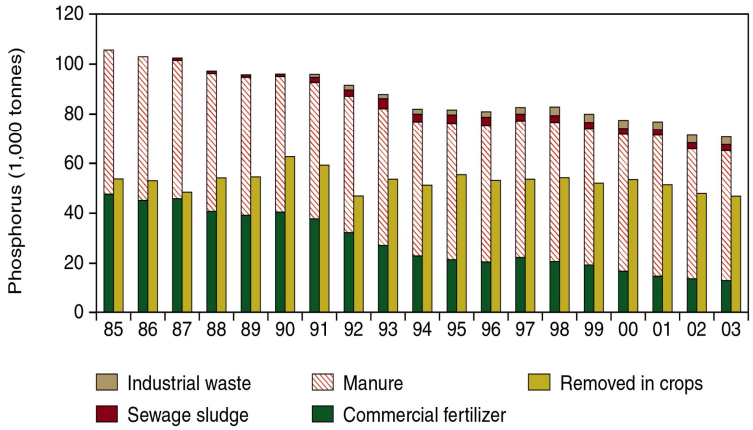
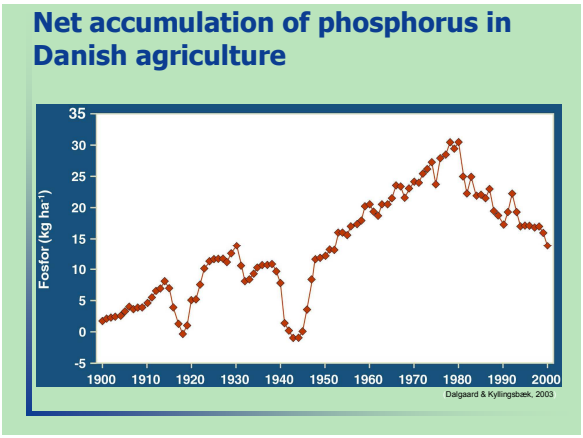


Figure 14

In *Figure 13* the percentage of loading removed by the crops is increasing, quite dramatically. You can also see the effect on the flux from the root zone; a dramatic reduction in nitrate loading of 30% has occurred. The concentration in the upper ground water is also going down. Phosphorus in *Figure 14* is the same, the amount removed by the crops is increasing compared to the total loading and the use of artificial fertilisers has gone dramatically down. But we still have at a surplus of loading to the system. So we are accumulating a ticking bomb. (*Figure 15)*



We have done a lot on trying to establish the wetlands and restore lakes and streams all over the country. This is because we have lost about 90% of the wetlands/wet areas in Denmark due to increased agriculture in the 1930-60's. Now we are trying to get them back again to enhance the nutrient retention capacity of the system. We are also trying to remove the cows out of the near-shore areas to the streams and have less agriculture near the stream systems. We have built buffer zones along the shores to help reduce the loading to the system. We established wetlands, both artificial and natural ones, and they have a high capacity to remove nitrogen – not so for phosphorus. We also tried to bring the rivers back to the valley. There are many such projects around Denmark. One of the most comprehensive ones in Europe was a multi-million restoration process. *(Figure 16)*

Figure 16

The effects of these action plans are clear; nitrate is going down in the surface water and we are now in most cases below the critical levels defined by EU. (*Figure 17)* Phosphorus is going down in the agricultural areas but it is still far from the levels found in low impacted streams.

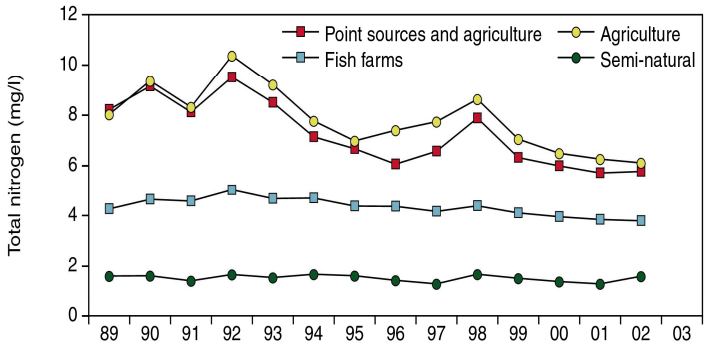


Figure 17 – Nitrogen reduction in surface water

We see some improvement in the lake systems also; *(Figure 18)* this is the chlorophyll level going down as the transparency of the water goes up. We are also dealing with delay factors like internal loading in the system. A lot of phosphorus is accumulated during the period when you load the system and when you reduce it the phosphorus comes up from the sediment releasing nutrients to the lake water which prevents an improvement of the ecological state of the lakes.

So far small improvement in secchi depth (blue) and chlorophyll a (green) can be seen in Danish lakes.

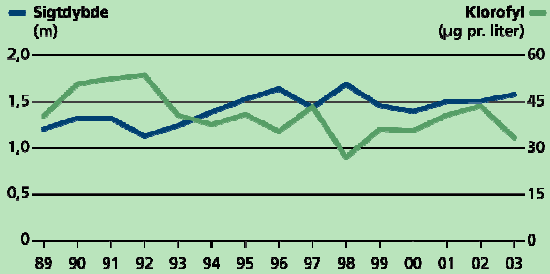


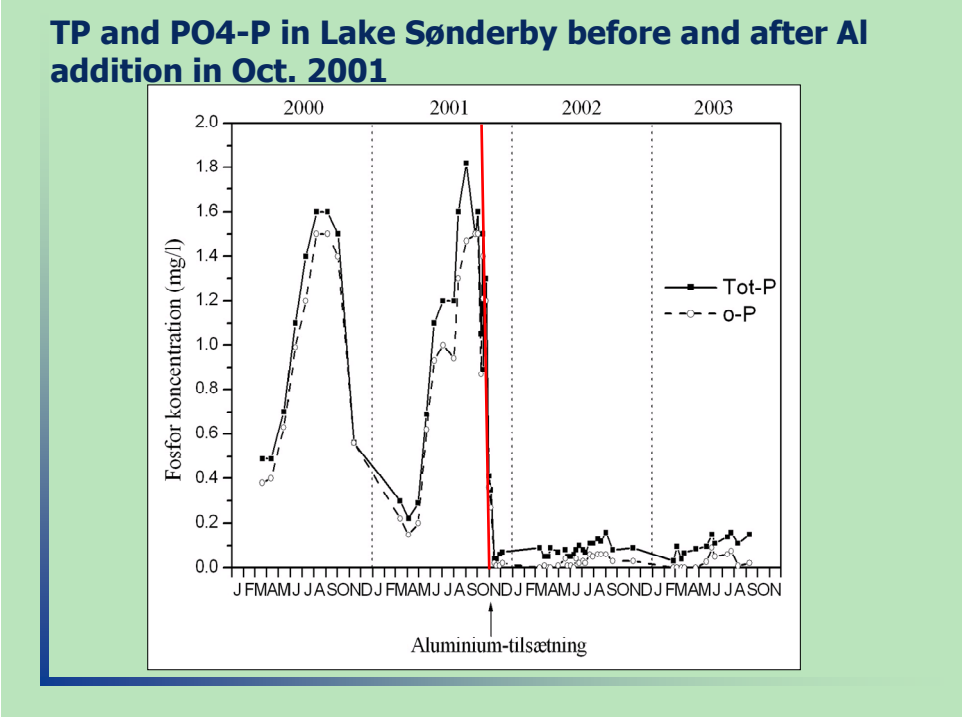
Figure 18

It is important to take this into account in New Zealand with the rising loadings because it will significantly increase the cleanup costs later if there is no action now. To remove sediment is very expensive. We use aluminium treatment also in some systems to improve the conditions and *Figure 19* shows in summer that phosphorus levels were very high and at much lower levels after aluminium treatment. But it is costly and a lot of extra effort to add to the system to try to wipe this pollution.

Lake Brabrand: dredging of 500.000 m³ sediment from 1988-1995

***Principle*: phosphorus rich sediment removed to reduce the internal loading of phosphorus.**

We also use biomanpulation because fish may prevent recovery; we have in the system many bad guys, as we call them – fish which eat the zooplankton that graze the algae and keep the



water clear. We removed some of them and gave the good fish control over the bad ones, and this helped in some systems. We needed to remove a lot of fish, more than 200kg per hectare which is an enormous amount of fish to get an effect. If you remove too little then there is no effect even though a lot of fish have been removed. But if done well there is a payback at least in the short term.

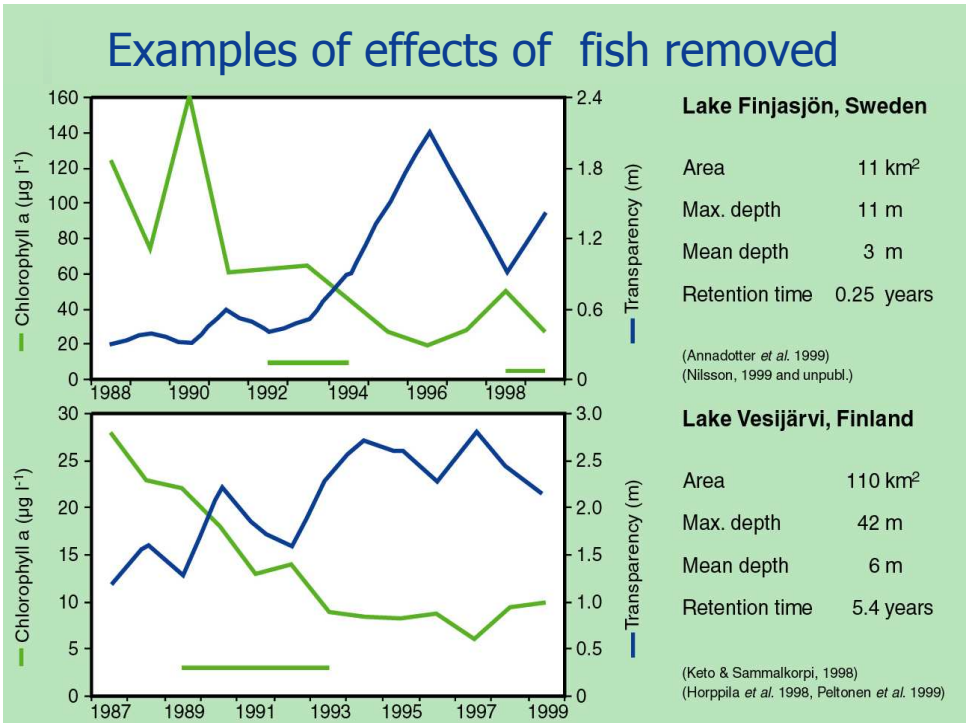


Figure 20 shows the effect in the system, as chlorophyll goes down the transparency of the water is going up. It is not only small systems; there are 110km^2 in Finland showing a major change after fish removal, without doing anything else on the loading to the system. *(Figure 21)*

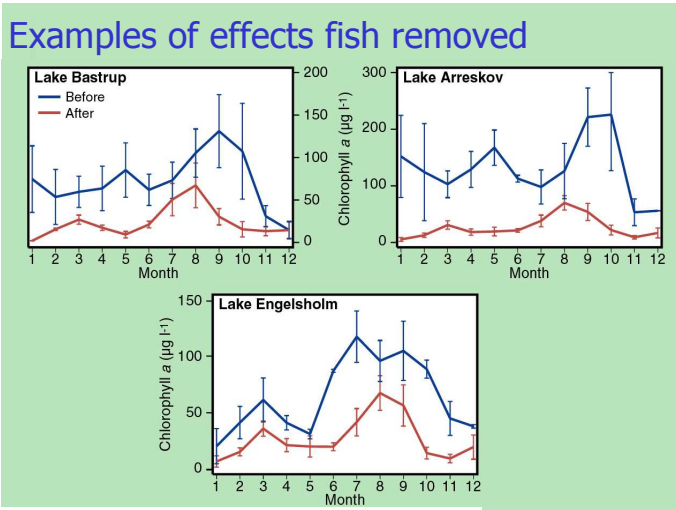


Figure 22 shows in Lake Engelsholm the chlorophyll and algae biomass, and all year round there is an effect on the algae biomass - it goes down dramatically in these systems, so it can be a way to help the system.

There is also a reduction in phosphorus concentration - you are not only attacking the algae, the phosphorus and nitrogen as well go down to a much lower level because there is less internal loading in the system, and it is more than half in the system from before to after. It puts further constraints on the algae as nutrient and this may become more limiting. A double effect.

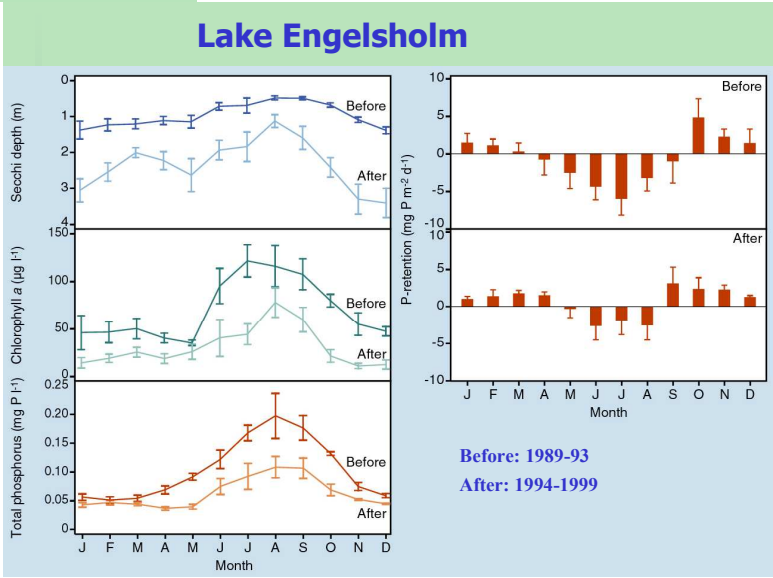
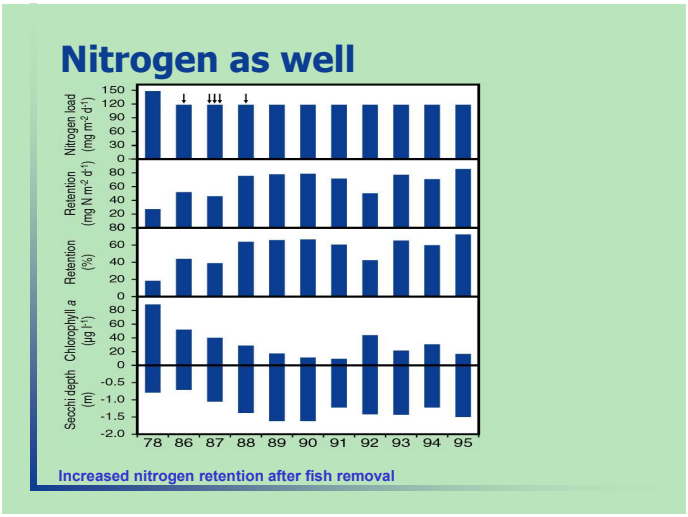


Figure 22

You may think we do not have to do anything, just remove the bad guy fish from time to time and keep the good guys for angling – but it is not like that – it works in the short term but not always in the long term. In *Figure 23* the chlorophyll level is much lower after the biomanupulation than before, but you can also see that after some years algae biomass (chlorophyll) is increasing again, though the water stays clear and suspended matter is lower. But the good thing about biomanipulation from a blue-green control point of view is that those that are most affected by biomanipulation are the blue-green (cyanobacteria). They went down to 20-30% of what they were before, but they came back again when the fish biomass increased. So an additional tool to loading reduction could be to eliminate the bad guy fish from time to time – but loading reduction is a must to restore degraded lakes. Fish manipulation is a symptom treatment only.



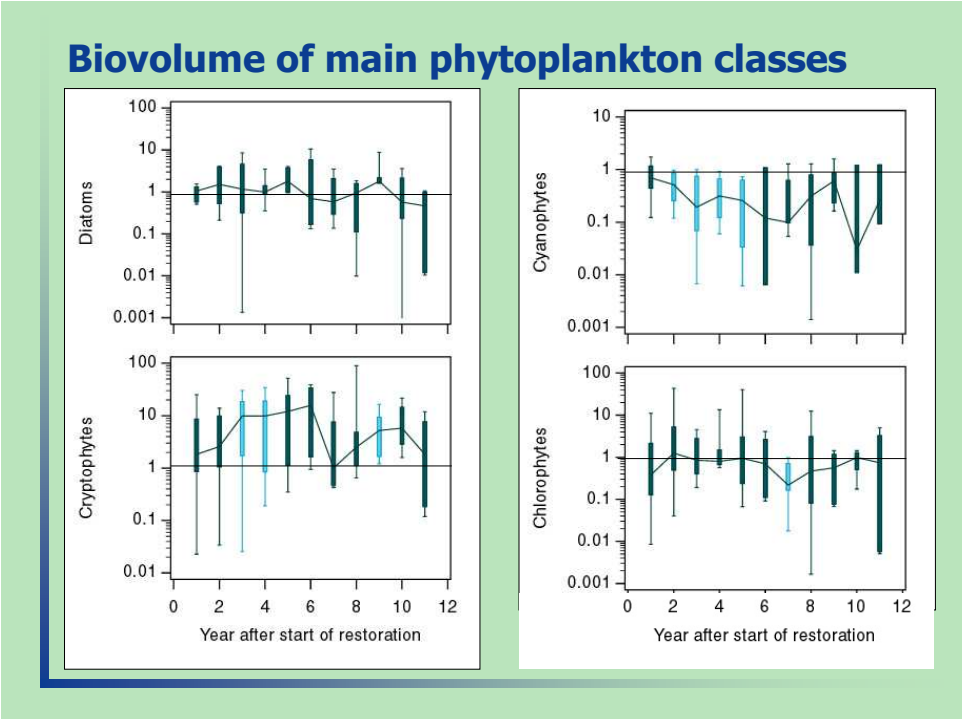


Figure 23

The final thing that I would like to talk about is that we are not only facing conditions with high loading from agriculture, but both New Zealand and ourselves in the north will also face climate change and this will not be beneficial for lake systems showing symptoms of nutrification. Areas of high precipitation will also come under pressure. They will be forced to produce more food in the future as many areas that are now used for agriculture will not have enough water (e.g. Australia). As you see in *Figure 24*, a comparison of today and in 2080 showing where we have agriculture and do not need irrigation. As one moves north there is a much narrower area in the future with non-irrigated farming. We know that as the price of food goes up the farmers want to change their land use and in Europe when farmers get permission from the EU to use that extra soil for agriculture which earlier had been set aside for improving the ecological state because of overproduction.

So we come under pressure in the areas with high precipitation. In Denmark we have more and more rain, and there is a major increase in run off; the more run off, the more nutrients run off – nitrogen and phosphorus. With more run off, the more the farmers need to fertilise, so this in itself means more nutrients added to the river and the lake systems. *Figure 25* is some data from Denmark showing an increase of 15-25% loading just because of the increase in rain. On top of that, if you get more loading to the system, you get more blue-green algae.

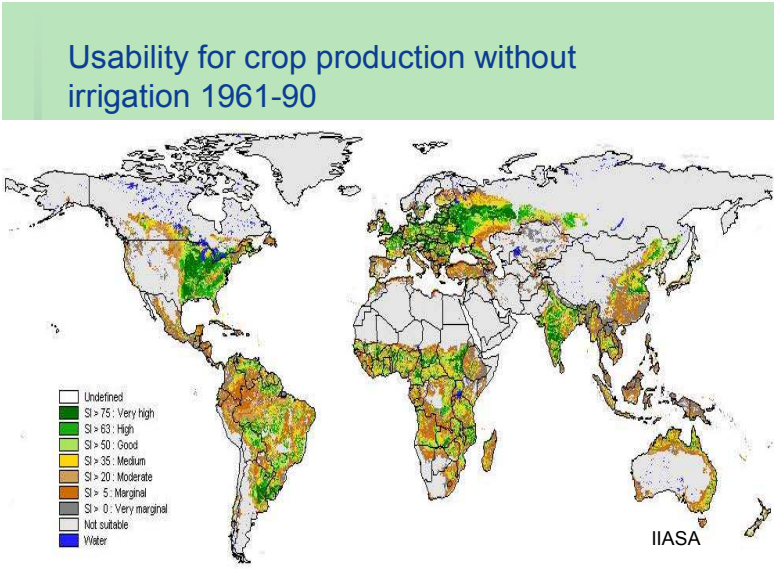


Figure 24 – Change in usability of land over time

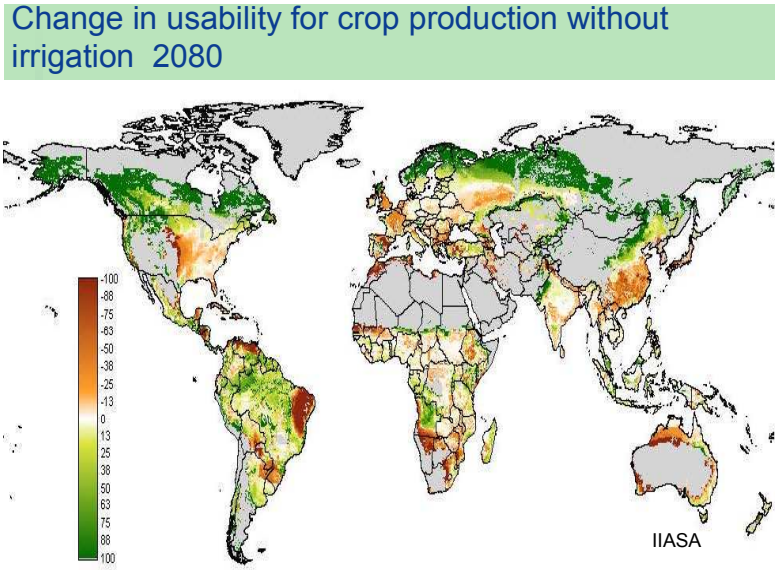
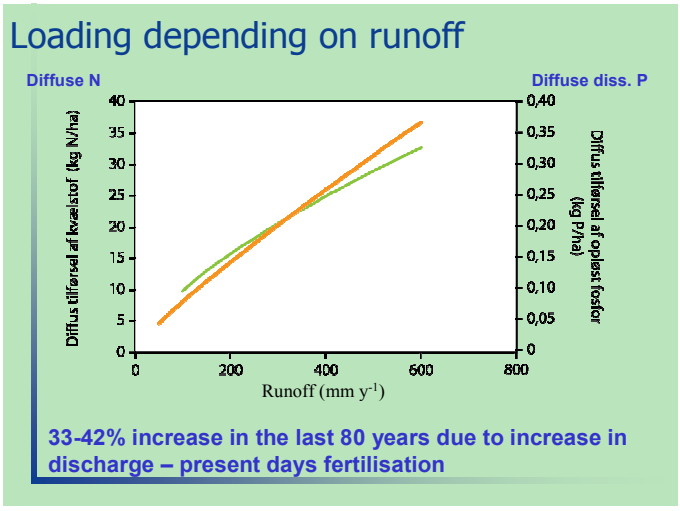


Figure 25



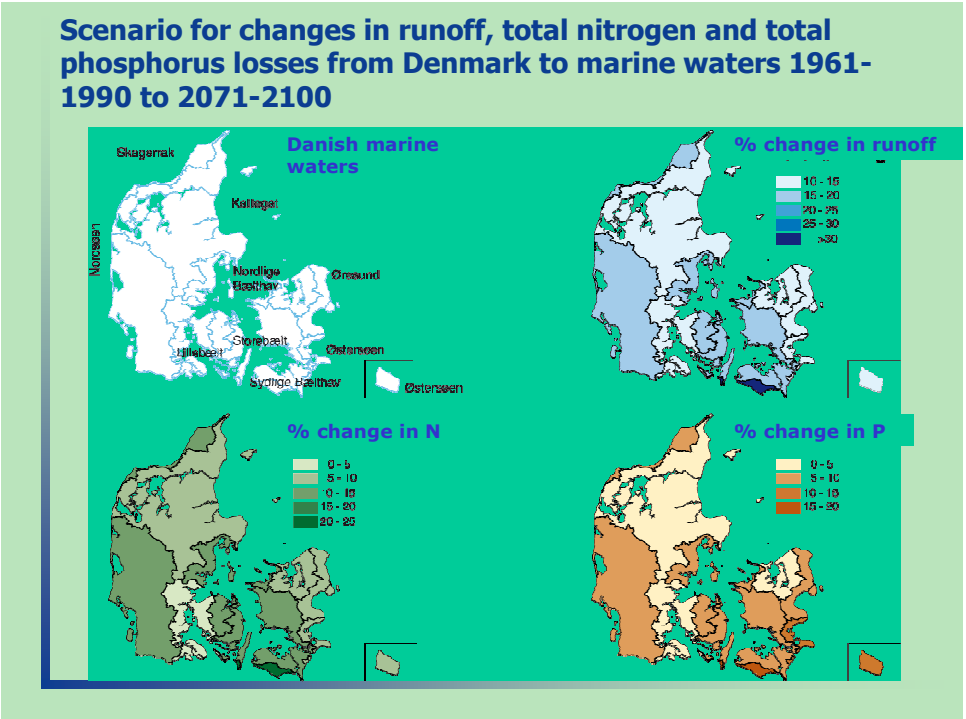
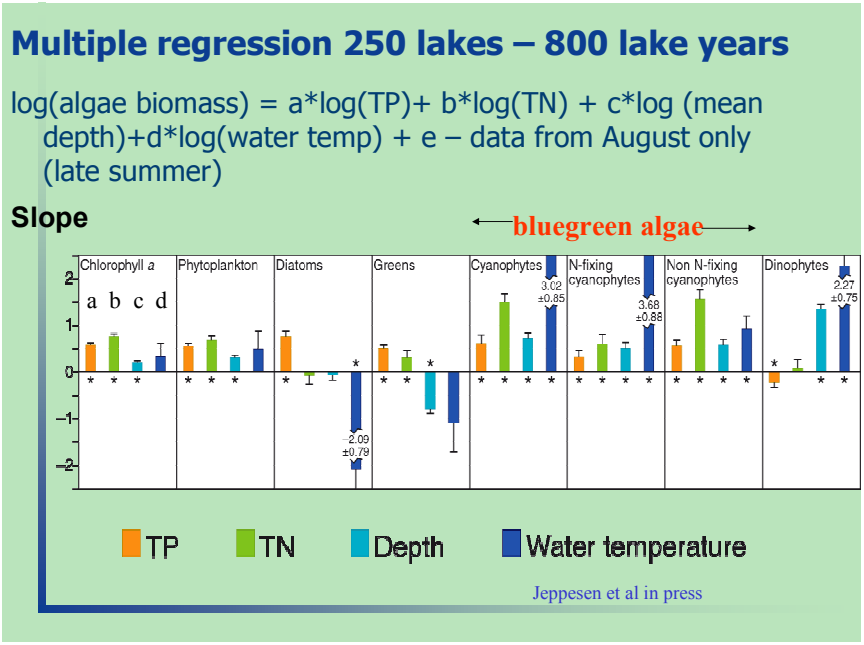


Figure 26

Temperature change will also affect blue-green algae. *Figure 26* shows data from 250 Danish lakes, how the algae biomass is affected depending on phosphorus, nitrogen, depth and water temperature. If the values are positive it means that you have more algae, when you have more phosphorus in this case, more nitrogen, higher depths and higher temperature. With increases in temperature, nitrogen and phosphorus levels, then you get more algae in the water. But what is also important is that looking at the percentage of the different algae, the blue-green and also dinoflagellates, which both can be toxic, increase markedly with temperature. *Figure 27* is an example from July to September which covers the three months during the bathing season when people like swimming in the lake.

Figure 27



Depending on temperature at a given phosphorus level, we will see a major increase in blue-green algae – at the same phosphorus level, same nitrogen level – we have an increase in blue-greens in the future. You have higher summer temperatures in New Zealand so it will be much worse for you.

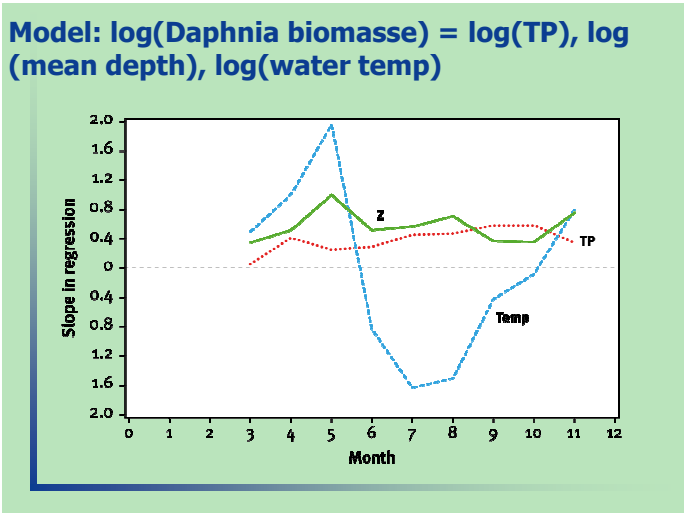


Figure 28

You also change the food web structure in *Figure 28* with Daphnia – these are the ones that graze the algae and keep the water clear in the system. In the summer months there is a negative slope, with less Daphnia with an increase in temperature – if you get less Daphnia to graze the algae, it is more difficult to control the algae. The other reason is we get more of the bad fish guys. We have the good guys who are predacious and the bad guys which are the carp or koy-carp in your systems here. Remove them; they are really bad for the system. In the future climate change it will get much worse. It is not easy to keep Daphnia in the system to keep the water clear and keep algae down.

You may think that what I have presented is just representative for Denmark and there can be other factors involved, so we will look at data down through Europe from the north of Sweden to Spain, and they are divided into three different categories. *Figure 29* shows the number of fish per unit of daphnia/zooplankton and as you can see this ratio increases when you go from north to south. This

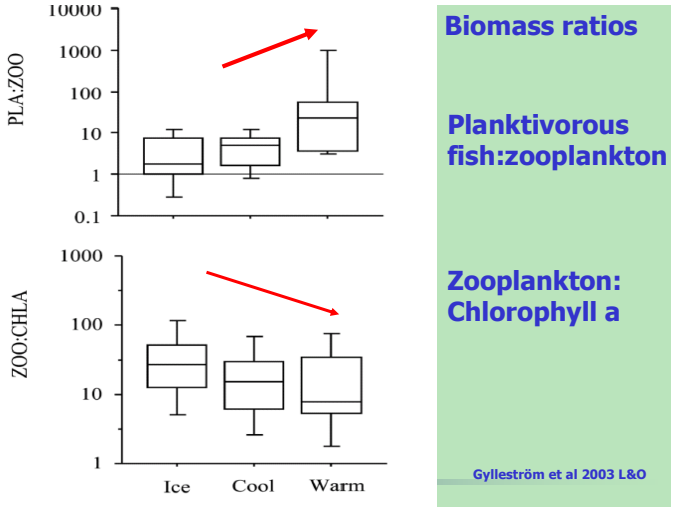


Figure 29

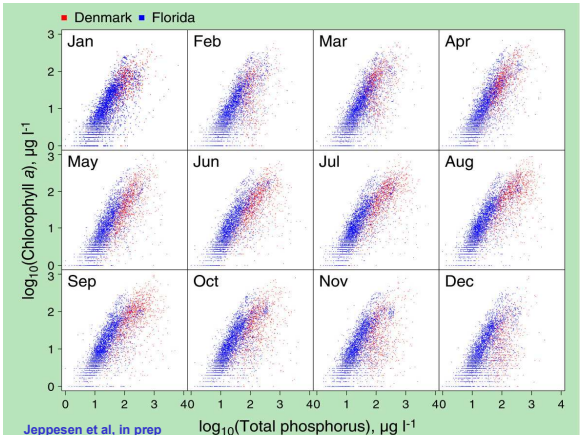


Figure 30

means that the fish goes up and up … and then you can see the relationship between zooplankton and algae which goes down and down. The capacity of controlling algae thus decreases markedly from north to the warmer south. Moreover the zooplankton become smaller and we loose the big ones, the Daphnia, that can to some extent remove the blue-green but the small ones prevailing in the south cannot.

In *Figure 30* we go even further and look at data between Denmark and Florida. So at a given phosphorus level, a given loading to the system of nutrients, you have much more chlorophyll in the warmer lakes than you have in the colder lakes. So climate warming or

the warmer countries have higher yield - you get much more algae in the system for each nutrient added – that means an increase in nutrification with an increase in warming and that's bad because this means the threshold for good ecological status goes down when it gets warmer. You have to take that into account now.

So if I decide to conclude here, then we can discuss the farming and water quality. Who cares, that would be one way of doing it – just lie down and say we get a lot of money out of it. But the consequences if you take this strategy is that it will not only smell of money but it will smell of other things (maybe not in Rotorua because it smells already!). You have to take action to make it sustainable.

- **Farming regulations have to be strict , comprehensive and obligatory**
- **Good management practices and advice are not enough!!!**
- **Taxes on fertilisation are very efficient**
- **Farming is an industry and has to be treated as such**
- **Early action is much cheaper than delayed action, due to the accumulation of nutrients in soil, groundwater and lake sediment – avoid expensive restoration!**

As the Minister said before, we have a perception that the farmers are taking care of nature, or at least not damaging it. In Denmark the perception now is that farmers are like those running an industry: clean up after yourselves.

- **Good monitoring programs a must……**
- **Political will to take strong actions is a must……..**
- **Scientific based solutions - a must……**
- **Forget about fast ad hoc solutions recommended by "smart" guys….**
- **Partnerships, farmer focal groups, education are great additional tools, but far from enough…..**

I heard some very good examples yesterday and I know you are doing a lot of great work here around the Rotorua lakes and elsewhere in the country in partnership with farmers; that are very good – and we can learn from that in Europe - but it is not enough and you need strong national regulation also. In Europe we have strong regulation from the EU at the national level and now with the new Water Framework Directive. Returning to the theme of this Symposium - nutrient sensitive zones – it is important of course to have nutrient sensitive zones but do not forget that those that are not nutrient sensitive zones may very well be so in the future; so that is why you need national regulations. Thanks.

QUESTIONS

Warwick Murray – Environment Bay of Plenty: As somebody who works for a regulatory agency around the Rotorua lakes, I am really excited at the prospect of removing fish as a tool. My question is around the economics, what is the impact on the productivity of the agricultural sector as a result of the regulatory regime that has been put in place?

Erik Jeppesen: It can have an effect as it can mean less than economical optimal fertilisation. But in practice it has not been a very big effect at all – if any, because the soil is so saturated with nutrients that the extra additional fertiliser that farmers used in the past was not really needed, it was only a safety fertilisation. So they have reduced the cost of fertilisation and the production has not decreased at the moment, but of course in the long term when the additional fertiliser pool is emptied out from the soil, then it may have some impact. But then farmers find other ways to save costs – one is that the manure is now much more valuable than before (also thanks to increasing prices on artificial fertilisers) and can be used as a commercial product. They also change production strategy. I heard yesterday that you put the cattle in shelters for some months so they are not peeing on the ground when the nutrients are running out of the system with the heavy rain. In Denmark most of the cows are not on the fields. When people come to Denmark they say, "where are the cows and the pigs?" They are indoors all year round. Farmers produce food for the animals on the fields and serve it for them in the stables and many do not see nature anymore.

Dave Donaldson – Rotorua District Councillor: I see that you are advocating interventions that will pay off in the long term and one of your take home messages there was avoid the past *ad hoc* solutions. Do you have any examples which you know of that we have, or you have had in Denmark, of past *ad hoc* solutions which we should forget about?

Erik Jeppesen: The problem is that the politicians are elected for a four year period in Denmark and you want to show some improvement in this period, so it is difficult to always take the right decision that helps in the long term. Take biomanipulation as an example. If the phosphorus or nitrogen concentration is high the only sustainable solution is to reduce the nutrient input. I always say that at high nutrient levels biomanipulation is like peeing in your trousers to keep you warm, because the bad guy fish will come back a few years later and you have wasted a lot of money - but the politicians can say: "see the lake is clear", and then maybe two or three years later it is not clear anymore but managed anyway to be elected for another period. So there are many of such short-term *ad hoc* solutions to show immediate response that have no long-term perspectives.

Sally Brock – LakesWater Quality Society: You obviously have a strong regulatory framework in terms of setting standards for nitrogen reduction. A two part question: who is basically responsible for setting those standards, and what, if any, influence did stakeholders such as farmers and the general community have in actually setting that regulatory framework?

Erik Jeppesen: The strong regulations we have were set at the national politician level. But farmer unions, NGO´s, managers in the Ministry of Agriculture and Ministry of Environment and local managers in the different counties have been involved and participated in the negotiations.

The new Water Framework Directive in EU is decided by the Parliament and the member states after long negotiations and also various interest groups have been asked about their opinion.

Session Two - What's happening to our lakes? Why do we need to focus on Nutrients?

INTRODUCTION

John Green: Professor Warwick Silvester, Chair of this Session, has achieved an international reputation in his work and is a recent recipient of the Kudos Lifetime Achievement Award for his outstanding contribution to science. He is a Professor of Biological Sciences at Waikato University, with special expertise in farm nutrients. He is well known to LWQS and the Rotorua Lakes and has been involved in most of our symposiums. Will you please welcome Professor Warwick Silvester.

SESSION CHAIR: Professor Warwick Silvester

Thank you John. I have been involved with these seminars right from the very beginning and it has been seven years since the first one. I would like to congratulate the LakesWater Quality Society again for putting together such a magnificent programme. This Society has been a major irritant and catalyst in issues to do with the lake water. I emphasise both of those because they have been extremely important in bringing these issues into the public eye and getting something done about it.

It is a pleasure to chair this session on an incredibly important topic which is "What is happening to our lakes?" and "Do we need to focus on Nutrients?" They are not rhetorical questions but real questions which the scientists, of course, focus upon. We have got three speakers today who will talk about a progression in that theme. Just to start off with I would like to introduce Marc Schallenberg who describes himself as a Canadian who came here for one year to do a 1-year post-doctoral research position fifteen years ago and has been here ever since. He enjoys New Zealand lakes. He comes from the Lakes Group in Otago and works with people like Carolyn Burns, and he is going to talk to us on the issue of what nutrient zones are.

WHAT ARE NUTRIENT SENSITIVE ZONES & WHY DO WE NEED TO MANAGE THEM?

Dr Marc Schallenberg
Department of Zoology, University of Otago
Dunedin
marc.schallenberg@stonebow.otago.ac.nz

Mark's research interests include anthropogenic impacts on lake ecosystems, the structure and functioning of planktonic communities, aquatic microbial ecology and palaeolimnological reconstruction of historic environments.

ABSTRACT

In pristine catchments, the movement of plant nutrients (e.g. nitrogen and phosphorus) to waterways is usually slow. Therefore, pristine lakes have low levels of algae because algal growth is limited by the scarcity of nutrients. Even under small-scale development, the ecological processes within landscapes and lakes are able to "absorb" a limited amount of excess nutrients, maintaining oligotrophic conditions despite some disruption of natural nutrient cycles. These processes are known as positive ecological feedbacks, maintaining stability in the system as long as the key processes involved are not compromised. Currently in New Zealand, the primary production sector (especially dairying) is increasing its demands on freshwater resources and, in the absence of

effective regulation of non-point source pollution, the ecological, cultural and recreational values of freshwater environments is suffering. For example, the self-purification capacities of many catchments and their freshwaters have already been exceeded and numerous landscapes have been disrupted to the point where they have become **nutrient sensitive zones**. The desirable algae, which formerly inhabited the lakes, have been replaced by species including potentially toxic bloom-forming cyanobacteria and filamentous algae. The new, degraded ecosystems develop their own ecological feedbacks, which create a state of ecological inertia, resisting our restoration efforts. Unfortunately, nowadays many ordinary New Zealanders can name lakes from Northland to Otago, which have undergone such regime shifts. Given that dairy farming is rapidly intensifying, to avoid the pitfall of lake eutrophication, it is important to identify **nutrient sensitive zones** and turn them into effective **nutrient management zones**.

In this presentation, I will explain the importance of nutrient sensitive zones to lake management and discuss some of the benefits for lakes of managing nutrients at the catchment scale.

TRANSCRIPT

Thanks Warwick. Firstly, I would like to thank the Lakes Water Quality Society for inviting me to speak to you all here today. As Warwick said, I am originally from Canada and have been studying New Zealand lakes for fifteen years - fourteen of those years at the University of Otago. At last count I have sampled about seventy lakes around New Zealand so I have seen a lot of what is going on out there. I would like to share with you some of my thoughts.

I was asked to speak about nutrient sensitive zones and just a quick look through the literature revealed a few different definitions of what a nutrient sensitive zone is. One definition said that it is "where fertiliser use is licensed and a nutrient management plan exists". A similar definition said that "farmers in these zones are only allowed to buy fertiliser if they have a nutrient management plan backed by approved soil tests". The third definition that I found is a little bit different, and says that it is "a zone which is sensitive to the delivery of nutrients such as a wetland or near shore coastal zone".

There seem to be two different kinds of definition. The first two are about what nutrient **management** zones are like. The third definition actually mentions sensitivity and I think better describes what a nutrient **sensitive** zone is. I would like to make a distinction between nutrient sensitive and nutrient management zones; and I hope that distinction will become clear as I go through my talk. Actually, I do not particularly like any of these definitions; from a scientist's point of view, I think they are a bit vague and wishy-washy, so I came up with my own definition:

A nutrient sensitive zone is a water catchment supplying surface and/or ground water to an aquatic ecosystem in which plant productivity and/or biomass increases with increasing nutrient supply. A nutrient sensitive zone entails a supply zone, from which nutrients are supplied, and the receiving waters, where ecological impacts may result. In the first part of my talk, I will focus on the supply zone and its importance. Then I will talk about the receiving water and biological responses to nutrients in the zone.

So firstly, what is a catchment?

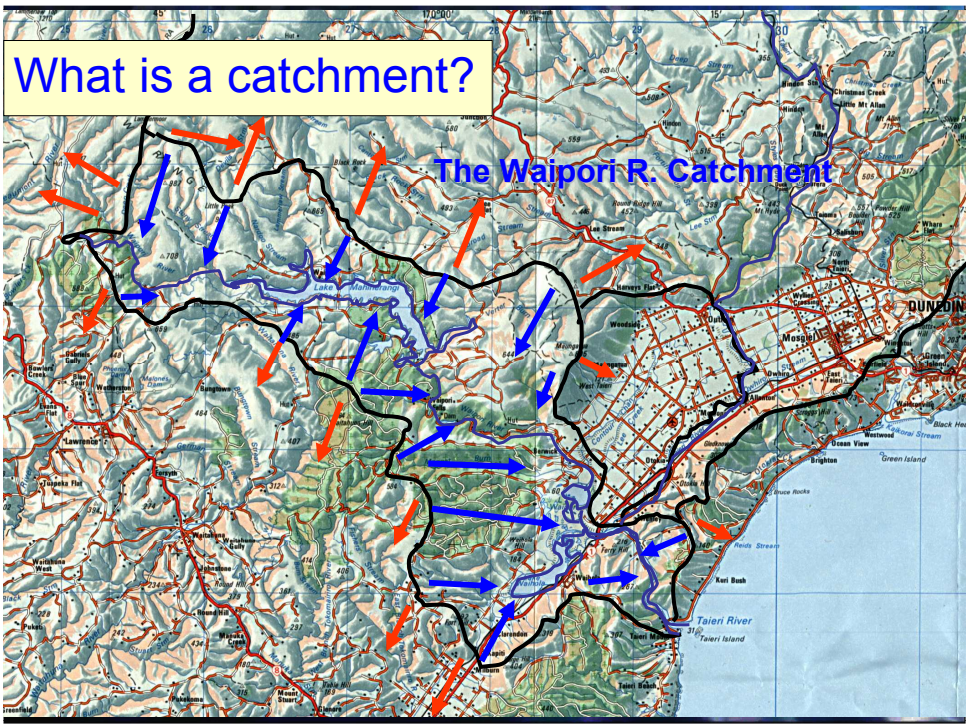


Figure 1

It is a geographical feature, (*Figure 1*) illustrated by the Waipori River catchment near Dunedin, where I have done some research relevant to this topic. It is bounded by a watershed: all runoff in a catchment eventually flows into one particular river system and/or lake system (and/or aquifer). If the rainwater falls outside the watershed of the catchment it flows into a different river system and if it falls inside the watershed it flows into the Waipori River system. This slide represents a surface water catchment. However, in my definition of a nutrient sensitive zone, groundwater is also included. In many cases surface water and groundwater catchments overlap approximately, but in some cases the true extent of the groundwater catchment may not be indicated by the surface water catchment - the former may extend beyond the latter. Therefore, one should also take into account groundwater catchments when delimiting nutrient sensitive zones. Why is the catchment so important? Because lakes are intimately related to their catchments. The catchment is the supply zone of the lake ecosystem and, thus, lake quality will reflect what is going on in the catchment.

For example, consider a pristine catchment like *Figure 2* in Fiordland National Park where we observe old growth beech forest. Incoming nutrients such as nitrate in rainwater or phosphorus from weathering rocks are cycled through the ecosystem at a very slow rate because the dominant organisms (e.g. beech trees) are very long-lived. So any phosphorus "sucked up" into the beech tree will be sequestered there for a few centuries, before the tree will die. The phosphorus atom will then end up in a thick soil layer that could sequester the nutrient for millennia before the phosphorus might be taken up by another beech tree, and so on. The cycling occurs over a very long time period. Eventually gravity wins and nutrients end up in the lake. A pristine catchment is characterised by slow nutrient cycling and slow flow of nutrients to receiving waters. As Colin Reynolds has pointed out, in climax communities nutrient retention and recycling efficiency is maximised.

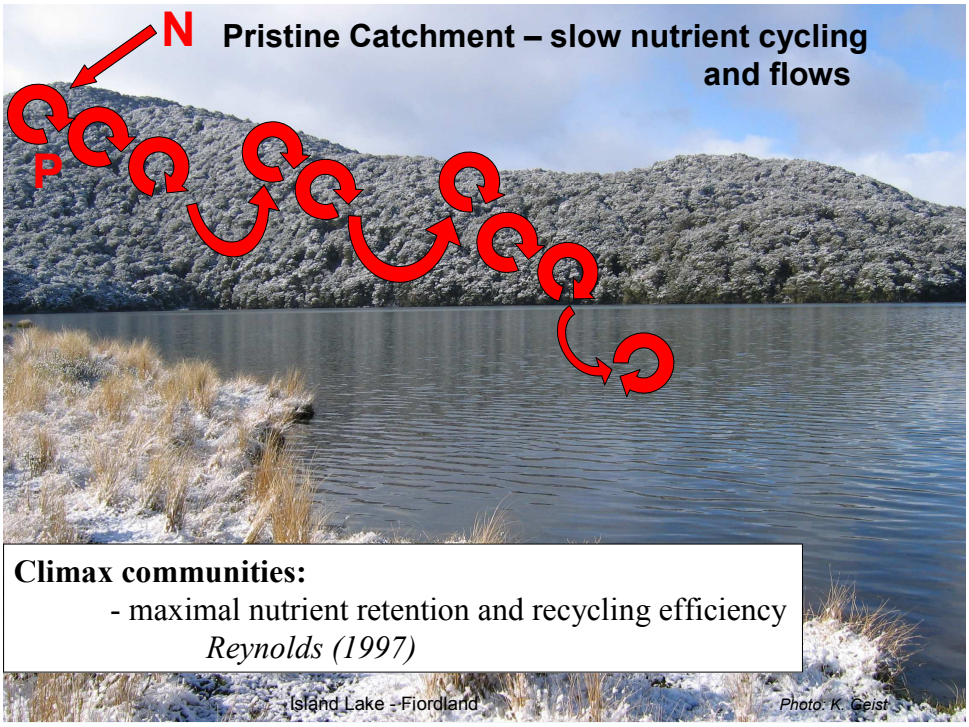


Figure 2

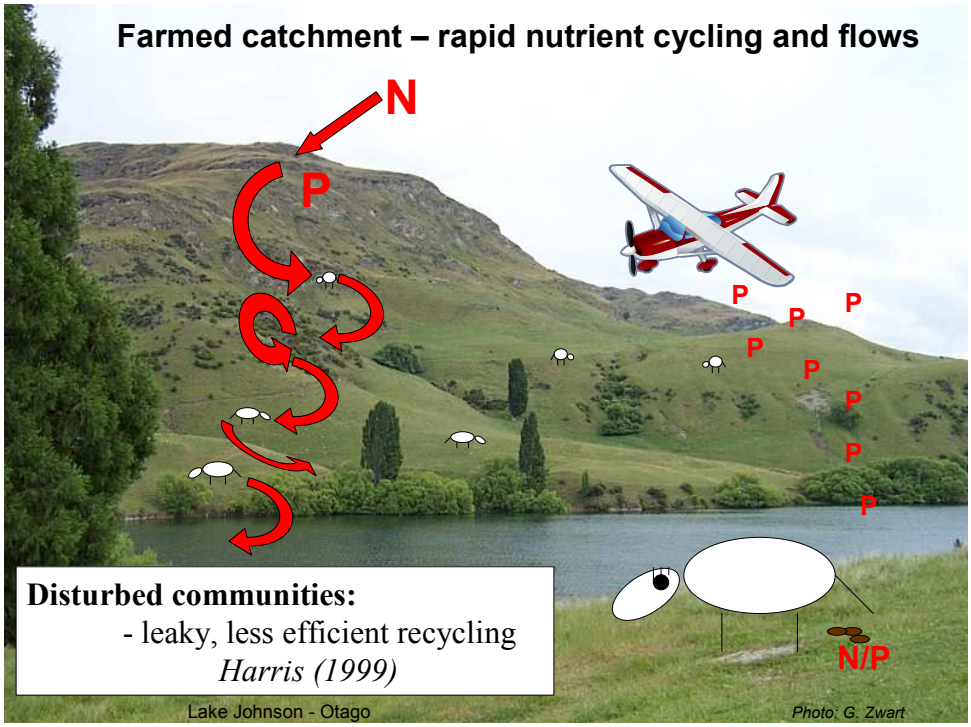


Figure 3

Figure 3 shows a farmed catchment, it is quite a different story. Firstly, the forest has been removed and replaced with fast growing grasses; so the nutrients that enter the catchment end up cycling very quickly through our fast growing grasses. Sheep and cattle graze and then defecate the nutrients. Thus, the nutrients move more freely downhill with the aid of gravity and in this way, natural nutrient cycles are short-circuited. In addition, soil erosion is rapid, runoff is higher, and nutrient sequestration in the soil no longer occurs - and the result is rapid movement of nutrients into the lake. As a result, soil fertility eventually decreases to the extent that plant nutrients must be sourced from outside the catchment. Superphosphate and urea are both imported into farmed catchments to maintain the fertility, to keep our intensive agricultural systems running. So, disturbed ecosystems are leaky and less efficient at recycling nutrients, as Graham Harris has pointed out. This slide illustrates the situation with regard to dry stock farming in New Zealand, which has been dependent on superphosphate additions and the planting of clover to fix nitrogen into the soils. In the last twenty years, there have been many conversions from this old style farming to much more intensive dairy farming systems, which involves adding nitrogen in a readily available form to the pasture.

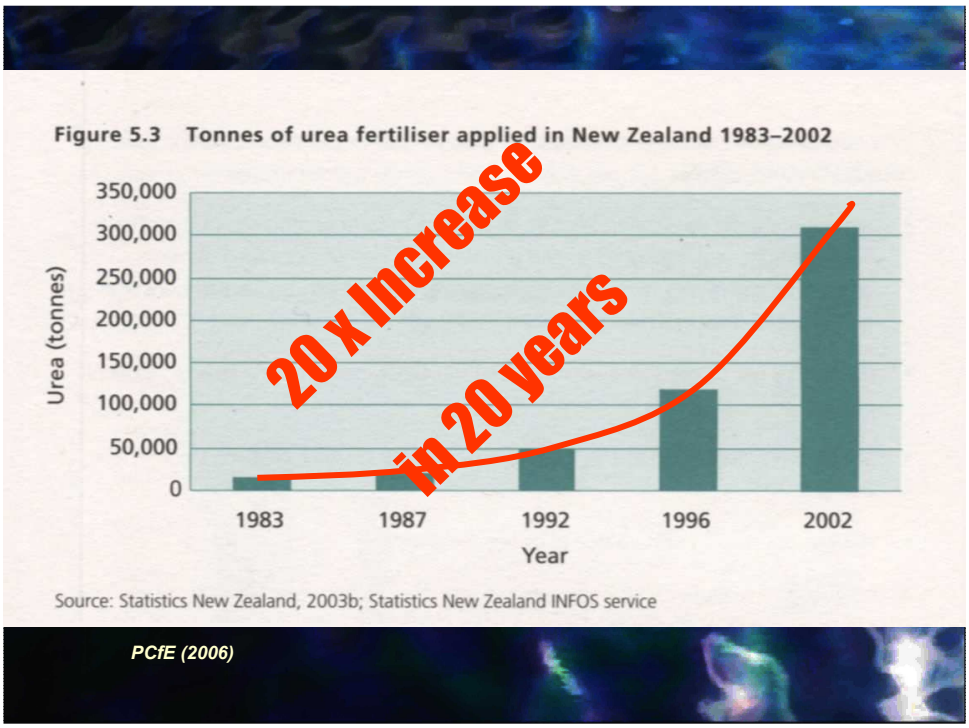


Figure 4 – Tonnes of urea fertiliser applied in New Zealand 1983 - 2002

Figure 4 comes from the report which Morgan Williams produced as Parliamentary Commissioner for the Environment, called *Growing For Good*, and shows the rate of urea application in New Zealand from 1983 to 2002, indicating a dramatic upward increase; in fact in New Zealand there has been a twenty fold increase in urea application in the twenty years to 2002, and I imagine that it has continued to increase since 2002. We have had a fundamental shift in the kind of fertilisation that occurs on many New Zealand farms toward a heavier reliance on the application of available nitrogen.

I remind you that loading from the catchment is only one source of nutrients to algae in lakes. Within lakes there are a number of processes that determine the nutrient levels. These are interesting and important processes, some of which Erik Jeppesen discussed earlier. Specifically, I re-emphasise the importance of nutrients coming from the sediments into the water column - a historical nutrient load returning to the water column via diffusion from the lake bed. (*Figure 5*) shows a number of nutrient transformation

processes occurring in lakes. Managing eutrophication is not as simple as merely managing how much nutrient is entering the lake from the catchment.

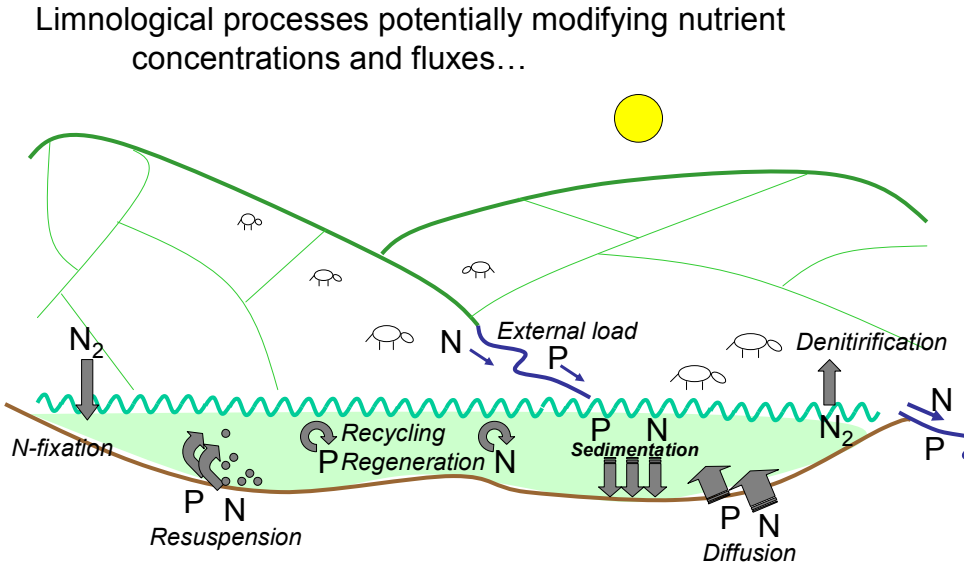


Figure 5 – Limnological processes

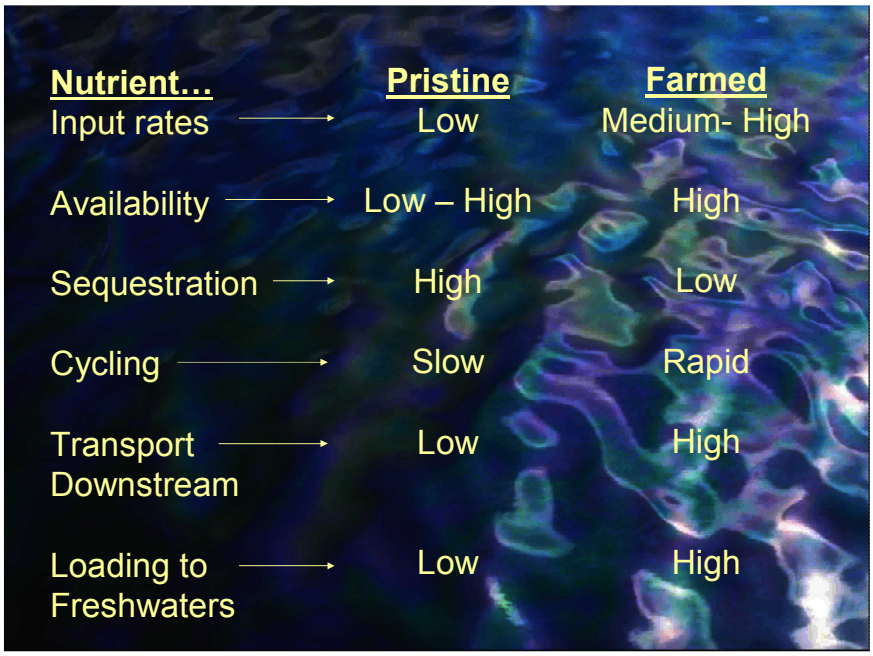


Figure 6 – Differences between pristine and farmed catchments

To sum up, *Figure 6* shows the differences between pristine catchments and farmed catchments: nutrient input rates are very low in the pristine and medium to high in the farmed. In terms of the availability of nutrients to plants and algae, there may be a range of availability in the pristine catchments as some of the nitrogen may be in the form of nitrate but substantial amounts may be in less available form of organic nitrogen. In contrast, in farmed systems we apply nutrients in highly available forms. In pristine systems with long-lived organisms and thick soil layers, cycling is slow and sequestration is much greater than on farms, leading to slower transport of nutrients downstream and

lower nutrient loading rates to freshwater ecosystems. I have just described some important differences between pristine and farmed catchments from a biogeochemical point of view and I hope I have made clear why the catchment is the right scale for looking at nutrient sensitive zones.

What has been going on in New Zealand? In 1987 Bill Vant (who is here today) said that cultural or accelerated eutrophication is the main cause of water quality problems in New Zealand lakes. I can tell you that not much has changed in twenty years. For example, Brian Sorrell and others recently completed a report for the Ministry for the Environment in which water quality changes over a ten-year period were analysed in over one hundred lakes. The report had some disturbing conclusions: 30% of the lakes examined had deteriorated in the ten years up to 2006. So while we had warnings twenty years ago, eutrophication has worsened in many lakes. People here may not be surprised by that as the Rotorua lakes are an example.

Figure 7 – New Zealand fresh water resources

I will show you a couple of photos of scenes reflecting what we often observe as we travel the country sampling lakes. This is not the focus of the problem - that cows are standing in our lakes - but it is indicative of a widespread lack of respect for New Zealand's fresh water resources.

I have addressed the first part of the definition – what is a catchment? It is the area that supplies surface water and groundwater to an aquatic ecosystem. The second part of this definition has to do with biological responses that occur as a result of nutrient loading. Specifically, in a nutrient sensitive zone, plant biomass will increase with an increase in nutrient supply.

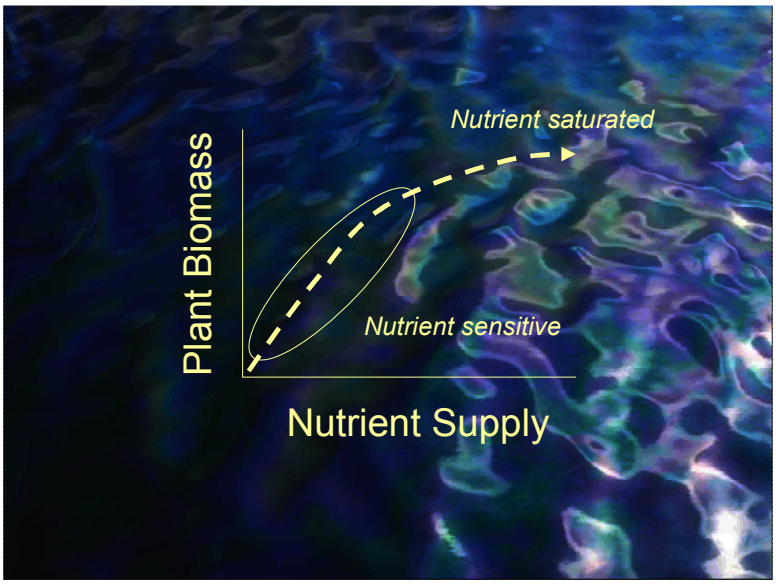


Figure 8 – What happens in a catchment

Figure 8 explains what we see in a catchment; within the domain bounded by the oval, biomass increases with increasing supply. If we keep adding nutrients to the system - like over fertilising a paddock - we eventual stop seeing a growth response because the plants just can not take up any more nutrient because other factors become growth-limiting. Let's explore briefly the ideas of nutrient limitation and nutrient sensitivity.

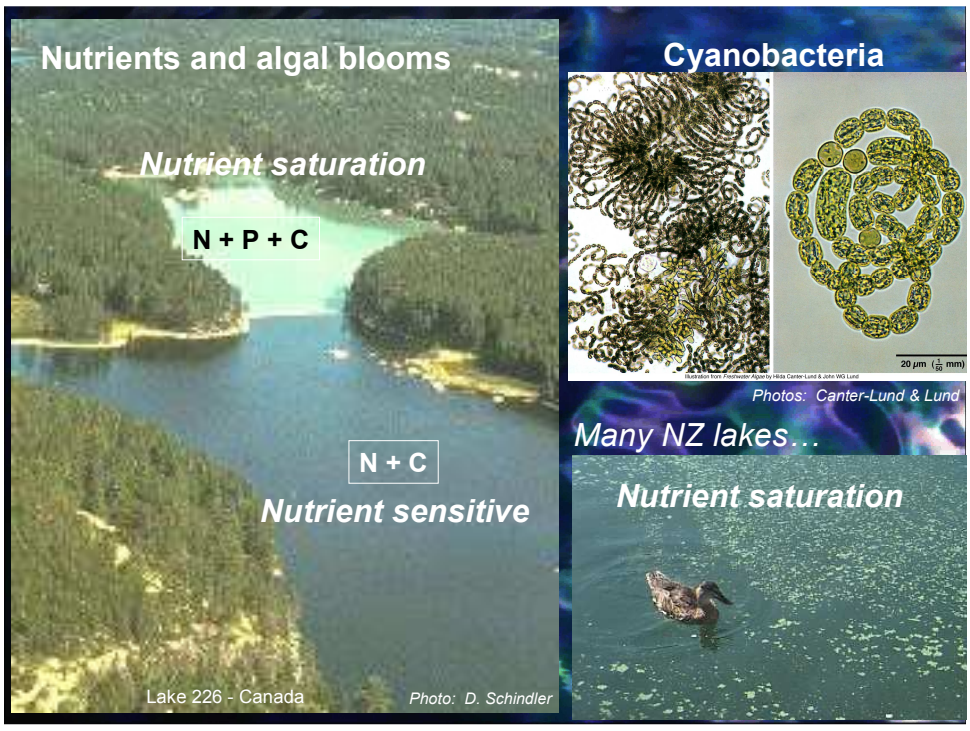


Figure 9 – Nutrient limitation and nutrient sensitivity

Figure 9 is a fantastic photograph that played a big role in North America in encouraging legislation to remove phosphates from detergents and to improve phosphorus removal from sewage discharges to the Great Lakes. This photo is of Lake 226 in the Experimental Lakes Area in northern Canada. In Lake 226, David Schindler found a lake that was roughly an hour-glass shape. He installed a barrier (plastic sheet) in the middle constriction. To prove to legislators that phosphate was the limiting nutrient which was causing eutrophication, he fertilised one half of the lake with nitrogen and carbon and the other half with nitrogen, carbon and phosphorus. He then took a photograph of the result.

It has been argued that this photograph was probably more convincing to the legislators than all the science that had previously demonstrated that phosphorus was indeed the culprit.

Single nutrients can be growth limiting to phytoplankton, but the limiting nutrient in lakes is not always phosphorus. It just happens to be phosphorus in some lakes, but in New Zealand we seem to have a lot of nitrogen limited lakes. Note that the limiting nutrient in lakes may also alternate between nitrogen or phosphorus (or other micronutrients) over time in a given lake. What happens if we add the limiting nutrient to a lake? We end up with the type of situation that we generally find undesirable - algal growth. Sometimes cyanobacteria will bloom. Sometimes we will approach the condition of nutrient saturation, where the lake is no longer sensitive to additional nutrient loading.

I would like to describe a couple of studies that we have been doing, which are relevant to the idea of nutrient sensitive zones.

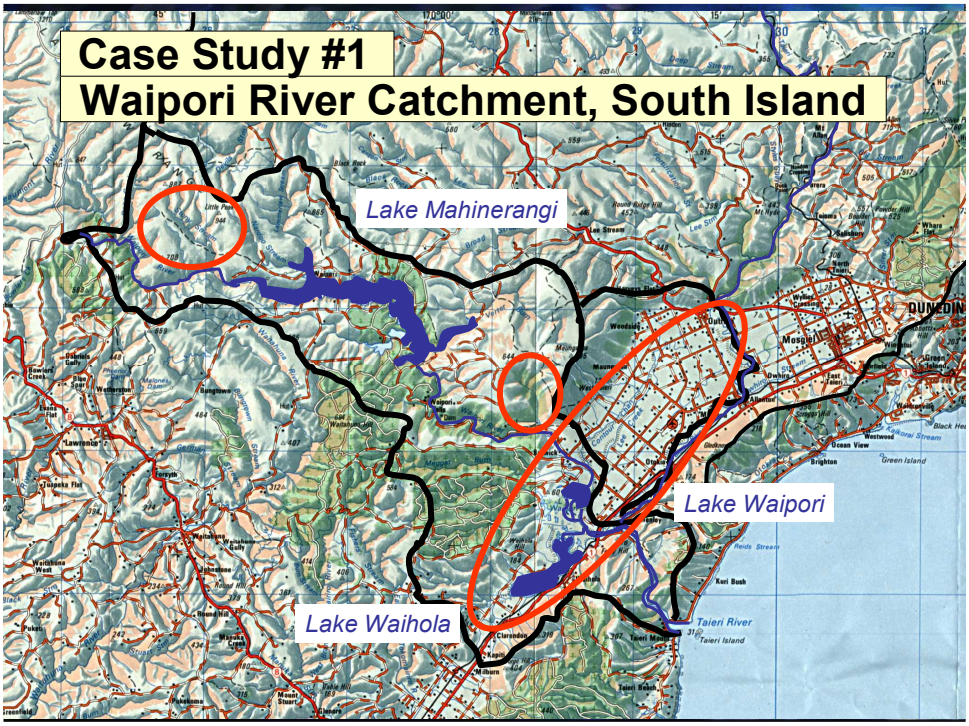
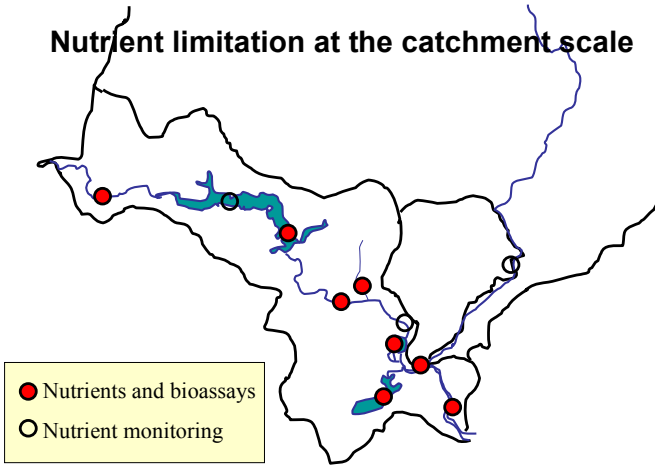


Figure 10 – Waipori River Catchment, South Island

The first study is from the Waipori catchment, near Dunedin. *(Figure 10)* This is an interesting catchment to work on because in the uplands there is very low intensity agriculture (tussock and pasture highlands). Then further downstream, towards Lake Mahinerangi, there is moderate intensity agriculture. The water flowing out of this lake eventually discharges into the lower Taieri plain where there is more intensive agriculture and quite a bit of dairying. After passing through a lake-wetland complex, the Waipori River then joins the Taieri River before flowing out the Taieri Estuary. There is also a small headwater stream within a bush catchment that flows into the Waipori River just before it reaches the lower Taieri Plain. So there are two different, low disturbance headwater situations – a bush catchment and a tussock catchment - within the study catchment. There is a useful land use gradient from headwaters to the sea.

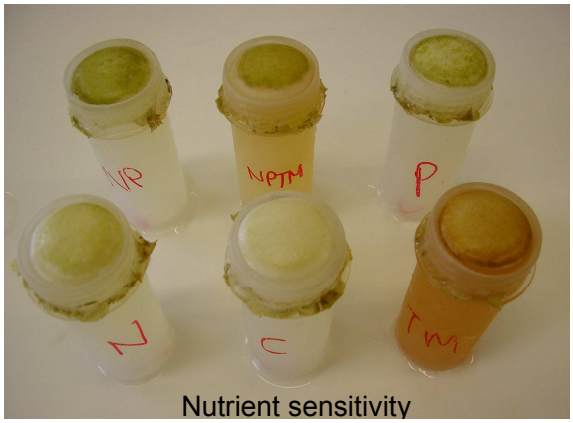
Figure 11



We are interested in measuring how nutrients enter the system from the headwater to the sea and also how algae respond to the nutrients. *(Figure 11)* An important question for nutrient management is: "Are algae equally sensitive to nutrient additions among sites within the catchment or does nutrient sensitivity change in relation to land use intensity?"

Figure 12

To answer this question, we put nutrient diffusing substrates into the stream bed and left them for two to three weeks to let algae grow on the surfaces. (*Figure 12*) Each of the pottles was filled with agar - some were spiked with nutrients and some of them were left without nutrients (the experimental controls). Over a few weeks, quite distinct differences in algal growth were observed, allowing us to determine which nutrients limited algal growth at the time of the experiments. Such experiments were repeated throughout the growing season.



Nutrient sensitivity

Figure 13

Figure 13 is a view of the resulting responses on the agar pottles - it is quite easy to visualise to which nutrients the algae responded. "C" indicates the control with no nutrients added. There was a bit of growth with added phosphorus (P), but in this experiment (I think even without extracting the chlorophyll and measuring it) it is possible to see that added nitrogen (N, NP, TMNP), not phosphorus, gave the strongest algal responses. We were also interested in the responses to trace metal limitations (TM, TMNP), but I will not discuss these now. In this way, we were able to examine nutrient sensitivity and nutrient limitations in the streams. In addition to these agar experiments, we also conducted bioassays in the water of the lakes and the estuary using a different method designed to measure nutrient responses in the phytoplankton.

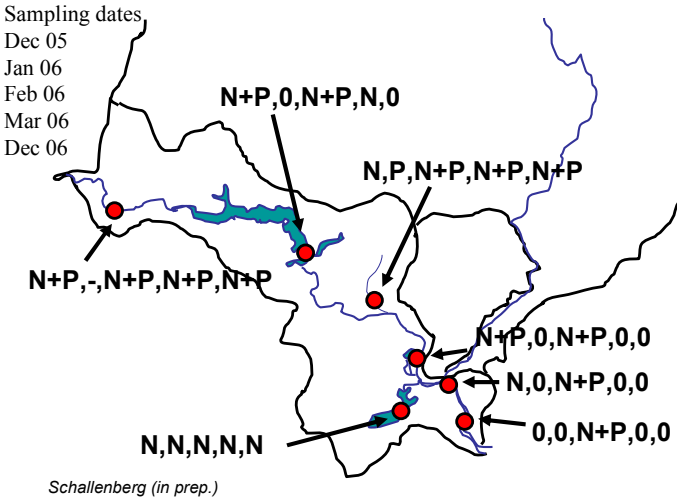


Figure 14- Nutrient responses in the phytoplankton

I will briefly go through the results of this study, which are relevant to nutrient sensitive zones. *Figure 14* shows the results from 5 different experiments each conducted at all sites, from the headwaters to the sea, during the growing season. The letters indicate the significant nutrient responses at each of these sites for each experiment. At the headwater sites nutrient limitation by N and P was quite consistent over time - always showing strong responses to nutrient additions (generally strongest with both N + P added). As we move down the catchment into a zone of moderate intensity agriculture we observed a couple of instances where there was no response to added nutrients. As we move further downstream to the more intensively farmed areas we observed more cases where no response to nutrients occurred - situations of nutrient saturation. Finally, down at the estuary it was rare to observe significant responses to nutrients. Lake Waihola is an unusual case where it appears that in-lake nutrient transformations resulted in continuous N limitation of the phytoplankton.

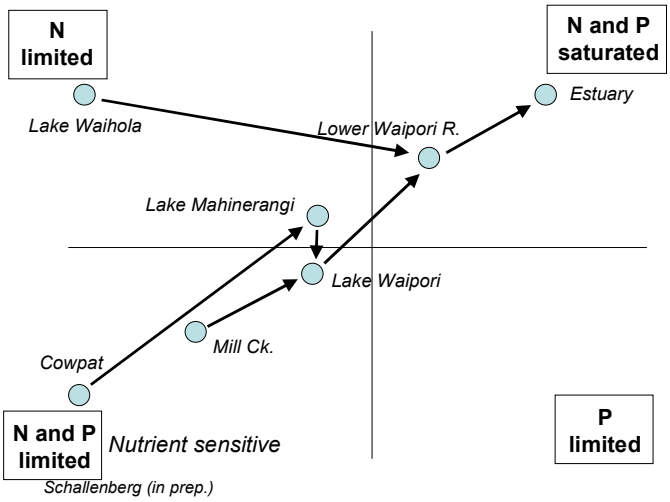


Figure 15

By plotting the average response for each of the sites going from headwaters to the sea, (*Figure 15*) we can see the same pattern, going from strongly nutrient limited or nutrient sensitive headwaters to highly nutrient saturated lowland sites. This follows the pattern of land use intensification and the pattern of nutrient availability as measured by the concentrations of available N and P in the water at the sites (data not shown).

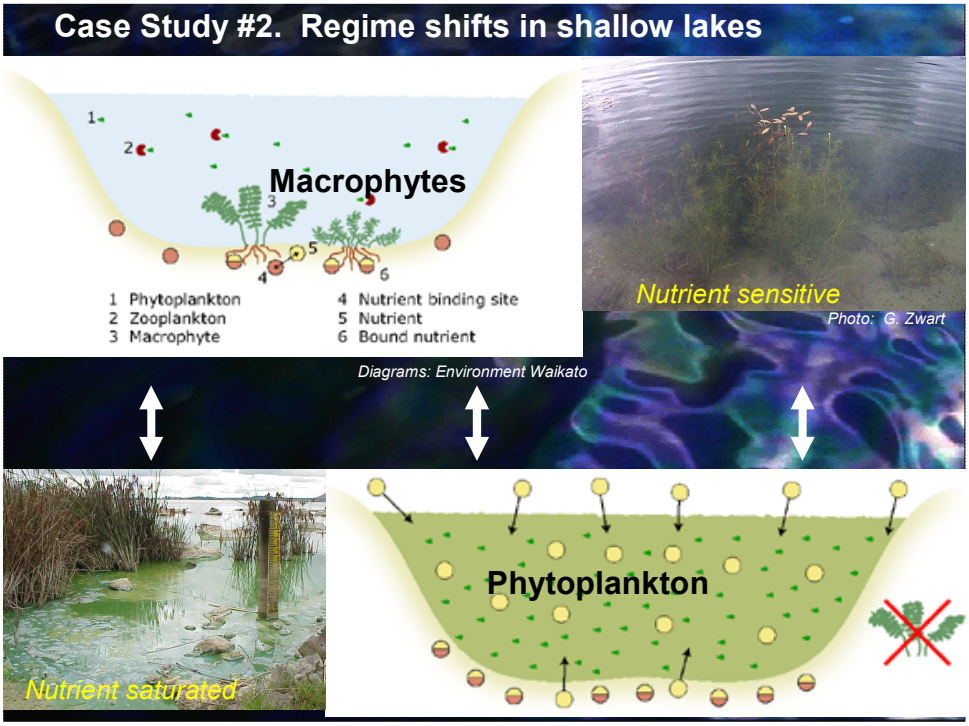


Figure 16 – Regime shifts in shallow lakes

The second study I want to describe to you concerned shallow lakes around New Zealand. (*Figure 16*) In shallow lakes, a phenomenon known as regime shifting can occur when shallow lakes receive too much nutrient. The typical regime shift described in the literature is from a generally desirable, clear-water, macrophyte (aquatic plant) dominated state (where nutrient concentrations tend to be low, light can penetrate to the lake bottom, and aquatic plants are healthy) to a state with excess nutrients in the water, phytoplankton blooms, low light penetration, where macrophytes are unhealthy or absent. Such regime shifts have been well documented in some Northern European lakes and Erik Jeppesen has been instrumental in developing ideas about how shallow lakes shift from the nutrient sensitive state to the nutrient saturated state. No one has yet assessed the extent to which this phenomenon occurs in New Zealand lakes. So, Brian Sorrell of NIWA and myself recently decided to try to do that by canvassing as many freshwater scientists, managers, and recreationalists as we could, concerning shallow lakes around New Zealand.

With the help of these people, and lake water quality databases we identified lakes for which there was good evidence that this type of regime shift had occurred. *(Figure 17)* We found thirty-seven shallow lakes in New Zealand that had exhibited such shifts. These were located across a wide range of latitudes, from Northland to Otago. Our next task was to find other shallow lakes with depths and mean annual temperatures within the range exhibited by the regime shifting lakes, but which had not undergone regime shifts - a sort of "control" data test. We found fifty-seven of these lakes which enabled us to begin to examine factors that were related to regime shifts in New Zealand shallow lakes. I will just show one of the results of the study - the relationship with land use.

Figure 18 shows the percentage of lakes that underwent a regime shift vs. the percentages of their catchments in pasture. To the left of the top graph are the lakes with < 10% percentage of the catchments in pasture and to the right of the graph are lakes with 90-100% of their catchments in pasture. There is a strong positive relationship between the frequency of lakes undergoing regime shifts and the percentages of catchments in pasture. In catchments with high percentages of pasture, close to 100% of the lakes have undergone regime shifts. In contrast, the bottom graph shows the relationship with percentages of catchments in forest, which shows the opposite relationship. This study shows that there is a strong relationship between land use and the tendency for shallow lakes to shift from a clear water, nutrient sensitive state to a plankton dominated, nutrient saturated state.

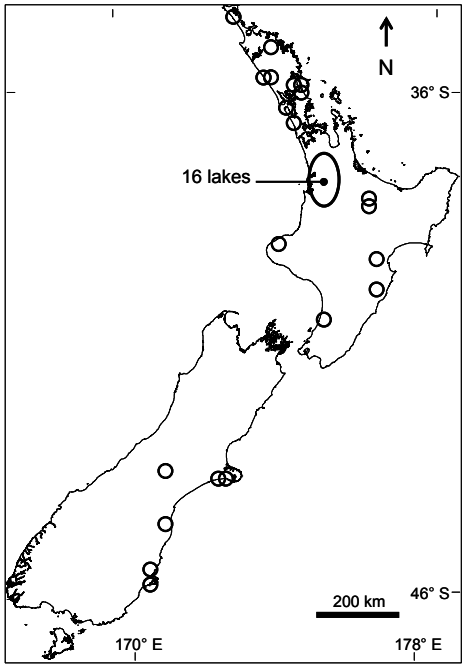


Figure 17 – Regime Shift Lakes

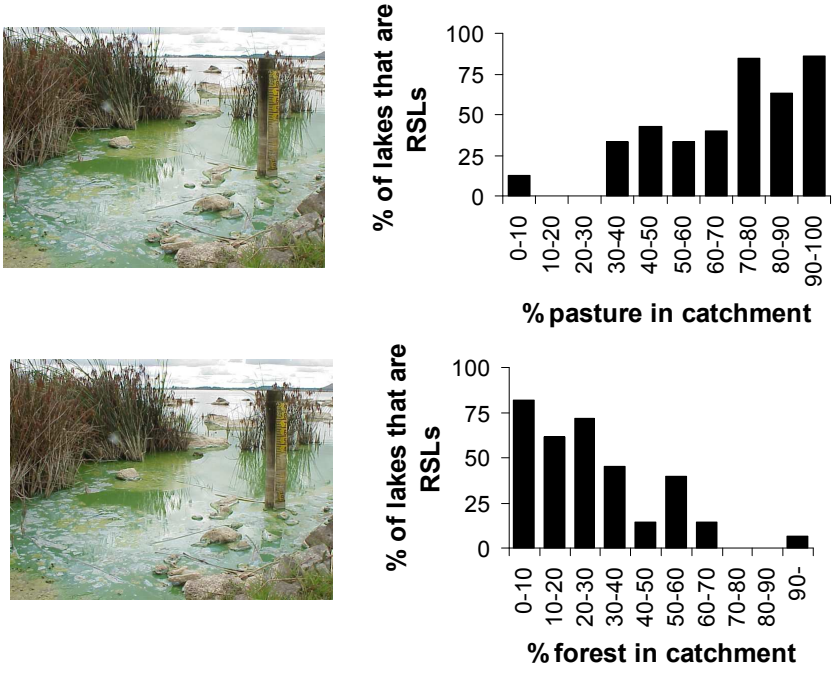


Figure 18 – Regime Shift Lakes, Forestry vs. Pasture

Well, the farmer might say, "So what? New Zealand is blessed with a wealth of freshwater, compared to other countries. Why shouldn't we convert some of that freshwater wealth into economic wealth, and why shouldn't we do it now when we're getting good prices for milk solids?" In response to that I would ask a couple of pertinent questions: 1. *Can our nutrient sensitive lakes sustain increasing fertiliser use and stocking rates in the catchment without undergoing undesirable regime shifts?* I think that is an important question, and the data indicate that the answer is "No". I do not think they can sustain more intensification and I think that engineering solutions probably are not going to solve the problem. As Erik Jeppesen mentioned, engineering solutions are only quick fix solutions, which tend to be quite expensive and may not work in many cases. We can not keep intensifying without saturating our nutrient sensitive lakes.

So what about the lakes that are already nutrient saturated? The second question we should be thinking about is: 2. *Should lakes that are already nutrient saturated continue to be sacrificed for economic gain?* I think that the answer to that question has to do with the value that we New Zealanders place on clean water. These values must be clearly expressed in District Plans and National Policy Statements, and so I encourage you to submit on the new National Policy Statement on Freshwaters and make sure that your views on the value of clean freshwaters are taken into account in environmental decisions.

To finish, I would like to say that it is clear that voluntary best practice does not work well enough, down on the farm. While the RMA has enabled point source pollution to be brought largely under control, it does not provide useful tools to manage non-point source pollution. By designating the Taupo catchment as New Zealand's first nutrient sensitive/management zone, a new regulatory model has been proposed specifically for managing non-point source pollution, and that is very exciting. In my view, the regulation of land use under a nutrient management zone framework is a sensible way to protect our lakes against increasing non-point source pollution. We have the scientific expertise and the tools to determine the desired lake nutrient targets. In my view, whether used in conjunction with a market based nutrient trading scheme or not, nutrient management zones are going to be the best way to achieve those targets.

Thanks a lot for listening.

QUESTIONS

Brentleigh Bond, LWQS: I recall about two years ago at a New Zealand Freshwater Scientists Conference here in Rotorua, you made a comment that we could have intensive farming or we could have clean water but we could not have both. Are you still of that opinion?

Marc Schallenberg: Well I have yet to see a situation where we have an intensively farmed catchment **and** we have good water quality. So if people believe that we could have both, I would be very interested to see an example of where that occurs.

THE CURRENT STATE OF THE ROTORUA LAKES AND LAKE TAUPO

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ABSTRACT

The theory of alternative stable states in lake ecology can be extrapolated to provide a working example of how Rotorua lakes are responding to the pressure of increasing nutrient loads. This theory has been applied widely to shallow lakes to describe two alternate states; a vegetated, clear-water state and a de-vegetated state with poor water clarity and high algal biomass.

In applying this theory to the Rotorua lakes and Lake Taupo, it is possible to separate at least three regimes:

(1) the traditional vegetated/de-vegetated state which is observed in Lake Rotoehu and shallower western parts of Lake Rotoiti, including Okawa Bay;
(2) a clear-water state with a deep chlorophyll maximum, observed in lakes Taupo, Tarawera and Rotoma, versus a turbid state dominated by algal blooms in Lake Rotoiti;
(3) well oxygenated bottom waters with little release of nutrients from the bottom sediments, observed in lakes Taupo, Tarawera and Rotoma, versus seasonally deoxygenated bottom waters with large nutrient releases, observed in lakes Rotoiti and Okaro.

Lakes Okareka, Okataina, Rotokakahi and Tikitapu could be in a transitional state according to the third regime, with some seasonal deoxygenation of bottom waters, and these systems could be prone to rapid deterioration of water quality. The seasonal deoxygenation of bottom waters in deep lakes leads to an increase in denitrification, the conversion of nitrate to nitrogen gas, leading to lower nitrogen to phosphorus ratios in the water column and an increase in the relative abundance of nitrogen-fixing blue-green algae (cyanobacteria), despite high catchment nitrogen loads. The combination of high catchment nutrient loads, seasonal deoxygenation and cyanobacterial blooms has necessitated a concerted effort to reduce releases of phosphorus from the bottom sediments, using Lake Okaro as a case study. Scaling up successful results from Lake Okaro to larger lakes is now the major challenge.

TRANSCRIPT

The topic that I was assigned is “the current state of the Rotorua lakes and Lake Taupo”. I will begin with a brief outline of my talk including a brief introduction to lake ecology, the importance of nutrients, and the effects of mixing and stratification. I will discuss the significance of oxygen in the bottom waters of lakes and describe how oxygen is basically the life force of a lake. I will use examples to show how oxygen concentrations impact upon lake water quality. I will also talk about the distribution of algae through the water column of lakes and about recent management options to restore degraded lakes.

The topics not covered in my talk are regime shifts between phytoplankton and macrophytes that Mark Schallenberg has already alluded to. In the Rotorua lakes, Lake Rotoehu is a case where either macrophytes dominate or phytoplankton blooms tend to dominate; and there are rapid transitions between these two states. In Lake Rotoehu or the shallower regions of Lake Rotoiti these two states tend to alternate. Further, my talk does not cover temperature variations in the context of climate change, because Eric Jeppesen has already alluded to that.

A quick summary of this topic, however, is that there have been no temperature changes in the Rotorua lakes that we can associated with long-term climatic variations. They will come but they are not evident yet. I do not discuss modelling of the lakes but in terms of projections it is clear that we will need to factor in a sort of ticking bomb of nitrates coming through from the groundwater into the lake, and so a very active area of our research has been to model the potential impact of this effect as well as the potential impact of climate change, so that we can make forward projections.

The nutritional requirements of algal cells (*Figure 1)* in water include primarily carbon, nitrogen and phosphorus as the main 'macronutrients'. There is sufficient carbon in the atmosphere and as it diffuses very easily into the water, that carbon is not often limiting to phytoplankton production. With nitrogen it is a similar sort of thing; nitrogen diffuses into the water but this nitrogen gas (N_2) is not the form that phytoplankton can readily use. The CO_2 can be used, for example, by the algal cells, the N_2 generally cannot. One of the interesting features of some algal cells, particularly some types of blue-green algae [cyanobacteria] is that they can actually fix atmospheric nitrogen in identical ways to what clover does, and so this feature offers an opportunity for some cyanobacteria to potentially reduce limitation by nitrogen.

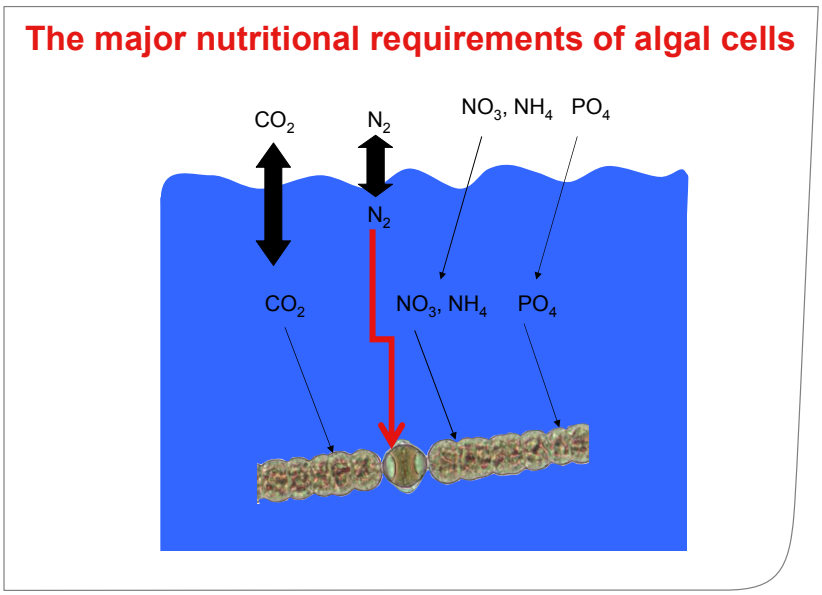
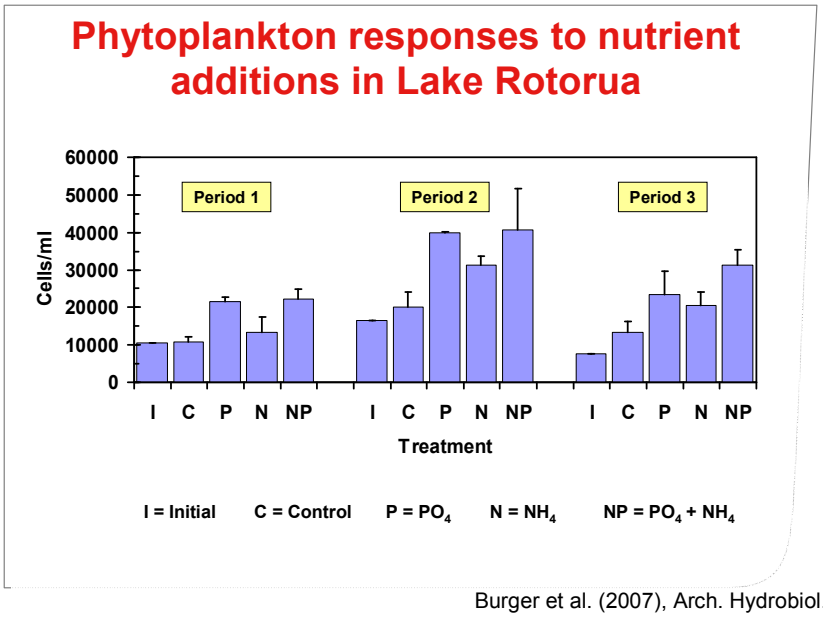


Figure 1: The nutritional requirements of algal cells

Lakes that are enriched in phosphorus in particular are more likely to have increased incidence of harmful algal blooms from these N-fixing cyanobacteria. But the message, therefore, is very clear; nitrogen and phosphorus are critical and are key nutrients that potentially limit algal growth.



Burger et al. (2007), Arch. Hydrobiol.

Figure 2: Phytoplankton responses to nutrient additions

An interesting study that was done by David Burger (*Figure 2)* about two years ago as part of his PhD at the University of Waikato, demonstrated that in Lake Rotorua it is both nitrogen and phosphorus that are important, i.e., may be limiting phytoplankton production. This finding may represent a shift from some of the findings of the pioneering work that Eddie White and others did in the 1970s, in which they showed that it was nitrogen that was most frequently limiting in the lake. Three different periods of study by Burger, each involving incubations over about four days, show fairly clearly that the greatest increase in algal growth was with enrichment of both nitrogen and phosphorus. There is perhaps a hint that phosphorus was more important, but the target for control of eutrophication should still be for control of both nitrogen and phosphorus.

Figure 3 shows periods of lake mixing and stratification are very important in lakes. In winter the profile is typically constant with depth. In *Figure 4* the remaining nine months or so, typically from September through to May, there is vertical stratification of temperature. In the deep lakes this stratification involves the surface water being mostly isolated from the bottom water, and this has very significant effects in terms of the loss of oxygen from the bottom waters. The rate at which those bottom waters deoxygenate is primarily dependent on the rain of algal cells that falls from surface waters together with the organic enrichment of the bottom sediments.

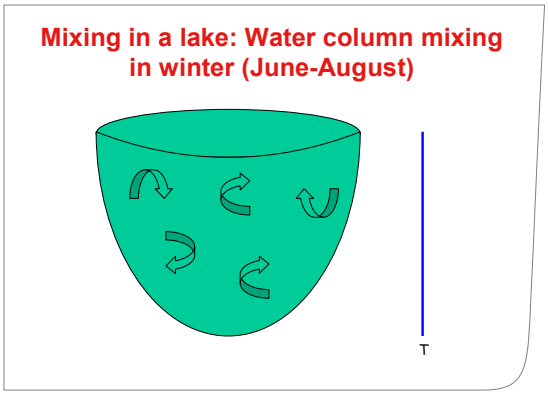


Figure 3

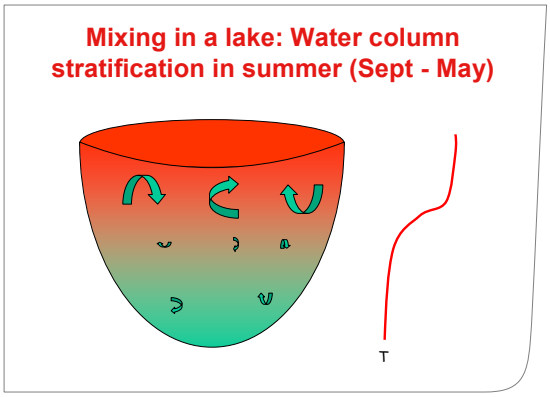


Figure 4

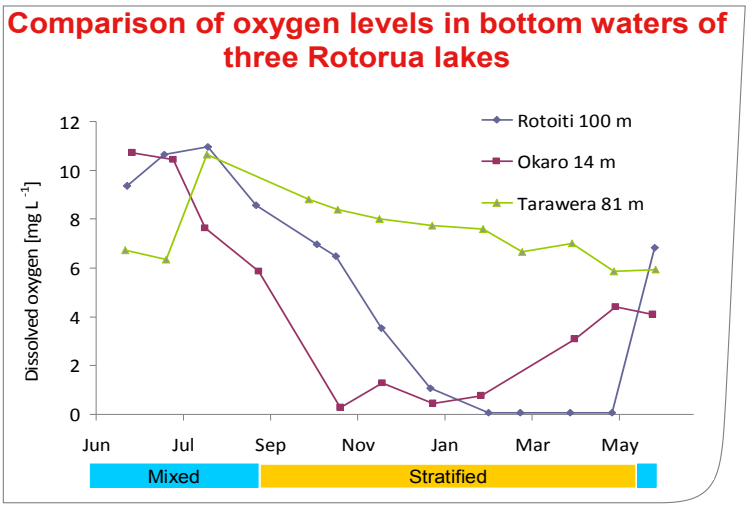


Figure 5

Figure 5 demonstrates the seasonal changes in oxygen during stratification in three of the Rotorua lakes: Rotoiti, Okaro and Tarawera, for two different periods – one when the lake was mixed and one when the lake was stratified. When the lake mixes there is plenty of the oxygen in the bottom waters (i.e. oxygen levels are close to saturation). When the lakes stratify through to about May or June of the following year there is progressive deoxygenation. The rate at which that deoxygenation occurs is really quite different between a nearly pristine Tarawera, and Okaro where that deoxygenation takes place over a couple of months.

In Lake Tarawera (*Figure 6)* there is slow deoxygenation over the season whereas in Lake Rotorua at a depth of 21 metres, there are intermittent periods of strong deoxygenation and reoxygenation.

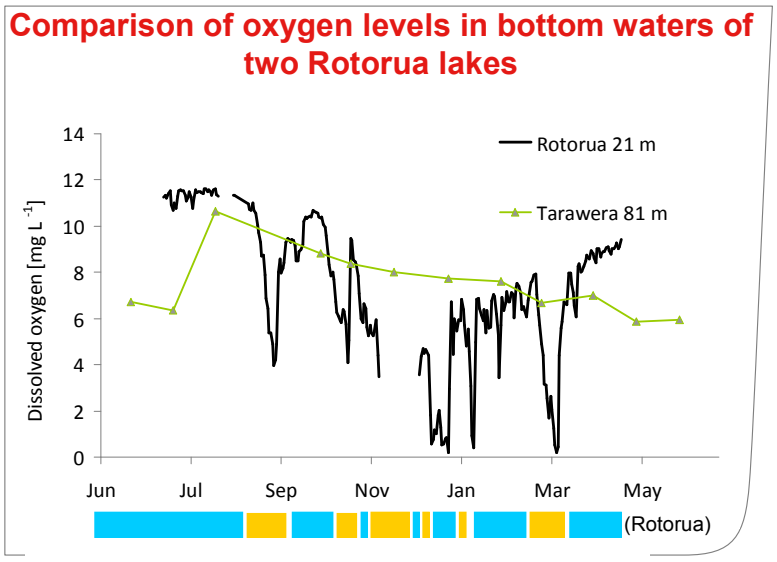


Figure 6

Readings taken every 15 minutes from a buoy (*Figure 7)* on Lake Rotorua show this great variability of oxygen in the bottom waters, with three major deoxygenation events over the past year.

In the deeper Rotorua lakes, the seasonal low of dissolved oxygen, just before mixing in winter, provides a great deal of information on the trophic state of the lakes shows in the bottom waters of Lake Taupo there is only a slight reduction in the level of oxygen by May or June of each year. By comparison in Lake Rotoiti there is no oxygen below about 35 metres by this time and in Lake Okaro deoxygenation occurs well within depths of 10 or 11 metres from the surface after about two months of stratification.

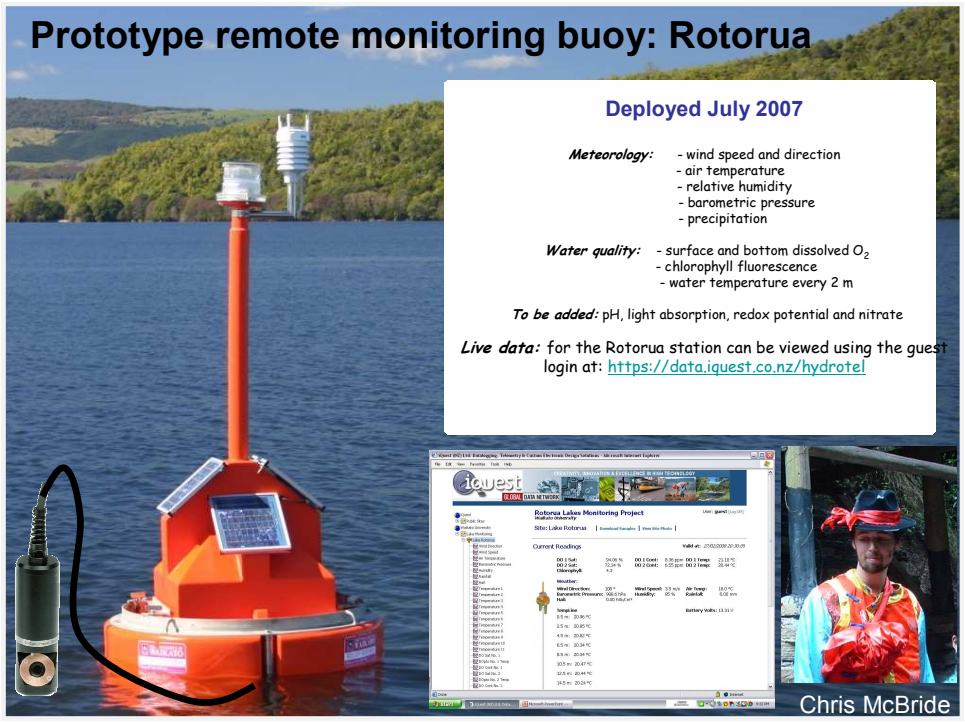


Figure 7

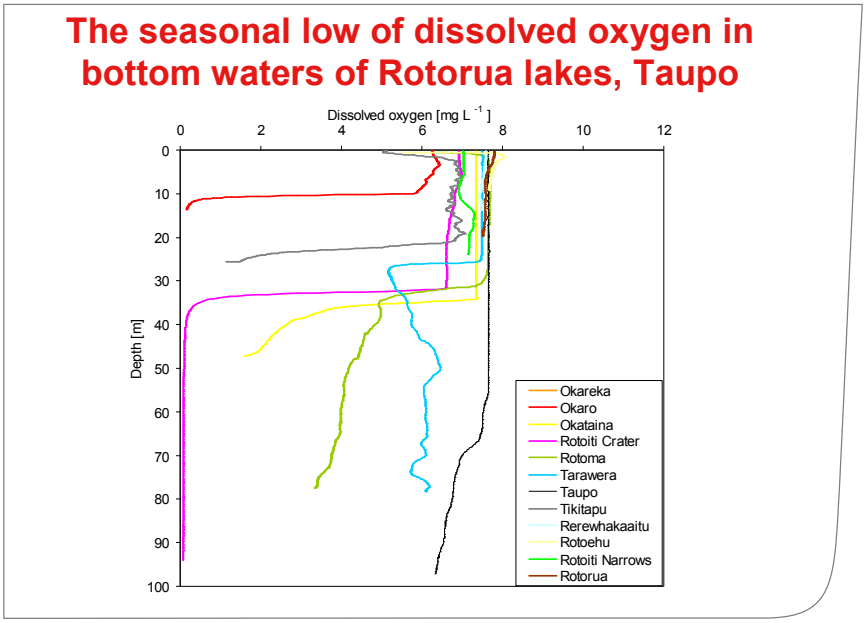


Figure 8

Rob McColl put together a similar sort of analysis of oxygen in *Figure 9* when he looked at a time series of data from 1956 through to the 1970s for six lakes in this region. He looked at the percentage of saturation of dissolved oxygen in the bottom waters of these lakes. Extending his data out to 2008 it is clear that only Lake Rotoma still has oxygen in the bottom waters of the lake at the end of stratification.

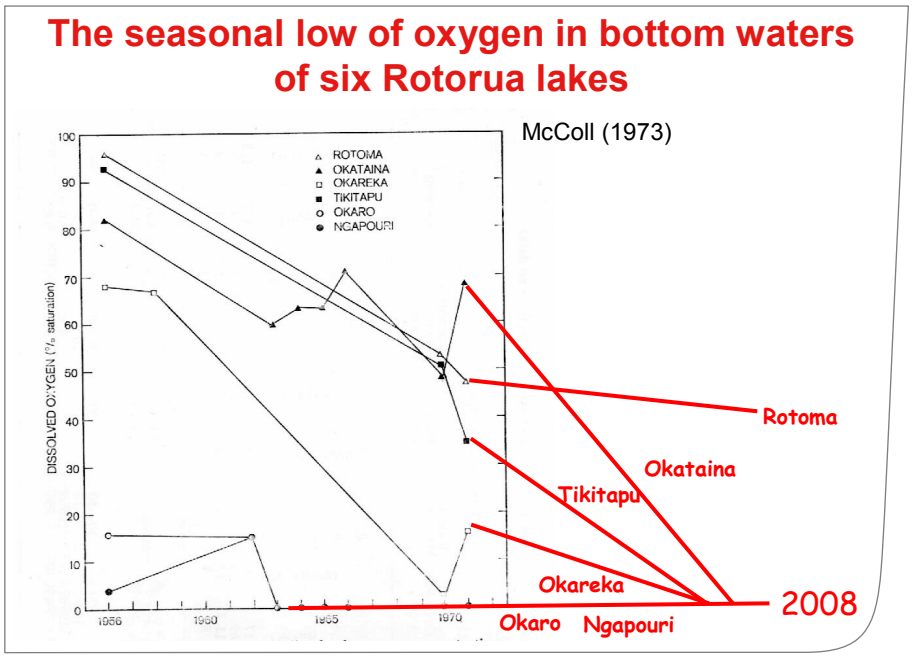
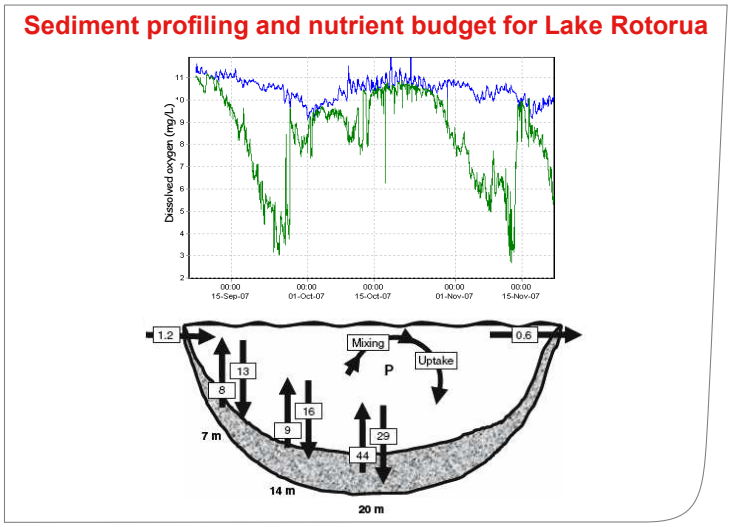


Figure 9

The effect of deoxygenation has been very clearly illustrated in *Figure 10,* by David Burger, for Lake Rotorua. Numbers represent relative amounts of phosphorus (expressed as areal loads) coming in and out of the lake. A value of 1.2 is from the inflows, but the values associated with recycling at different depths are far higher. In just one of those deoxygenation events the equivalent of nearly one year's supply of nutrients from the catchment comes out of the bottom sediments from Lake Rotorua. With three major deoxygenation events taking place over the previous summer in Lake Rotorua, it means that the sediments have a major role in the trophic state of the lake. Examining different lakes,



Burger et al. (2007), Hydrobiologia, Ecological Modelling

Figure 10

Figure 11 shows that Lake Tarawera is fairly stable on a seasonal basis, with almost no change in phosphorus levels in bottom waters through the stratified period, as the bottom waters do not become deoxygenated. By contrast phosphorus levels in Lake Rotoiti climb progressively through the stratified period, and in Lake Okaro phosphorus concentrations in bottom waters are even higher.

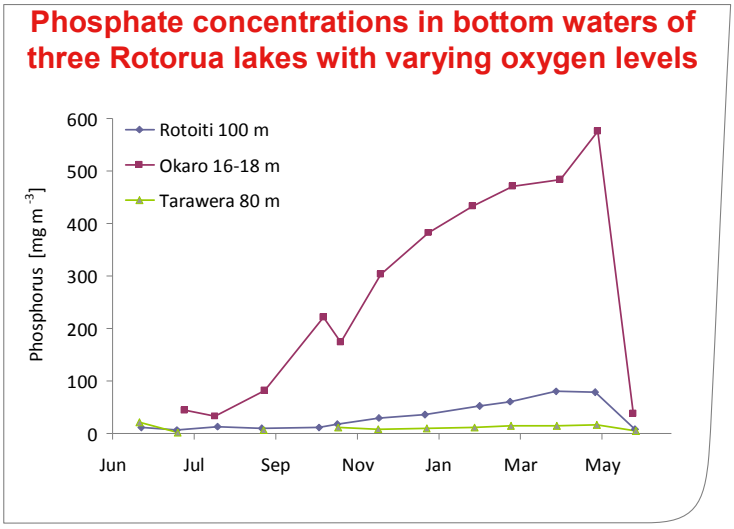


Figure 11

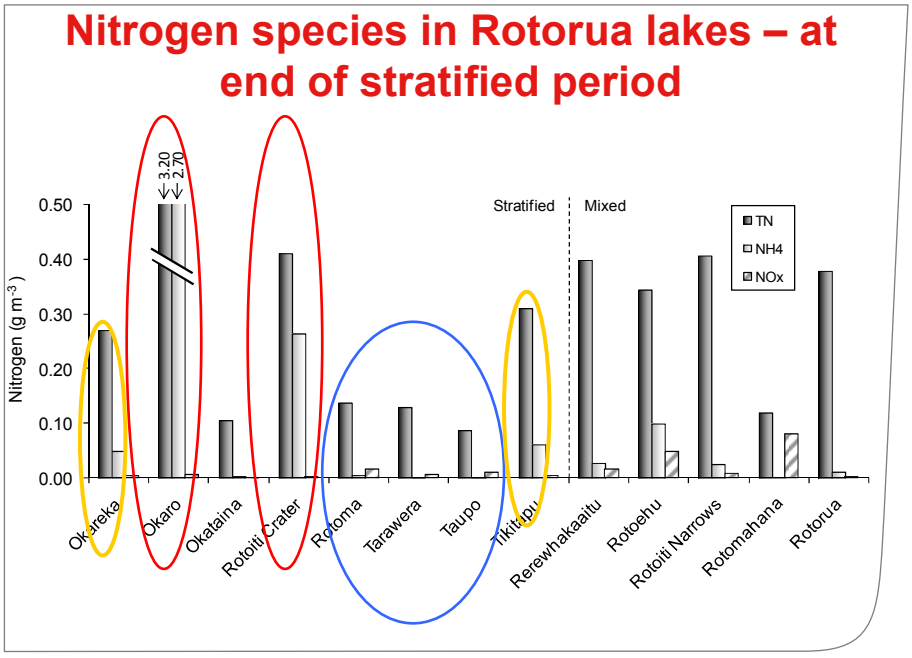


Figure 12

At the same time ammonium is also being released from the bottom waters of the lake. In *Figure 12* for Lake Okaro most of the nitrogen that is present in the bottom waters is ammonium. For Lake Rotoiti a substantial amount of ammonium is also present in the bottom waters. Comparisons with three of the almost pristine lakes; Rotoma, Tarawera and Taupo, shows that there is almost no detectable ammonium in their bottom waters, only a small amount of nitrate. These are the "healthy systems", they have not been

deoxygenated and there is nitrate present in bottom waters as opposed to ammonium. Lakes Tikitapu and Okareka are the lakes that could be classified as being at risk, as there is ammonium rather than nitrate present in bottom waters.

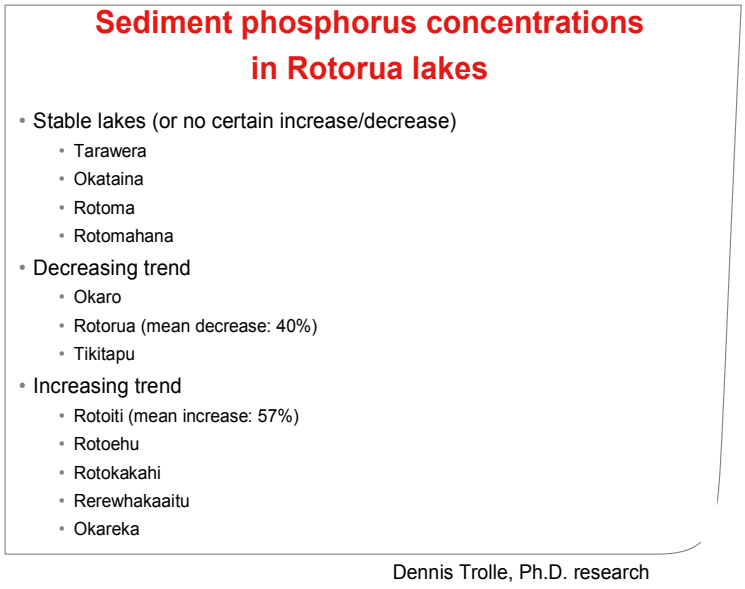


Figure 13

One of the concerns for the Rotorua lakes is that the levels of nutrients are increasing in the bottom sediments of many of the lakes. A PhD study by Dennis Trolle involved sampling of 12 of the lakes, examining sediment nutrient concentrations in the lakes and comparing them with previous studies on the same lakes, shown in *Figure 13*. Lake Rotorua sediment phosphorus levels have actually decreased by 40% while in adjacent Lake Rotoiti they have increased by 57%.

What are the effects of these changes?

Some of the changes in oxygen status and sediment nutrients are reflected in the trophic state of the lakes, which can be gleaned visually through a remote sensing image which showed that Lake Okaro had relatively high concentrations of chlorophyll in 2002, and similarly for Okawa Bay, the western arm of Lake Rotoiti and Lake Rotoehu. These are the lakes that also have the highest nutrient concentrations.

A comparison of lakes Taupo, Rotoma, Tarawera, Rotoiti in *Figure 14* shows that the three former lakes have both low nutrient and chlorophyll levels, whereas they are much higher in Lake Rotoiti. In Lake Okaro they would be in order of magnitude or so higher again. One of the key points of this is that we have some very useful indicators of water quality in our lakes.

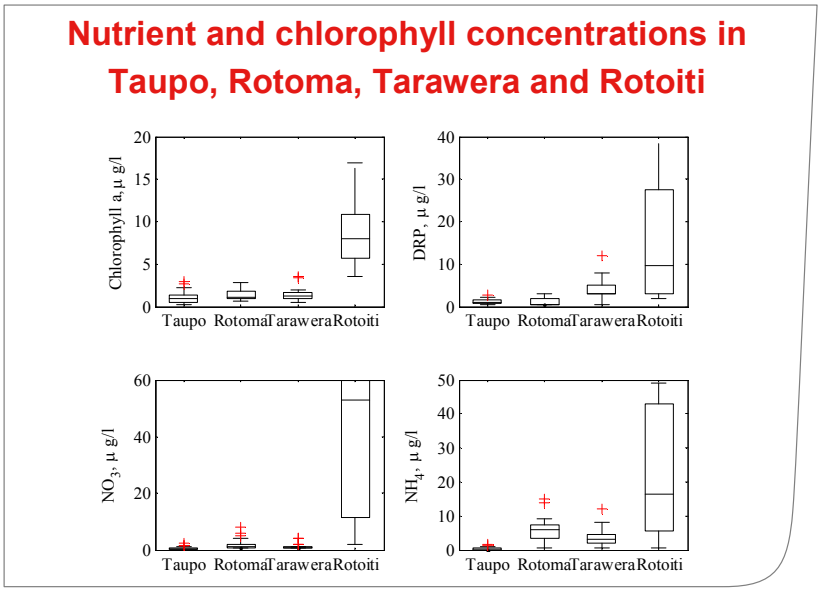


Figure 14

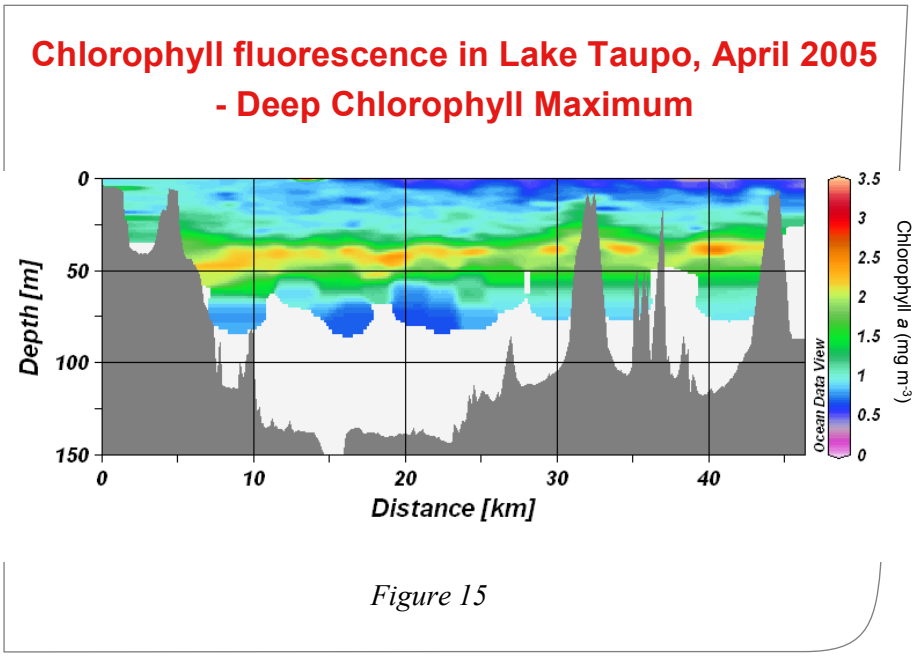


Figure 15

Figure 15 shows a transect across Lake Taupo with levels of chlorophyll of up to 3.5 (equating approximately to levels in μg L^{-1}). There is a high density of chlorophyll or algal biomass situated nearly 40-45 metres below the surface in Lake Taupo. The algae can obtain sufficient light to be productive and would otherwise not do very well in surface waters which are especially nutrient-poor. Therefore there is a balance in the depth distribution of algae, with nutrients coming from below versus light coming from above.

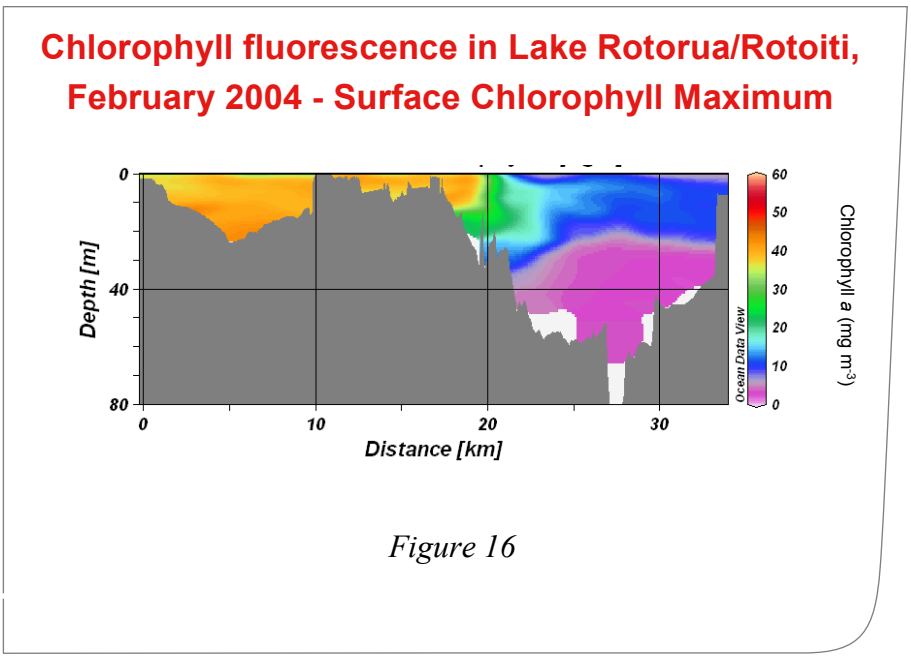


Figure 16

Figure 16 shows in the case of lakes Rotoiti and Rotorua, the scale is 0 to 60 (μg L^{-1}), with very high algal levels in Lake Rotorua and lower levels in Lake Rotoiti, and no deep chlorophyll maximum in this lake, which contrasts sharply with the case of Lake Taupo. In Lake Rotoiti, nutrients are much higher in surface waters and the deep chlorophyll maximum is being shaded by the higher algal levels in surface waters.

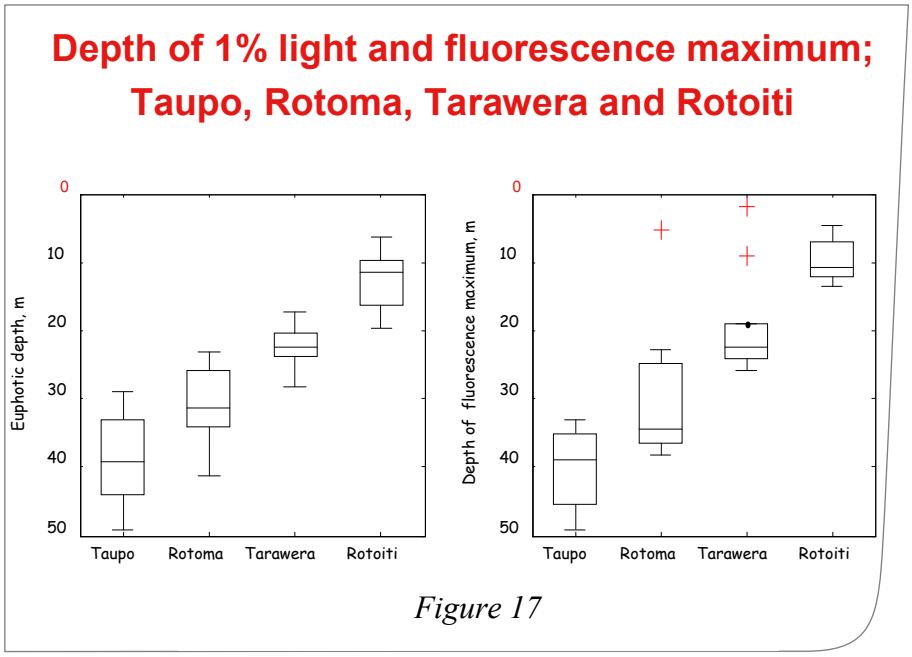
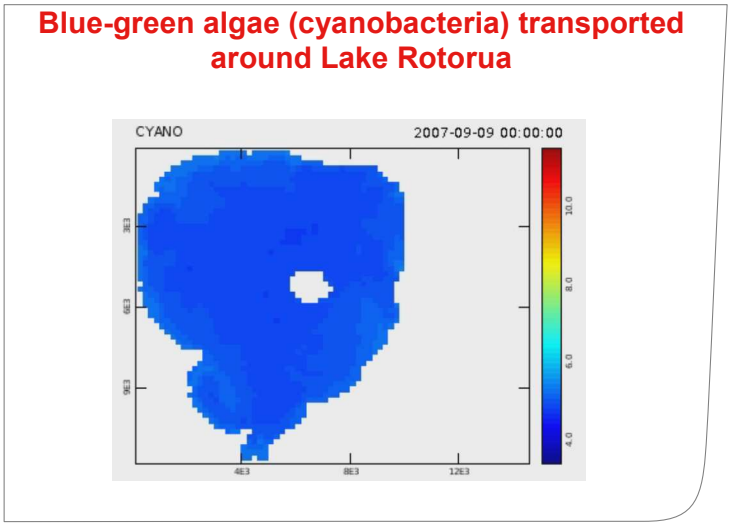


Figure 17

Figure 17 shows there is a very good relationship between the depth of the maximum chlorophyll in Taupo, i.e., below 40 metres, Rotoma a little bit shallower, then Tarawera and eventually Rotoiti where the depth maximum of chlorophyll levels are close to the surface. The depth of the 1% right level corresponds very closely to the depth of the maximum biomass in each of the lakes. So the clarity of these waters is absolutely integral to the distribution of algae.



Dennis Trolle, Post-doctoral fellow

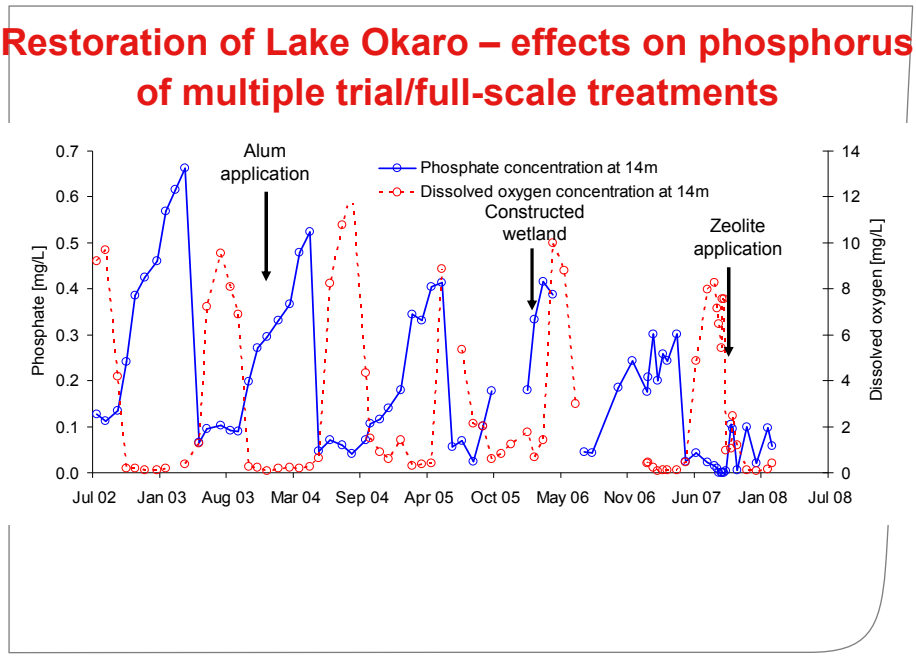
Figure 18

Figure 18 The greater the concentration of nutrients, the more algae grow near the surface, the lower the water clarity and the greater the likelihood that there will be high levels of buoyant blue-green. These blue-green algae tend to be transported by surface currents into shoreline regions and so are often important influences in the perception that people have of water quality. Many people will remember prolific blooms of *Anabaena planktonica* in 2004, especially in Lake Rotoiti. This species was very buoyant and often reached very high concentrations in bays and confined areas of the lake. More recently *Aphanocapsa* has been the dominant species, which has extremely small cells compared with *Anabaena planktonica.* Despite the fact that cell counts of *Aphanocapsa* have at times been very high, the water has often been clear, because the cells are so small.

Scientifically, one of the interesting things has been what has driven this phytoplankton species over the past three or four years. *Daphnia dentifera* is a North American invasive zooplankton which was first detected in the Waikato River around 2000 and is now turning up in many of the Rotorua lakes. It is possible that this invasive species may have had an impact in grazing on larger cells as opposed to the much smaller cells of *Aphanocapsa*.

My talk ends with a consideration of some of the management options – mostly for those who were not on the field trip. We have a long-term issue in the basin of Rotorua with increased nitrogen loads as the groundwater begins to reflect the prevailing land use. The Ohau Channel diversion was mooted some time ago as a means to prevent water from Rotorua travelling into the main basin to Rotoiti. Approximately 5 m^3 s^{-1} is a residual flow out of Lake Rotoiti as a result of inflows from the local Rotoiti catchment. With construction of the wall around 16 m^3 s^{-1} goes from Lake Rotorua directly towards the outflow of the Kaituna River.

Another very active research area involving collaborations between Environment Bay of Plenty, NIWA, Scion and ourselves is the examination of potential impacts of various types of nutrient-locking materials on the lakes. A modified zeolite system has been developed by Scion and a PhD student, Deniz Oezkundakci, has examined the impacts of the application on the water chemistry and sediments of Lake Okaro.



Deniz Oezkundakci, Ph.D. student

Figure 19

There have been multiple treatments to Lake Okaro including a constructed wetland and an earlier alum application, which collectively makes it difficult to isolate any one treatment. (*Figure 19)* However, phosphorus concentrations in the bottom waters have declined progressively over the past five to six years. The modified zeolite application seems to have decreased phosphorus levels substantially over the past year. The next potential extrapolation is to Lake Rotorua, with an area of 80 km^2.

A statement made by Morgan Williams, the Parliamentary Commissioner for the Environment in April 2006 said that restoring the Rotorua lakes was the ultimate endurance challenge, mostly because of the store of nutrients associated with the old age groundwater. It is possible to extend this statement a little more globally to say that restoration is the ultimate endurance challenge for society currently, and that the options

for restoration are very expensive options once an ecosystem has been strongly degraded.

Oxygen is the key life force and also an excellent indicator of the health of a lake. Therefore, the major messages are -

- Early interventions are much less expensive than after major degradation has occurred
- Don't let the lakes asphyxiate!
- The deep chlorophyll maximum is a key indicator, particularly in deep lakes
- Introduced species have and will continue to play an important influence in lake water quality

Finally I would like to acknowledge the team at Waikato University and this talk would not have been possible without the support of these people and organisations. Major funding from Environment Bay of Plenty and the Foundation for Research, Science and Technology and major contribution from Chris McBride, Dennis Trolle, Mat Allen, Deniz Oezkundakci, Liancong Luo, Austin Zhang, Paul White, Warwick Silvester, Wendy Paul, Susie Wood and Craig Cary.
Web: www.lernz.co.nz

Thank you.

NUTRIENT GENERATION FROM THE LAND – HOW BEST ARE THEY MEASURED AND MANAGED?

Dr Stewart Ledgard
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Stewart is the Principal Scientist at AgResearch's Ruakura Research Centre in Hamilton and the New Zealand representative on the Agricultural Working Group of the UK Carbon Trust. He has been working on the nitrogen cycle on the land for nearly thirty years. One of his key focuses in research is developing new technologies and management practices for use on farms to enable an increase in nitrogen efficiency by converting more into products going out the gate at the same time allowing less to leach into our waterways or to enter the atmosphere as a greenhouse gas. He was a major instigator of the model OVERSEER.

ABSTRACT

Agriculture is critical for the New Zealand economy but it does lead to some nutrient losses to waterways. Our focus must be on increasing production and environmental efficiency i.e. less nutrient loss per unit of agricultural production. Achieving this requires knowledge of the main determinants of nutrient losses, tools to accurately estimate losses and a range of effective practices to mitigate nutrient losses.

Nitrogen (N) and phosphorus (P) are the two nutrients of concern for water quality. Measurement of N and P losses to waterways is complex, expensive and difficult because of high spatial and temporal variability. The only practical method for farmers to estimate N and P losses from their farm is through use of a simple model, which has been well validated using longer term grazed field trials. The OVERSEER® nutrient budget model is such a model based on research from throughout New Zealand. Key benefits of OVERSEER are that it:

- Is farm specific and is based on readily obtainable farm data
- Is well validated with data from grazing trials
- Includes a wide range of management and mitigation options to enable "what if" analyses.

The latter means that it provides farmers with flexibility in how they achieve N and P loss "caps".

Research has focussed on developing a range of mitigation practices, which cover soil, plant, animal and management options, including:

- Soil – nitrification inhibitors, N & P fertiliser timing and form, reducing soil damage/erosion.
- Plant – selections for increased recovery, lower nutrient concentrations, beneficial constituents.
- Animal – animal type, low nutrient feed supplements, diuretics (e.g. salt).
- Management – wintering off, winter stand off / feed pads.

Farmer group analyses have highlighted that optimum mitigation practices vary between individual farmers. Uptake of mitigation technologies by farmers depends on economics and the fit with their farm systems.

TRANSCRIPT

This talk focuses on the land and issues around measurement of nutrient losses and the management or mitigation of those losses. Agriculture is critical to the economy. Next year it is predicted that it will top 20 billion dollars in terms of its contribution to New Zealand. But as we have heard from many of the speakers so far, agriculture contributes to nutrient losses to water.

Most of the focus of my talk will be on nitrogen and occasionally on phosphorus. Research on measurement of nutrient loss in different systems has shown the magnitude of losses particularly with leaching of nitrogen from land. Annual leaching starts with low levels in forest systems of about 2 kgN per hectare, through increasing intensity of land use systems up to numbers often exceeding 200 kgN per hectare from some of our intensive vegetable growing, in Pukekohe for example. Of course within any one of these there is quite a wide variation in the magnitude of loss.

I would like to cover five areas. Firstly about the measurements of nutrient losses; then comment on modelling which is one of the main aspects I have been asked to talk about; then move to management and mitigation options, some of which are currently available; the importance of local research; and then end with issues around the effects of adoption of mitigation practices by farmers.

There are a range of methods for measuring nutrient losses and basically they focus on surface run off which is the main route of phosphorus loss. With nutrients that leach down through soil, nitrogen in particular, losses are lower in poorly drained soils but increase if they have mole and tile drains. When it comes to the free draining soils which are basically almost all those soils around the Rotorua lakes and around Lake Taupo, we really have to focus on different methods. In *Figure 1* there are two main methods used, one involving lysimeters, which are basically just large cores of soil. These are either kept within pastoral systems and used directly, or collected, moved and treatment applied. The other method that is widely used is porous ceramic cups. These small porous cups are typically buried about a metre deep in the soil and regular samples are taken of soil water as it moves down through the profile beyond that of the plant roots towards ground water.

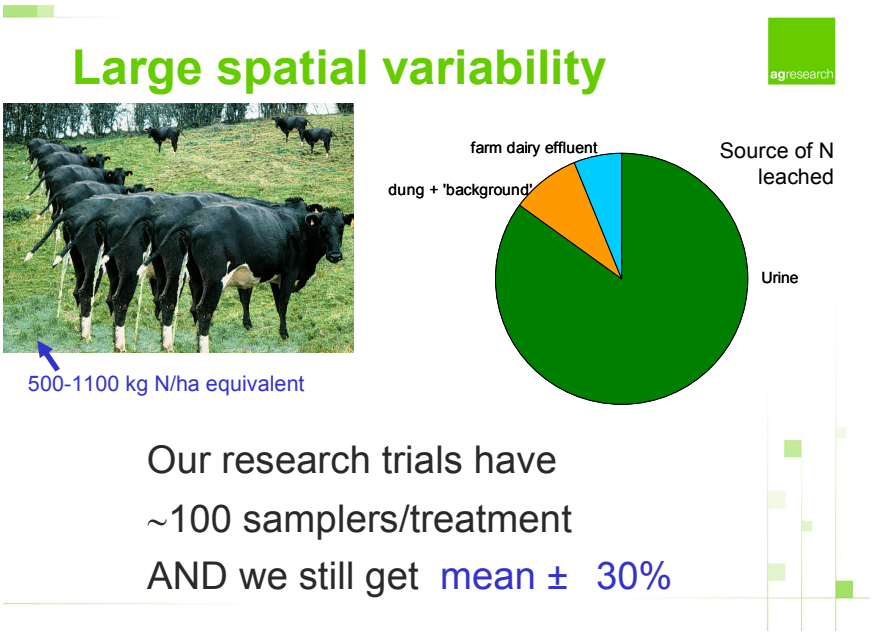


Figure 2

One of the issues in terms of the difficulty of effectively measuring nutrient losses is large spatial variability. In the case of nitrogen, animal urine patches, in particular, have very high rates of localised return of nitrogen. (*Figure 2*) It is important that we keep an accurate estimate of the effects of this. In grazing systems we quantify the relative sources of nitrogen that contribute to leaching and in virtually all the studies it is dominated by animal urine, with others such as farm dairy effluent, dung and background N. Fertiliser N if applied inappropriately, or during winter periods, can also contribute to some extent to direct loss. So consequently if we look at the spatial variability from urine and the localised sampling area with the porous cups it means that most of the research trials have had in the order of 100 samplers for every treatment. Even then with regular sampling to get data over time, there is something like a 30% standard deviation.

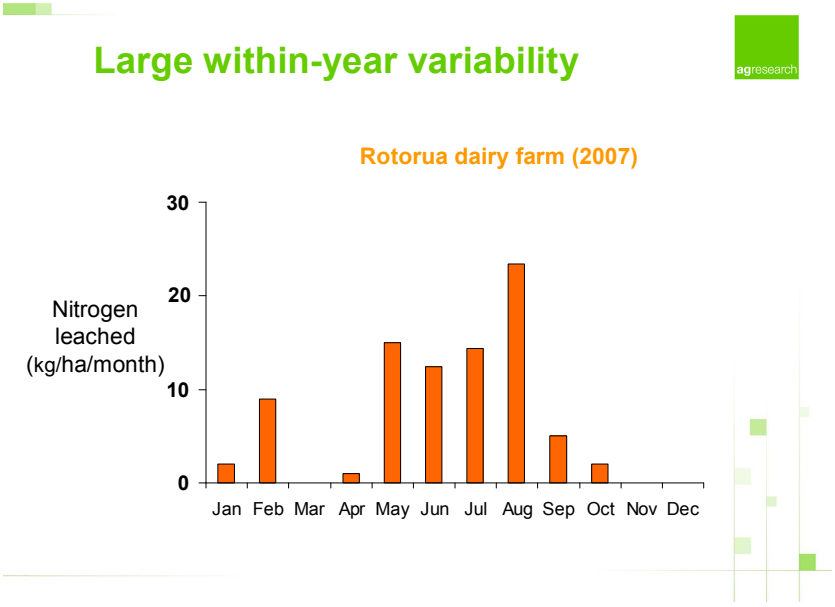


Figure 3

There is also temporal variability within a year. *Figure 3* is an example of data from a Rotorua dairy farm which I will refer to several times, showing the amounts of nitrogen that are lost on a per monthly basis. Many studies around the country are dominated by winter leaching when soils are wet and drainage occurs. But you can sometimes get events with very wet conditions, such as in this case in February, where there were also significant losses of nitrogen. However, probably the more difficult variability to deal with, and why there has been an interest in using models to look at nitrogen and other nutrient losses, is the large variability that occurs between years. *(Figure 4)*

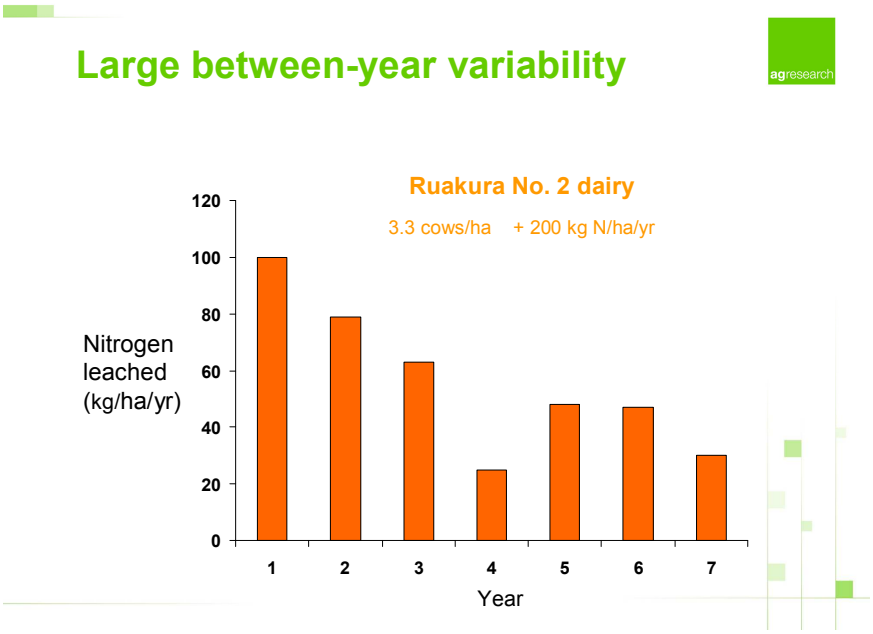


Figure 4

This is one example of a site where we measured nitrogen leaching over 7 years in a constant system that has been under the same stocking rate and inputs for quite a long period of time showing large yearly variability. In fact another site near this with no nitrogen fertiliser use also showed about a five-fold variation; so it can not be attributed to the fertiliser. Some of the variation was caused by rainfall differences, for example in the first two years of the study there were very wet winter conditions and very high drainage which contributed to this high loss.

Sometimes we get a question like – "why don't we put samplers on farms and directly measure the magnitude of loss?" Well firstly, to get a good estimate of the amount lost or the average annual amount, we would need a long period of time of measurement. Then if we were to change our management practice and try and measure what the effect of this might be; the high variability would clearly make it extremely difficult to quantify effects of changes over time just by measurement within a site; and in fact decadal type measurements would really be required.

That is the reason why there has been a shift towards using detailed measurements that are critical in terms of getting good base information, but having models that are able to predict losses. The model needs to represent the key drivers of the losses that I mentioned earlier. If we look at a simplification of the components that are within the OVERSEER nutrient budget model, (*Figure 5)* it shows the main sources that contribute towards nitrogen leaching. These are urine, in particular, but also farm dairy effluent, some direct leaching of fertiliser N and also indirect leaching. The model itself is determined to a large extent on accurately estimating these components by providing a good estimate of pasture intake by animals, excretion and their partitioning of excreta-N between dung and urine. When we have a good estimate of the sources, the magnitude of leaching from these sources is altered by the main driving factors. These are things like soil texture, drainage, rainfall, development, animal type and winter management.

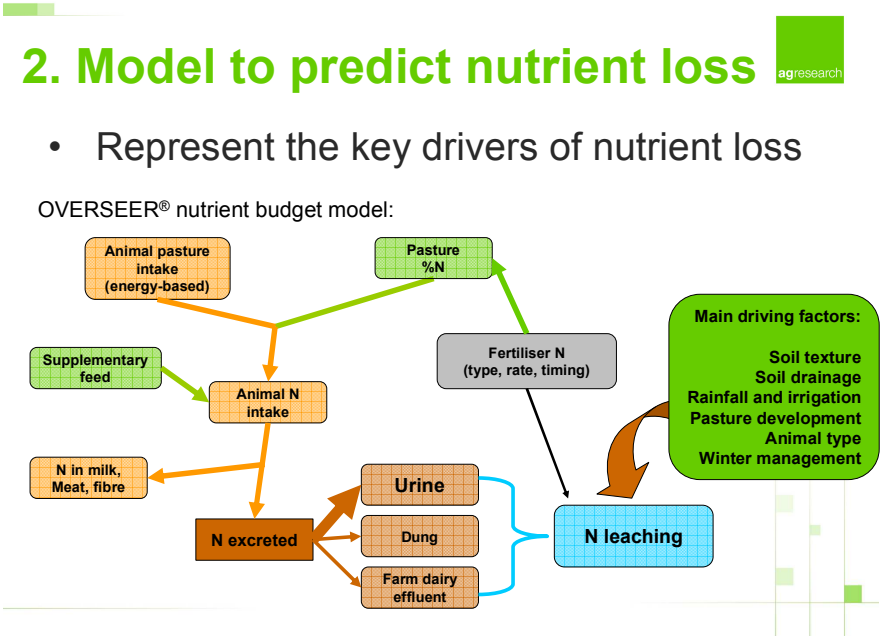


Figure 5

OVERSEER is the most widely used nutrient model in New Zealand, and based on a summary of a lot of New Zealand research, in particular, but also overseas research. The model owners are MAF, AgResearch and FertResearch, and there is a strong commitment from them – in fact $1 million a year over the next 5 years - for regular development and updating of this base model as more research becomes available and for integrating new management and mitigation practices into the model.

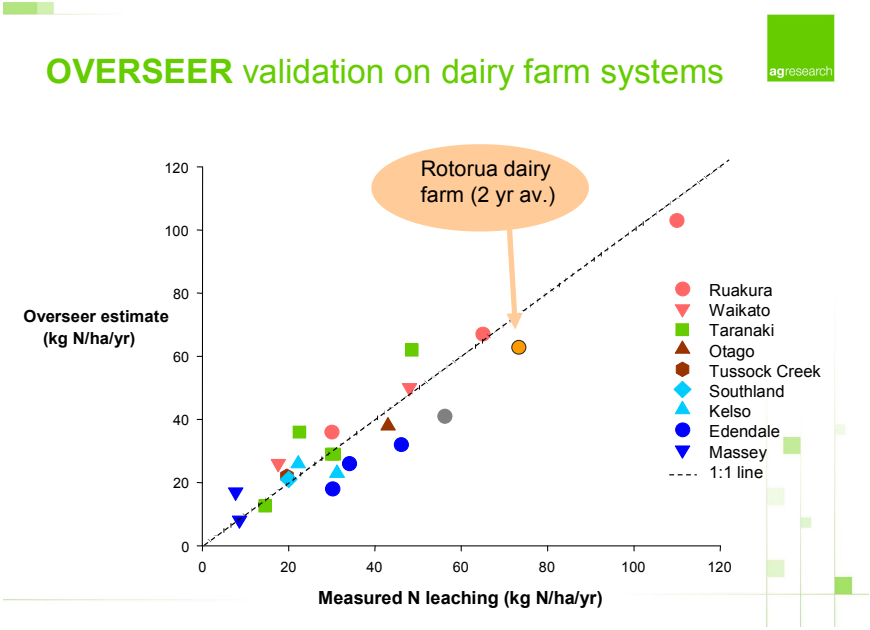


Figure 6

The latest version which has recently been released has included addition of the nitrification inhibitor DCD, wetlands, riparian areas and greenhouse gas emissions. The other key thing with any model is that it is adequately validated; and if we look at the data that has been collected in *Figure 6;* it shows the sum of all the published longer term dairy

farm system studies that have been carried out in New Zealand. This covers a range of sites from one end of the country to the other; and the one to one line for measured versus model estimates shows a highly significant relationship between them.

Each point on this graph represents an average for a number of years actually studied. To put a local Rotorua site in here, a study which only had 2 full years of data, carried out on a commercial dairy farm was also within 15% of that one-to-one line.

The key aspect of the model is the fact that it covers a range of management options and mitigation practices for the farmer. It allows the ability to do "what if" type scenario calculations to look at the effects of changes in management or mitigation practices on farms. Because of this it allows some flexibility in how a nutrient target or cap might be achieved. I believe this is one of the important reasons that it is being used as a tool in the Variation to the Regional Plan around Lake Taupo.

The other point is that this approach is more in keeping with New Zealand's Resource Management Act and the flexibility intended in how a cap is achieved, rather than looking towards targeting specific inputs, like nitrogen fertiliser as we heard earlier in the case of Denmark.

We have got a reasonable understanding of most of the processes and flows that drive the nitrogen cycle and also of where some of the key inefficiencies occur, shown in *Figure 7*. Therefore we understand where some of the opportunities exist for us to target and improve the efficiency of the nitrogen cycle and reduce total input to the system.

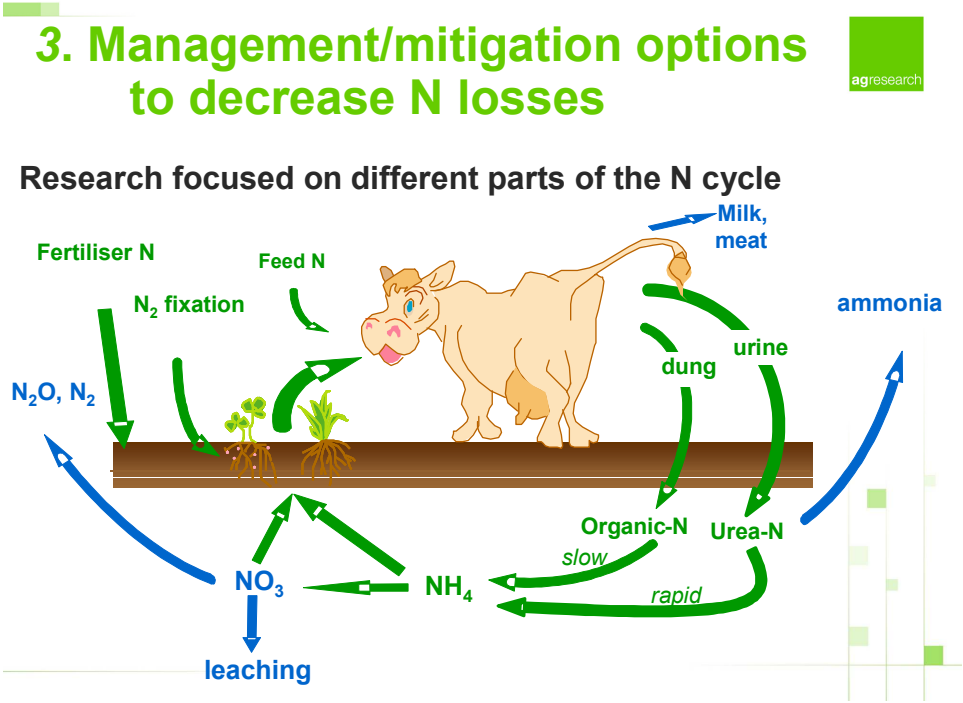
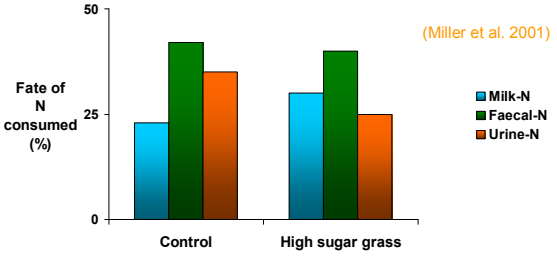


Figure 7

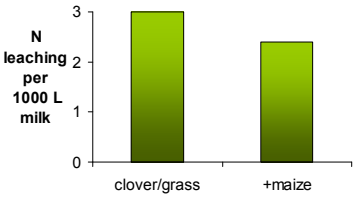
I would like to pick three examples of different parts of the nitrogen cycle. The first one is altering the composition of the diet. (*Figure 8*) There is research going on in different aspects of plant composition; with two fairly new areas being sugars and tannins. Some work out of Wales has led to the first high sugar ryegrasses and they have shown to result in increased retention of the nitrogen consumed by the animals in products and relatively less in the high risk urinary nitrogen output, which in principle means an increased efficiency of nitrogen cycling. This has just started to go into field testing in New Zealand. *Figure 8*

i. Altering diet composition

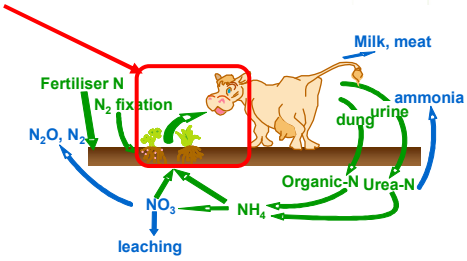
i. Increased sugars or tannins



ii. Optimised N concentration



(Ledgard et al. 2006)



The other way in which farmers can target leaching is by looking at the nitrogen concentration in the pasture. It is well recognised that pastures have higher levels of nitrogen than animals require. An option is either to develop plants that have more optimal nitrogen levels for animal production, or to add low protein feeds such as maize to the diet. This is just one example where maize was added to a clover based pasture system. It lowered the nitrogen concentration in the diet and resulted in a reduction of around 20% in terms of the amount leached per 1,000 litres of milk produced.

Another area is the back end of the cow. We know that this high localised rate of nitrogen in urine is an issue. One of the mitigations currently being looked at is diuretics such as salt; particularly since salt or sodium levels are actually low in quite a lot of this country anyway. (*Figure 9*) These results were from a cow feeding study where there were different levels of salt supplemented through drenching. This was associated with an increase in water consumption, increase in urine output, number of urinations, and lower nitrogen concentrations therefore equating to a greater spread of urine with lower N levels. This means more likelihood for the grass to take up nitrogen and cycle it rather than it being lost.

The other option of course is to just use the natural variation that exists between animals. Around Taupo, a farm system study compared animals of different types given the same levels of feeding and same intake. This showed that the amount of nitrate leached from beef cows was about twice that from sheep and deer with the same level of nitrogen intake. That is largely due to greater spread of urinary nitrogen from sheep and deer.

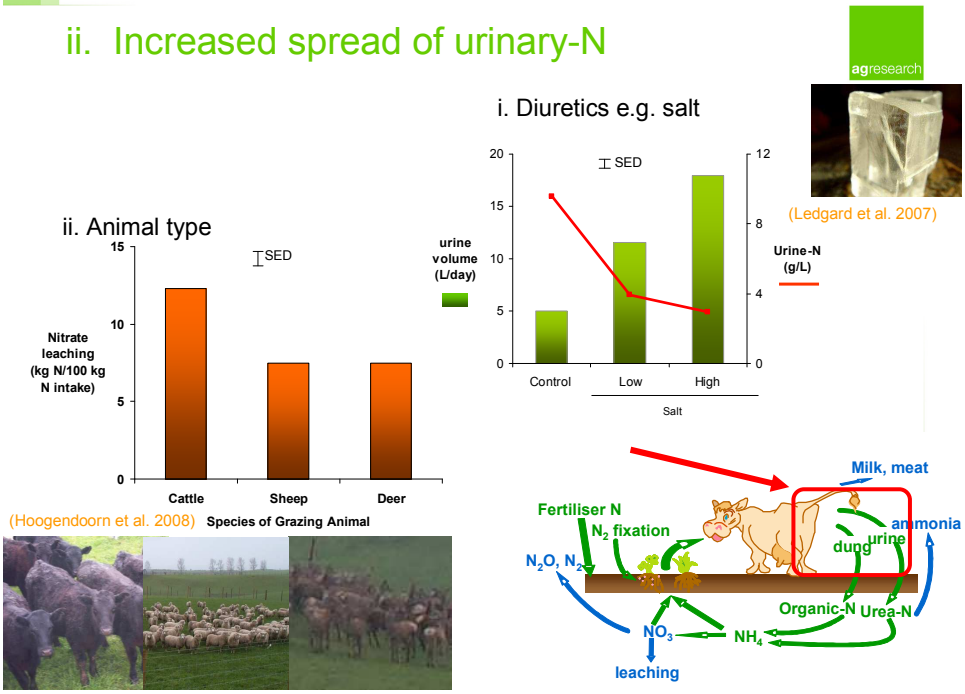


Figure 9

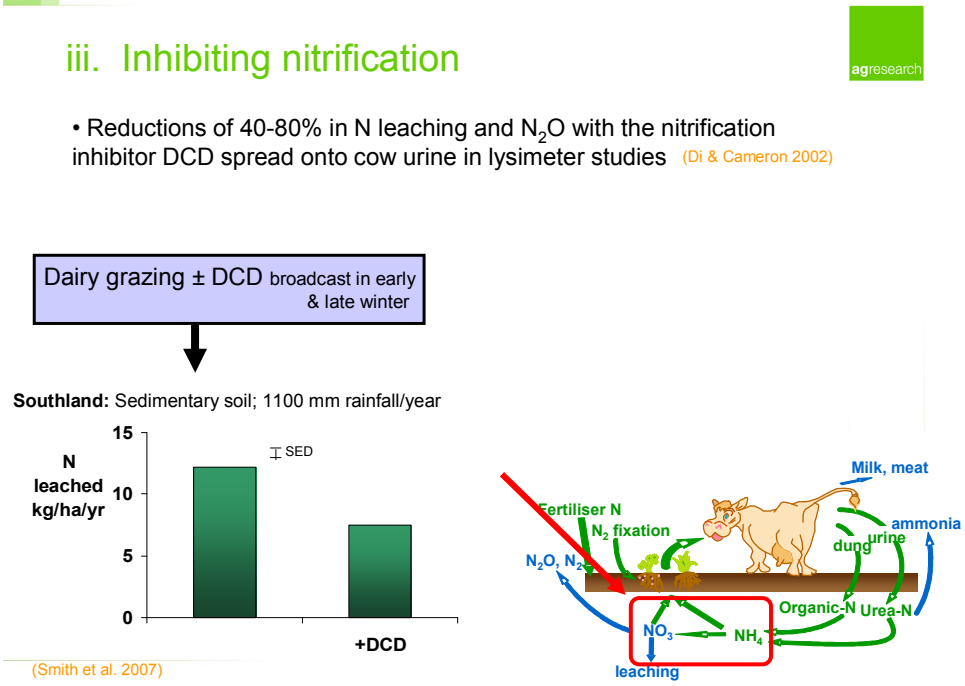


Figure 10

The last one I would like to mention focuses on soil management and the process of nitrification or the conversion of ammonium through to nitrate in the soil. (*Figure 10*) Ammonium is relatively immobile, but readily taken up by plants so it is more efficiently used than nitrate which is readily leached and also contributes to nitrous oxide emissions. Research using lysimeter studies at Lincoln University have shown reductions in the order of 40-80% in terms of nitrogen leaching losses from use of the nitrification inhibitor DCD. This has now gone into a number of grazing system studies around the country. This is just one example in Southland where the dairying system has a low leaching loss environment and DCD gave a 40% reduction in leaching over three years of measurements.

One of the questions, of course, when data like this is presented to farmers at field days in this area or around Taupo, they say "it's all very well if there's low rainfall and different soils at the other end of the country, so what does that mean here?" Local research is critical in terms of a number of areas. Firstly in terms of understanding the drivers of loss, and the assessment of the magnitude of losses that occurs from local farm systems. Secondly, for assessment of whether some mitigation practices actually work in the local environment.

About three years ago a Sustainable Farming Fund project was initiated by Rotorua Lakes Land & Trust with key representatives from Ngati Whakaue and also from the local branch of Federated Farmers. This involved a number of on farm and field studies. One of the first parts of this was a workshop which involved getting farmers together and asking them what key things were important to look at in their environment in terms of options for mitigating losses. One of the main ones suggested was nitrification inhibitors in this particular environment. This was incorporated into a dairy system study on a farm just northeast of here. This had two full years, and three winters, of measurement of leaching loss, and showed a 20% decrease in nitrogen leaching where it was used. That reduced nitrogen loss, and led to more nitrogen remaining in the soil which was associated with a small increase in pasture production. When that was factored into some modelling it was indicated that it could just cover the cost of application.

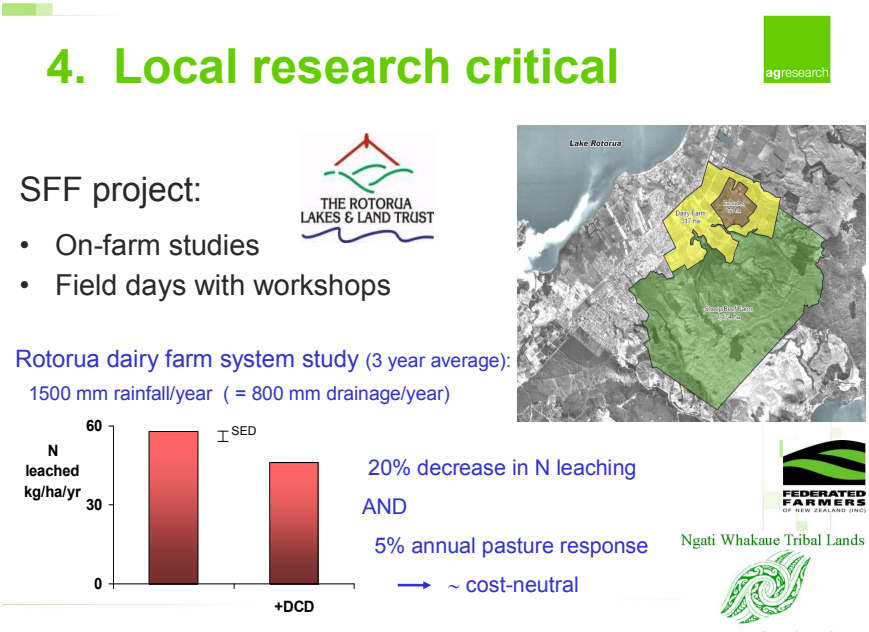


Figure 11

This local site has about 1500 mm of rainfall, or around 800 mm of drainage per year, and at the field days we had questions like "I live up near the Mamakus which has rainfall at

least half as much as that again, so what does that mean?" So again we have a situation where despite local research we need to be able to account for differences between site factors and losses. We return to the importance of models for accounting for this.

If we look at the recent addition of the nitrification inhibitor DCD into the OVERSEER model, this was based on a review of work that was carried out around New Zealand. It covered a range of soils, rainfall and management practices. One of the points identified is that its effectiveness is actually quite strongly dependant on the level of rainfall and drainage. While it might be seen as a bit conservative, the model would suggest that DCD is basically ineffective where drainage is above 1,000 mm per year or 1,750 mm of rainfall. BUT we need to be able to account for variability in site factors.

I would like to briefly comment on another local project that was carried out here which involved 26 dairy farmers around Lake Rotorua, with involvement from Dairy Insight and Fonterra contributing key parts to running this project. For each farm we modelled their farm situation using OVERSEER in terms of nutrient flows and UDDER which is basically a production and economic model. We then set a base farm situation and tested a range of options that they could look at in terms of management or mitigation practices, and we looked at effects on leaching, production and economics.

The focus initially was on what practices they could use which would be seen as having little cost and possibly even some increase in profitability. These included factors like increasing the effluent area for land application, no nitrogen fertiliser on the effluent areas, no nitrogen applied in winter, and increased levels of wintering off of cows from the farm. Most of the farms already do some level of wintering off. The study showed that on average across all of those farms a reduction in leaching of around 12% was possible but this varied a lot between individual farms. There were a couple of farms that were already doing all of these things very well at an optimal level where there was nothing that could be done to reduce leaching at little cost.

This was somewhat different to the target that Environment Bay of Plenty have mentioned for Lake Rotorua from their modelling information with NIWA and their targeted reduction for pastoral land being over 30%. We looked at a range of options and practices that might be able to get down towards that sort of level of reduction, but significant costs started to occur to meet those goals.

I guess that is a key part of what this Symposium is about. It is about recognising that agriculture has a contribution; that to meet some of these strong targets there is a cost needed to achieve this and how is this most efficiently and equitably achieved.

A project which looked at adoption of nitrogen mitigation practices and involved sheep and beef farmers around Lake Taupo used the method of multiple criteria decision making. It is a methodology to look at some of the factors that affect farmers' decision making in terms of taking up different practices. *Figure 12* shows that basically A through to F represented a range of land uses or management options with one being a typical sheep and beef farm, and others included implementing mitigation practices, changing land use, integrating forestry and so on. All farmers were presented with information on the effects of those practices on leaching losses and on economics. Basically this slide shows the contributions from the different criteria to their decision making. For any one of these you will see there is a range of different colours which represent a range of criteria. Only three of those represent economic factors; the rest of them were factors such as risk, lifestyle, complexity, skills needed and some environmental indicators. The importance of these criteria varied between individuals.

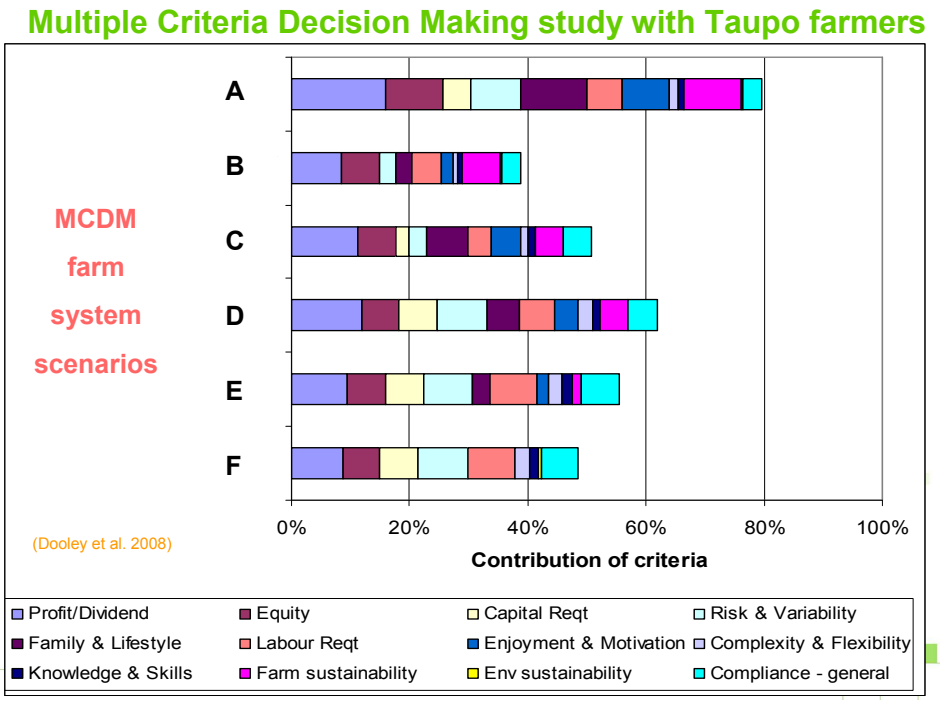


Figure 11

In conclusion, nutrient loss measurement is complex and shows very high variability. A model is valuable to account for farm and site specific factors. Models need to be well validated and able to reflect the scenarios for farm systems. There are a range of nitrogen mitigation options that are currently available and in the process of being developed. Some reduction in leaching is possible at little to no cost on some farms. Large reduction targets can be costly to meet. We have to bear in mind when we wish to get uptake of nitrogen mitigation practices, that these depend on economic and also on non-economic criteria and that there is large variability between individuals.

QUESTIONS

Brentleigh Bond, LWQS: Can we have intensive agriculture and clean lakes?

Stewart Ledgard: Potentially, but it depends – on the sensitivity of the lake, the manageable nutrient loads and the efforts needed by farmers to limit nutrient losses. For Lake Taupo, which is very N-sensitive, it would be extremely difficult to change current farming to very intensive operations without a major effort, and cost, to minimise nitrogen leaching.

Rowland Burdon - Royal Society of New Zealand: You mentioned the results from a local study estimating a 12% drop in nitrogen leaching, but that was a relatively short term figure. On the other hand you have results indicating that you have very long lead times for nitrogen leaching responses to land use change. Now how do you square those two configurations?

Stewart Ledgard: The information that I presented related to current nitrogen leaching from existing dairy farm systems around Lake Rotorua. That is for nitrogen leaching below plant roots and moving down through soil, eventually reaching groundwater. The 12% reduction figure was a calculated average for nitrogen leaching down from surface soil from changing to some new management practices. You're right in that what is coming out of groundwater to streams and into the lake represents the nitrogen leached

from land due to practices in the past, in some cases 50 or so years ago. The difference is simply time lags. It can take a long time for currently-leached nitrogen to make it down to deep groundwater. This means that making changes now will take time for these to work through to reduced levels in groundwater and in water entering the lake.

Warwick Silvester, University of Waikato: You showed about 60% of the nitrogen lost in the 4-5 winter months, why can't we get better than 12?

Stewart Ledgard: Due to cold winter conditions, most dairy farmers actually graze their cows off the farm during winter and are therefore already capturing the benefit of avoiding excreta deposition in winter. In some cases there is potential to increase this with all cows off for longer periods. Hence a lower reduction than that measured in studies where cows were on farms all winter. One thing that I will add, which is important in considering mitigation options, is that they are not simply additive. For example, nitrification inhibitor used to reduce leaching of excreta in winter will be of limited value if cows are grazed off to avoid excreta deposition in winter. These practices are targeting the same nitrogen source.

Bill Vant – Environment Waikato: I'm wondering whether I'm hearing mixed messages about the importance of nutrients and whether we need to debate nitrogen and phosphorus. Eric told us we shouldn't be because both are important. David talked about Berger's work which suggested contrary to what we thought in the past, phosphorus might actually be more important than nitrogen in the Rotorua system. Mark talked about nutrient saturated systems and we probably shouldn't have to worry about nutrients any longer. Given the predicted increase of large amounts of nitrogen coming into central organic plateau lakes, Rotorua for example, how important actually is it? Should we really be concerned about the load of nitrogen to come?

David Hamilton: I think that Eric summed it up beautifully – it is nitrogen and phosphorus. If you want to compare lakes of Europe where you have 10mg per litre sometimes of nitrate in the surface waters in winter; we are probably closer to 10mcg per litre; a thousandfold difference sometimes. So in terms of nitrogen we have a long way to catch up. I think it would be a very dangerous ploy to say forget about nitrogen. We have already seen this in Europe and it is absolutely integral to their nutrient management strategy.

Marc Schallenberg: About the nitrogen/phosphorus balance. Sometimes, we get a phosphorus limitation, sometimes nitrogen limitation, sometimes both and sometimes none in the same system. So it is temporarily dependent but it is also dependent on the kind of nutrient abuse the system has had too. For example, if it has had a sewage input that has been really high in phosphorus, that might make it more likely to be nitrogen limited. But in general plants need both of these nutrients. ITo focus on one only could be a mistake, unless you have really good evidence that it is one in particular consistently in that system.

I would also just like to clarify about nutrient saturated systems. I certainly do not want to leave the impression that we do not need to worry about those. Those are the ones that I think we DO need to look at in terms of restoration. Those are the ones that we find really distasteful and are often toxic and I think those are the ones that we have put so much nutrient into them that they are not responding to additional nutrient load. They have so much that the systems are pretty much not useful to humans or to wildlife anymore. So just because I say nutrient saturation doesn't mean I do not think we need to look at that in terms of restoration.

Hailong Wang - Scion: I have a question for Stewart. When you talk about the leaching from the same area, over different years varying greatly from about 20 to 100 kg of

nitrogen per hectare per year. What do you think is the main factor for such a huge variation?

Stewart Ledgard: I alluded to the fact that the highest nitrogen leaching year did coincide with a very wet winter with very high drainage, so the average drainage to that site was about 500 mm per year; that first year happened to be about 800-900 mm. That is one factor, but certainly not the only factor. We looked at correlations with a whole lot of different potential contributors and we were not able to get very good predictions overall, apart from variation in drainage between years. Other factors include climatic conditions prior to winter leaching, carry over of nitrogen in soil between years and timing of grazings relative to the period of drainage. Basically there are a range of factors, not just one simple one, although the amount of annual rainfall and associated drainage is quite an important factor.

Mike Barton, Taupo Lake Care Inc: I am a capped farmer: one of the first farms in the country to be capped in Lake Taupo. Our farm is the site of one of Stewart's research projects. I would like to focus on the issue of science and economic modelling. At your respective universities and within AgResearch, is there any work being done that balances your work on nutrient losses and the impact of nutrient management with the economics of this issue. It seems to me that as a capped farmer we presented evidence to the Environment Court that shows that over the next 10 years we are unlikely to survive financially because we have basically a capped income and uncapped costs. Is there any chance of seeing your good work carried out in tandem with economic modelling so that we are, as a nation, able to look at the choices associated with each of these issues?

David Hamilton: Kit Rutherford is probably the best here to comment. He has been working with Susie Kerr from MOTU and they have been doing economic assessments of the value of nutrient trading and other economic instruments for evaluating lake water quality as much as anything. Environment Bay of Plenty commissioned Brian Bell & Associates who put out two reports roughly 3 years ago relating to general assessments of the value of the lake, and that work is very much ongoing. It is one that we also want to progress using some of our models to link in with which has predicted water quality and the link ultimately with land use change.

Marc Schallenberg: I think that is a very good question and I sympathise with your situation. But I go around telling people at the Otago Regional Council that we need to start putting economic values on ecosystem services, which has been overlooked through most of what has been going on. I am trying to adjust the balance in favour of the ecosystem services side of things, which does not help your situation. I do not think we can ignore such things as what services wetlands perform in removing nutrients from water, and the value of recreational services and cultural values, things like that. There is a really interesting and important debate to be had around this area and how we put the true economic value around these things.

Stewart Ledgard: There are three levels of work that we have been involved with. Most of the mitigation practices that I mentioned earlier have had some relatively simple economic modelling, like gross margin analysis. The project with the local dairy farmers here included an evaluation over a ten year time frame and looking at the effects of increasing costs in a capped system, and assuming constant price of product because there is a lot of variability in that over time. This basically reiterated the point you made that the margins are going to become less over time as input costs go up.

The third area is a higher level FRST research project by Liz Wedderburn and others on the whole community including impacts on dollars flowing through the community and the implications of a capped environment and what they are willing to bear in terms of implementing changes.

Session Three – New Zealand Environmental Policy and Law

INTRODUCTION

John Green: The Chair would like to recognise John Keaney. John has been a County Councillor for three years, he was a County Chairman for four and a half years, he was Chairman of Rotorua District Council for thirteen and a half years and he was Chairman of Environment Bay of Plenty for six years. That is twenty-seven years of public service. John is a Life Member of LakesWater Quality Society and it is wonderful to see you here today, John - thanks for coming.

Paul Dell, Chair of this Session, is well known to us all. He has worked in the environmental management field in Waikato and the Bay of Plenty for over twenty-seven years. With his considerable skills and experience he championed much of the Rotorua Lakes & Restoration Programme that we now have in place today. He is currently Environmental Policy and Monitoring Officer for the Whangarei District Council.

SESSION CHAIR: Paul Dell

I would like to say it is wonderful to be here and see such a huge turnout to another well run and well thought about conference by LakesWater Quality Society. So congratulations to them.

NATIONAL POLICY STATEMENT ON FRESH WATER MANAGEMENT

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Guy is a third-generation conservationist and co-founder of the Native Forests Action Council in 1975. He led the Native Forest Conservation Movement in many campaign successes and latterly he has focused on the challenge of integrating economic and environmental perspectives in decision-making. He has worked as an environmental policy specialist in consulting, policy advice and research roles. He has worked closely with business on environmental projects especially in the fishing, agri-food and waste management industries. He is the Chief Executive of the Ecologic Foundation.

ABSTRACT

The Resource Management Act, enacted in 1991, empowers regional councils to control diffuse source water pollution arising from land use practices. Over the seventeen years since, land use practices have rapidly intensified, but most regional councils have done little or nothing about the problem. New Zealand's latest *State of the Environment Report* confirmed that aspects of water quality are getting worse in areas that are dominated by intensive land use.

In 2003, the Government announced a *Sustainable Water Programme of Action* that would look at "how we can reduce or mitigate the negative impacts of land use on freshwater quality." Projected outputs for the 2004-5 financial year included a National Policy Statement (NPS). Almost five years after the Programme of Action began, we are still waiting for the first draft of the NPS. This is now expected to be released for public comment by the end of July. The purpose of the NPS is to address a governance failure by regional councils. This presentation will look at the nature of the governance failure, and whether the proposed NPS is likely to help.

TRANSCRIPT

Thanks, Paul and good afternoon everyone. A fantastic turnout here and a tribute to the LakesWater Quality Society. I would just like to say that this Society has done a fabulous job in mobilising public concern and building credibility around the cause particularly of these lakes. Having been involved as an environmental campaigner for many years myself I know what a huge amount of work and effort that takes. I would just like to say thank you to the LakesWater Quality Society for what you are doing in this part of the country, which is an inspiration to many groups around New Zealand.

I would also like to say something about Paul Dell; several people commented to me over dinner last night that if it had not been for Paul there would not be a nutrient wall and there would not be Rule 11. Paul shows a lot of other people in regional government around New Zealand that with a bit of energetic leadership things can get done. That is a lesson that many regional councils certainly need to hear.

My job today is really to provide some commentary on the National Policy Statement which was released a couple of weeks ago and which the Minister, Hon. Trevor Mallard, this morning spoke briefly about. I was intrigued of course when Mike Barton got up and asked him a very interesting question, "why did the state owned enterprise Landcorp instead of using its renowned skills in innovative land use in the Taupo catchment, why did it simply sell out of the catchment, wash its hands of the problems and go somewhere else". I do not remember what the Minister's answer was, but I know I thought at that moment, "well that's pretty much what the Minister has done with his National Policy Statement".

I am going to cover briefly the context against which you have to judge this National Policy Statement. Firstly, the performance of regional councils in New Zealand in addressing these issues, and secondly, what the United States and European Union have done. Then I am going to address five main problems with the National Policy Statement and then in my last slide I will briefly address what we can do next.

The problem, of course, that we are addressing here is land use intensification. Our point source discharges to water are largely under control, or are very soon going to be under control. The major obstacle to improving water quality now is the process of land use intensification which, as Morgan Williams demonstrated, has grown enormously over the last twenty years or so. We are not just talking about nutrients, but also the impact of faecal pathogens and sediments on water bodies. This is essentially a property rights issue; we have landowners who are dumping material off the boundaries of their property onto other people's property and we have no rules to prevent this. Consequently the environmental cost is transferred off the balance sheet of the farm business onto the wider community.

Limits have to be set as they are being in Europe and other parts of the world. I would like to think that once the community has set those limits, we would be able to leave it to the farming community to find the best way of responding, because they are the people who have the knowledge of their local conditions and their farms' businesses to make the least cost adaptations to achieve the mandate given to them by the community. But the problem in New Zealand is that we have not set those limits, the community has not spoken.

Looking back at the *Resource Management Act* itself, regional councils clearly have a strong mandate for looking after clean water. It is obviously a prime attribute of any sustainably managed environment worthy of the name. Public opinion surveys done by Environment Waikato and Lincoln University over many years have highlighted this as the top priority expectation which the public has of regional councils. Since 1991 the *Resource Management Act* under Section 15 has set out a presumption that all water

uses will be controlled. That is the opposite presumption from what the Act says about land use. With land use you can do what you like as long as it does not breach a rule in the plan; but with water use you cannot do anything unless you have Resource Consent or you are allowed to do it by a rule in the plan.

Unfortunately most regional councils have reversed that presumption, they have turned it on its head. So when you look through regional plans in the majority of regional councils, activities like stock access to streams, applying fertiliser and farming erodible hill country outside its land use capability, are all permitted uses; often with conditions which, of course, are rarely enforced. So we have no pollution loading limits on our water bodies, no water quality standards that land users must meet; and regional councils over the years have allowed many intensive land uses into many sensitive catchments.

Farmers have taken advantage of that, their capital value has grown enormously, particularly in the last decade since they have intensified the land use. Now when regional councils are suddenly waking up and thinking they ought to do something about it, they find that their failure to set rules has made it very expensive to buy farmers out of what they have done in the meantime. Unfortunately looking over the twenty years since regional councils were first created, we have achieved very little in terms of control on diffused source pollution in this country. The *Sustainable Water Programme of Action* was launched by the Government five years ago with an explicit mandate to address that particular failing.

What do they do in Europe and America? They have a system of decentralised management and this is important. We need to understand the local characteristics of a catchment in the water body and the land uses that impinge on it. But nonetheless the decentralised management is accountable to some national objectives and standards. In the United States the legislation requires water bodies to be fishable and swimmable, and in the European Union they have spent thirty pages defining what they mean by good ecological status. They do allow exceptions because there are some bodies that are going to take a very long time to clean up, or where, for some reason of natural contamination, it is not possible to clean them up. But in Europe and North America the onus is on the polluters to justify those exceptions; and where those exceptions are not justified, then the high water quality standard prevails. There have been some impressive achievements in terms of improving water quality, as we heard this morning in the case of Denmark, for example.

Turning now to the wavy National Policy Statement response to that background context: the first problem in relation to water quality is the very inadequate objective which has been stated –

> *Objective 3: To ensure the progressive enhancement of the overall quality of Freshwater Resources, including actions to ensure appropriate Freshwater Resources can reach or exceed a swimmable standard.*

A very slippery-worded statement – and I put it there. Of course what I reflect when I look at it, is that when kids go exploring their local creek they want the water quality to be of good standard almost anywhere in New Zealand. It is not enough for us to come along and say look, there are a few icons like Lake Taupo or Lake Rotorua and we are going to clean those up, but the rest of the country can be allowed to go sliding downhill. That objective sets up that sort of situation.

A lot of these terms are not defined, we have no definition of what a swimmable standard is, we have no definition of what appropriate means, and when we speak about overall quality that implies that some things are going down while others are going up. It is a very

unsatisfactory objective when you compare with what is in the European Union and the United States.

The second problem is that the onus falls on the communities if they want to get their water cleaned up. Communities that want clean water have to demonstrate that:

(a) Their water bodies are outstanding
(b) The value of these water bodies for community purposes outweighs the economic gain from keeping them polluted.

People like Sandy Hunter, Tangata Whenua of Lake Ellesmere in Canterbury, gets absolutely nothing out of this National Policy Statement that is going to be of any help to her in terms of being able to hold people accountable for the state of that water body.

Summarising the differences between Europe and New Zealand in respect of the leading features of the National Policy Statement,

EUROPE:

- High standards at national/EU level; 2015 deadline is enforceable in the European Court of Justice
- Polluters have to justify any exceptions
- Citizens can rely on State authorities to drive improvement.

NEW ZEALAND UNDER NPS:

- No standards at national level; 2035 deadline has no legal effect
- Communities have to apply for ”outstanding freshwaters” to be restored through their regional council
- Citizens cannot rely on State authorities to protect environment – system depends on local NGOs having more influence than Federated Farmers and Fonterra.

In Europe it is not a question of the community having to do that; and generally speaking, citizens can rely on State authorities to drive forward water quality improvement. I say that having spent much of the last four years studying these very issues in northern Europe.

Our whole Resource Management System depends on local Non-Government Organisations having more influence and persuasive power than Federated Farmers and Fonterra. In most parts of New Zealand that is a big ask.

The third problem with the National Policy Statement is politicised waffle –

- Slippery and politicised language leads to loss of certainty, delay and cost
- “Degraded Freshwater Resources” means those freshwater resources of a region whose notable values have been so degraded by inappropriate land-use development, discharges of contaminants and/or the taking, use, damming or diverting of fresh water as to require that priority be given to enhancement or restoration in order to achieve the purpose of the Act.
- No objective benchmark: just another discretionary political decision
- This is a major problem throughout RMA system.

The tendency to use this slippery politicised language which has the effect of reducing the certainty as to what the regulations mean, thereby creating a lot of discretionary decision-making situations which give rise to unpredictability, uncertainty and of course litigations costs. One will always find a lawyer who will tell you that the language is so vague that it is worth trying an appeal. In the Policy Statement, an example of that is “degraded freshwater resources”. Instead of referring to some standards, it refers to a political

judgement and it gives absolutely no guidance at all except to say that somebody has to decide what a degraded fresh water resource is.

With no objective benchmark, just a discretionary political decision that we can all argue about and we race off to the Court of Appeal trying to find out what it means. Indeed when I think about the Resource Management Act system as a whole, much of the language is too vague; it creates uncertainty, leads to very costly, lengthy and unsatisfactory processes for everyone.

A fourth problem is its cumbersome nature.

- Triggers over 100 plan change processes taking over a decade for little environmental purpose
- Based on extreme localist dogma, even though it is widely agreed more national direction is necessary.

Every regional council has to trigger off a process to change its regional policy statement, then it has to do its regional plan and every territorial authority has to go through a plan change on the district plan as well. That of course will take a decade at the very least and probably much longer, and it will all be done at huge cost but for very little environmental gain, based on the mandate given by this National Policy Statement.

When we question officials at the Ministry for the Environment as to how we ended up with this, one gets a sense of an extreme localist kind of dogma. We cannot blame anything at the national level, we have got to allow local communities to decide what to do. However, that flies in the face of the findings from the research project planning under a co-operative mandate which highlighted and built widespread consensus around the idea that we do need more national direction in our resource management system. It is not working properly without a national direction and I am afraid this statement has failed to provide it.

The fifth and last problem I see with the National Policy Statement are the huge issues that we face as a country relating to water, which it does not even attempt to address.

- Fails to deal with issues of ownership, governance, and allocation – despite overcommitted catchments
- There are big equity issues in privatising water without deciding ownership or charging rent – trading will increasingly force us to face these issues
- A water permit increases the value of Canterbury land by $5,000/hectare – but there is no return to water owners.

This is not addressed and notwithstanding the fact that we have in the South Island a great many catchments that are over-allocated. More than two-thirds of New Zealand will be fully allocated or over-allocated within a decade. These are huge problems coming at us which the National Policy Statement is silent about. There are equity issues here. We are in a process of privatising our water resources, especially in the South Island. If you pour water onto a hectare of land in Canterbury you increase its value by about $5,000 a hectare, so on a typical 200 hectare dairy farm that is a million dollar payment which has been made in effect from the owners of the water to the owners of the land. We are failing to address the equity of that issue. It is not something which is going to remain asleep because as farmers start to trade this water, the value of water will become transparent and the scale of the rip-off from the owners of the water – whoever they are, and you might well have thought it was the public or the Crown or indeed Tangata Whenua. None of these issues look very equitable from whatever ownership perspective you have. We are going to face these issues in the near future but the National Policy Statement fails to do it.

For an overall assessment the National Policy Statement –

- Adds little to the Resource Management Act´s integrated management mandate – which is already widely ignored
- It fails to provide an effective framework for holding land users accountable
- It delays needed actions for yet another decade.
- Hard to imagine a more pathetic outcome after five years of work.

If we can not oblige regional councils to control land use in order to protect water quality because it tells them to do it in the Act, I can not see how the National Policy Statement telling them the same thing is going to take us any further forward.

What can we do next? Well some of us obviously will have to take submissions to the Board of Enquiry. One of the things that we need to be aware of when we face the scale of the issues that we are taking to the Board of Enquiry - this Board is not electorally accountable. It is chaired by a Judge and there is a limited extent to which a Judge can substitute his or her judgement in place of those of an elected politician.

The main agenda for those concerned about water quality in this country is back with the politicians. We have to go back and press for much more significant changes at the national political level. Indeed I believe that this National Policy Statement marks the end of the road for the current system of Resource Management Act governance. It is too slippery, it is too cumbersome, it is too costly and it achieves too few environmental results. I think that is a comment about the National Policy Statement but also about the whole Resource Management Act system as it performs at present. I believe that a clean green country like New Zealand needs to have clear national water quality objectives and standards at least as good as those in the European Union.

I believe also that those polluters that cannot meet the standard should have to apply for some kind of status for protracted polluted water for those water bodies which they insist they can not clean up. Let the onus be on them to explain why they can not meet a national standard, instead of putting the onus on the community to explain why this or that little lake or waterway should be lifted above the rest of the mire.

Funding is going to be a crucial issue if we are to make much progress in restoring water bodies in this country, and we have already seen that with these lakes. It is a much bigger story when we look at lowland streams and waterways and countless other lakes around New Zealand. Where is that money going to come from? One of the things that I would like to happen would be that we might screw our courage to the sticking place and actually charge rent for the use of water in the same way that people charge rent for other resources like land. We would then get a very significant flow of income which could provide the basis for Trusts like the one which has recently been set up for the Waikato River, to exercise some joint Crown/Tangata Whenua governance over the process of spending the money on restoring the quality of waters in our rivers and lakes.

The last thought I would like to leave you with is this: one of the things that Erik Jeppesen did not touch on this morning (and he gave us a wealth of interesting material). When I studied the process of putting those action plans for water in place in Denmark, I found that there had been quite a lot of direct negotiation between farming interests and environmental interests; and that had created a consensus for action which was subsequently taken up by the Danish Parliament. In many cases those action plans were adopted by the Parliament on a completely cross party basis. In other words every political party in the Parliament supported the action plan. Now I would suggest there is something interesting going on there and perhaps rather than sitting around waiting for the Ministry for the Environment to come up with a decent National Policy Statement, we

might do better to sit down with each other – farmers and environmentalists – and try and work out something for ourselves which we could then jointly take to the politicians.

Thank you very much.

REGIONAL COUNCILS HAVE THE TOOLS TO ACT - WAYS OF MANAGING THE EFFECTS OF LAND USE ON WATER AND SOIL QUALITY

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Robert has extensive experience in Local Government having worked in the sector for sixteen years with a focus on water, land, soil and waste management. He is responsible for the Policy and Strategy Group which provides policy advice to the Waikato Regional Council. In this role he has responsibility for the development of the Waikato Regional Policy Statement, Waikato Regional Plan and the Waikato Regional Coastal Plan as well as the overall coastal, natural and physical related strategies.

ASTRACT

Over the past decade our economy has grown on the back of intensifying agriculture, meanwhile, our towns and cities have grown rapidly and demand for rural residential lifestyle blocks has grown. The benefits of these trends have come with a cost that is only now being recognized – declining water quality and soil versatility. In some parts of the country these environmental effects are now impacting on other sectors of the economy as well as treasured community and cultural values. Conflicts over access to natural resources are increasing.

It is the role of Regional Councils under the Local Government Act and the Resource Management Act to address these issues whilst striking the balance between social, cultural, economic and environmental aspirations of our communities and the nation.

This presentation will explore some of the novel public policy solutions that are available to local authorities under existing legislation. Case studies cited will include the Protecting Lake Taupo project, the increasing use of growth management strategies to plan for future urban and peri-urban growth and Environment Waikato's review of its water allocation policies.

Whilst these case studies show that the tools to address the issues are available, their implementation is fraught with difficulty and under current legislation require broad ranging and time consuming consultation. If the nation demands that these issues be addressed more quickly we may have to change our expectations of how decisions regarding natural and physical resources are made.

TRANSCRIPT

Thank you Paul and thank you Guy, this is going to be fun clearly. The wake of all my peers and political masters leaning over my shoulders, I suspect, as I go through this presentation.

I would like to start with some contextual information of the Waikato region –

- 1150 kilometres of coasts
- 20 per cent of North Island
- 1500 lakes, rivers and streams
- 30% of the region's GDP comes from agriculture –
  - 33,000 jobs
  - $1.2 – 2.3 billion per annum
- Generates 50 per cent of New Zealand's dairy production from over 4000 farms

This snapshot identifies key factors that influence how the community of the Waikato will engage with the issues of nutrients in our water bodies. We are a region that lives, works and plays with our water resources and around our water resources. Economically we are reliant upon agriculture for our economic well being and we recognise that we provide a key contribution to the national economy in that regard.

These issues are being played out in the Waikato and of national interest: -

- The role of cultural values in the management of natural and physical resources
- Agriculture and its effects on the environment
- Land use change
- Climate change adaptation
- Energy vs. irrigation vs. community and industrial water supply

As a consequence of this, we are amongst the first regional councils to have to try and use all of the tools in our toolbox. What we have come to learn is that a smart legislative fix or a silver bullet technical solution does not exist and probably never will. In order to confront the challenges we face we need to facilitate a fundamental change in our communities understanding of their relationships with the environment and each other, their rights and obligations as landowners and as members of the broader community. A change process on this scale can be slow and painful.

We have already heard reference to the Treaty Settlement negotiations between the Crown and Waikato Tainui, bringing to the fore the role of cultural values in the management of natural and physical resources. This has not been given due weight in the last twenty years of resource management in this country, and some interesting times are ahead for us.

Clearly the management of agriculture and its affect on the environment is one of our key roles of the Regional Council, and also the management of large scale land use change, which I will allude to later on. I will then look further ahead to climate change adaptation and how we deal with more climate extremes over the coming years. Lastly, but certainly not least, is the little war over access to water between different sectors of the economy, where interestingly the environmental interests are largely silent in the debate.

We will start with something nice – the Waikato River and how it changes along its length and what that might say about us as a community. At Huka Falls the river is crystal clear and thanks to the interventions that we have been making in Lake Taupo will remain so into the future. By the time it gets to Mercer it is a murky green, a soup of sediment from erosion, colour from industrial discharges, nutrient contamination from agriculture, and algae that have grown in the large hydro dams along its length. Where once it took three to four days for a drop of water in Lake Taupo to flow to the mouth of the Waikato it is now in the order of three to four weeks, and all along that time the algae is growing as it sits behind hydro dams.

The Waikato River at Mercer is never going to look like the Waikato River at Huka Falls, and probably never did because of the input from land as it flows down the catchments and soil issues in the Waipa and other areas. However, a headline in The Waikato Times in 2006 read – "*This is the future for the Waikato River - probably in the next 30 to 40 years if something doesn't change in the way we manage the impacts of agriculture.* The reality is that this actual headline is our future if the trends in nutrient inputs to the river are not reversed.

Unfortunately the wider community has not yet fully engaged in responding to this issue and there is a mismatch in expectations in areas such as -

- between farmers and general community
- presumed Private property rights
- public opinion – the rural/urban divide
- market access and reputation not seen as a threat

Our growing understanding of the effect of non point source discharges and their contribution to our water quality problems has forced us to confront a sacred cow, if you would pardon the pun. The way in which a farmer manages his land is none of the communities business. Long held beliefs about the nature of property rights must be considered and re-evaluated critically as we come to increasingly understand how the affects of activities that occur on private land can impact on the rest of the community.

I include the last point as a bogey-man that has been around for a long time in a world where we are told increasingly that being 'green' sells. Market access constraints as a consequence of poor environmental performance has not occurred in New Zealand to date. Thus far, fortunately, we have not been subject to the scrutiny that occurs in Europe.

My brief here is to explore the tools that are available to us and I want to draw out two pieces of legislation that define the mandate of local government. The Local Government Act's overriding purpose is to achieve sustainable development requiring decision makers to balance social, cultural, economic and environmental well-being when determining how to achieve community defiant outcomes. The Act provides an overarching philosophy for how local government will work with its community to address issues such as those we are discussing today. Under this Act the community is asked for its involvement in the setting of objectives that accept water quality will get worse in order to enhance the economic well-being of the community, and leave those long term issues of how to clean up the problem for future generations.

On the other hand, the Resource Management Act talks of sustainable management of natural and physical resources, as opposed to development. It springs from a model of sustainability where not only are well-beings balanced and weighed but a strong legislative direction is provided to enable the use, development and protection of natural and physical resources while explicitly considering the expectations of future generations, the need to preserve life supporting capacity and avoid, remedy or mitigate effects.

This Act is the legislation through which local government allocates natural and physical resources to be used for our economic, social, cultural and environmental well-being, it is a regulatory Act. The Local Government Act is about where we can deploy economic instruments and where we fund implementation of our Resource Management Act work. In essence, unlike the Local Government Act, the Resource Management Act is effectively environmental management or environmental protection legislation and it requires standards to be set that conflict with community aspirations derived by the Local Government Act. To my knowledge, the courts have not had the opportunity to determine the relationship between these Acts, but it could be an interesting decision when they finally do.

Although the legislation we work under is not entirely aligned, they do provide a comprehensive toolbox which local government can, and in a number of regions is, using to confront the kind of issues we have talked about today -

Regulatory –

- Targets
- Permitted Activity rules that incentivise good behaviour and compliance
- Resource consents
- Lake Taupo – cap and trade

Non Regulatory

- Incentives and assistance funding
- Voluntary Accords
- Education

The Future?

- Nutrient charges via rates
- New allocation methods
- More cap and trade systems
- Marketing opportunities

We have shown that both in the Rotorua Lakes and Taupo resource consents can be applied to land use, and in Lake Taupo cap and trade frameworks are already in place.

We also have available to us non regulatory options, such as above, and there are still other opportunities that we have not yet played with, within the legislation, but are available. We have not fully explored these but I can see that in future we could use them to establish pollution charges and to allocate resources in a variety of different ways. I think one can probably look at the local governments Rating Powers Act and establish a framework there. Clearly we have got the ability to allocate water or nutrients in whatever framework we can justify under the legislation. I encourage you to have a look at our water allocation Variation 6 where we have done so.

Cap and Trade is already there, and possibly in the future there will be some even more innovative things as Local Governments have a role in helping land owners going the extra mile to comply with our regulations, potentially to create opportunities for our products on the international market – for example there may be opportunities for a brand built around a supply chain from paddock to supermarket that has been certified as complying with an environmental regulator.

I wish to briefly traverse three case studies to demonstrate how we are already using many of these tools. Firstly, the Waikato Regional Plan, notified in 1998, operative in 2007 after five years in the Environment Court. The Plan adopts a water classification system which defines the purpose for which every water body in the region is being managed. It defines the uses and values that are important to Tangata Whenua and the community in terms of each water body. The major water bodies are all classified as contact recreation, so we have already got the goals that are lurking in the National Policy Statement in the Regional Plan. In fact, if you look at most regional plans in the country they talk about maintaining and enhancing water quality, net improvements and the concepts that underpin what is already in the draft National Policy Statement.

In the Waikato Regional Council's case we set out to achieve the maintenance and enhancement in water quality by strictly regulating industrial point source discharges and sediment discharges from forestry and earthworks. On the other hand, the Plan takes a permissive approach to the management of the discharges from agriculture, provided minimum standards are met. It is important to note that the Plan was prepared in the mid 1990's, at a time when agricultural returns were low, and our understanding of the importance of non point source discharges were only just evolving.

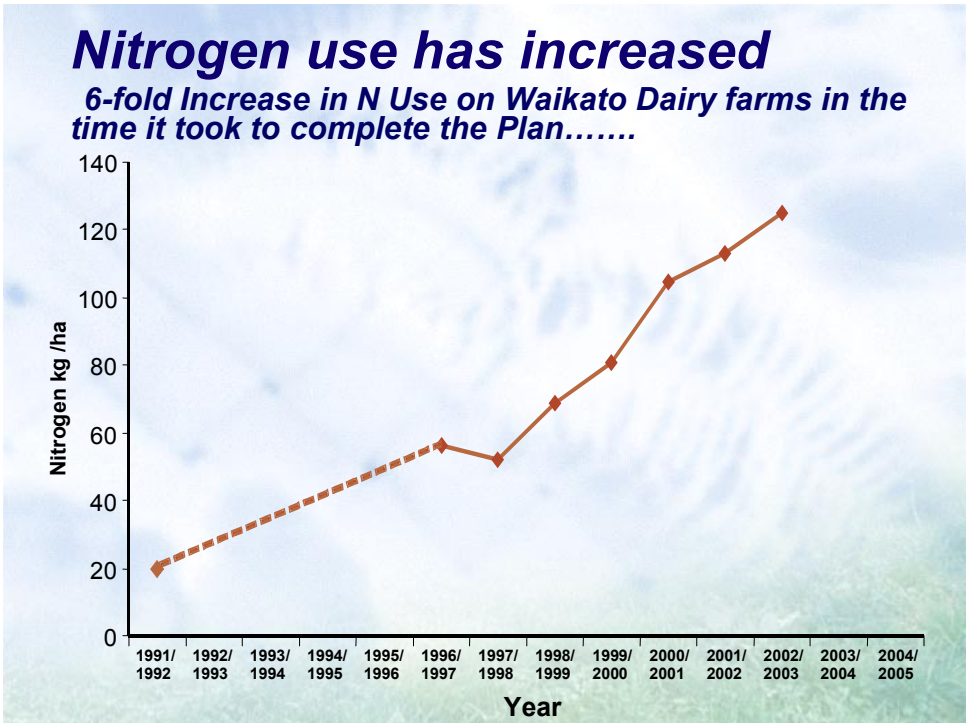


Figure 1

Looking at *Figure 1*, remember that at the plan-making process we are basically constrained to what we start with. We notified and wrote the plan in the mid 1990's, but we certainly did not see the enormous acceleration in nitrogen. By the time we did, it was too late to work on substantive changes to the planning framework, given the way the Act works. Effectively our plan was doomed to failure before we even made it operative.

There is some good news, and interestingly the changes to the plan that were made through the Environment Court process arose from a conversation between environmentalists and farmers, very much as Guy Salmon referred to in his presentation. We were able to take major steps forward with the consent of all parties -

- Nutrient management plans became mandatory long before they found their way into the lexicon of Fonterra, with the Fonterra Accord.
- There are stock-exclusion water bodies identified in the Plan, particularly for our most sensitive and ecologically important waterways.
- The Council committed to a comprehensive monitoring programme with a focus on assessing the effectiveness of our permissive approach to the rural sector.
- The farmers within the Waikato Region pay for that monitoring programme through a permitted activity monitoring rate at about $40 a property.
- The plan identifies the need to prioritise catchments for future plan reviews.

I am a bit under-whelmed by the National Policy Statement because it tells us to do stuff that is already in our Regional Plan and Policy Statement. It certainly does not move the Waikato forward particularly.

We heard a lot about Taupo. By the year 2000 we had realised that we needed to act swiftly to protect Lake Taupo from the effects of land use intensification, and we did so in partnership with the Crown, Taupo District and Tuwharetoa. We put into place the Protecting Lake Taupo Strategy. Even eight years later we have not finished locking the strategy down, the final Environment Court decision on appeals will be out by the end of the year. It took us eight years to get from start to finish of the policy.

I know Simon Berry is going to talk a bit more about the details of the Lake Taupo Variation 5. In eighty years Lake Taupo will look as it does today as a consequence of that Variation. It does not sound brave, but for its time, and given the facts that we need to take into account, it is certainly a challenge.

The objective of the policy is the legislative imperative to consider social, cultural and economic impacts of an intervention to protect the environment. It recognises that a more draconian intervention would have fundamentally damaged the fabric of the Taupo community by effectively forcing the land owners in the catchment off their land. Instead nitrogen leaching activities are capped at historical rates so that farmers can have certainty that they can at least continue to farm as they have farmed in the past. A public fund is to be used to find ways of removing at least 20% of the nitrogen allocated across the catchment.

Scientists told us midway through the Environment Court process that 20% will not be enough, so we are going to have to come back and revisit that number, it is probably closer to 30 or 40%. Taupo District Council is committed to reticulating all of its lake shore communities to reduce their contribution to the lake by 20%. The District Council is winding back its contributions, farmers are capped.

The Lake Taupo Protection Trust has been given $81.5 million to remove at least 20% of the nitrogen entering the lake and it will do so via nitrogen trading, research development and any other creative means it can find to achieve that goal. Farmers can reduce their nitrogen losses and sell surplus nitrogen allocations either to the Trust or other land owners. All of this work is to be underpinned by our rule framework that farmers must comply with. The status of the rules remains one of those issues before the court, so I will not discuss that any further.

It has been a torrid process for the community, iwi, elected representatives and officials to work through and we have learnt a lot about the importance of good transparent processes. Our experience tells us that the process is as important as the outcome and whilst we may not always agree it is important to keep talking, to be honest about what we know and do not know, to acknowledge the importance of local knowledge and farmer knowledge and how their land operates. Early on we learnt that the farming community will want a say in how it is involved in the discussion and be able to ask questions directly of the scientist.

All this takes time and costs money but the proof is in the pudding. At the end of the Environment Court Hearing we were pleased to find the local farmer groups, Taupo Lake Care, Tuwharetoa interests and Council had adopted a common position that was at odds with the positions of the national lobby and corporate interests that are involved in the case. For those who were involved in the early meetings in the catchment this has been a fundamental turn around in the nature of our relationship. Whilst we still do not agree on everything, at least we have a relationship going forward which should stand the community well.

In summary, it takes time to line up all the factors, streams of information and conversations that are necessary when we are seeking to change the way in which a community as a whole interacts with its environment.

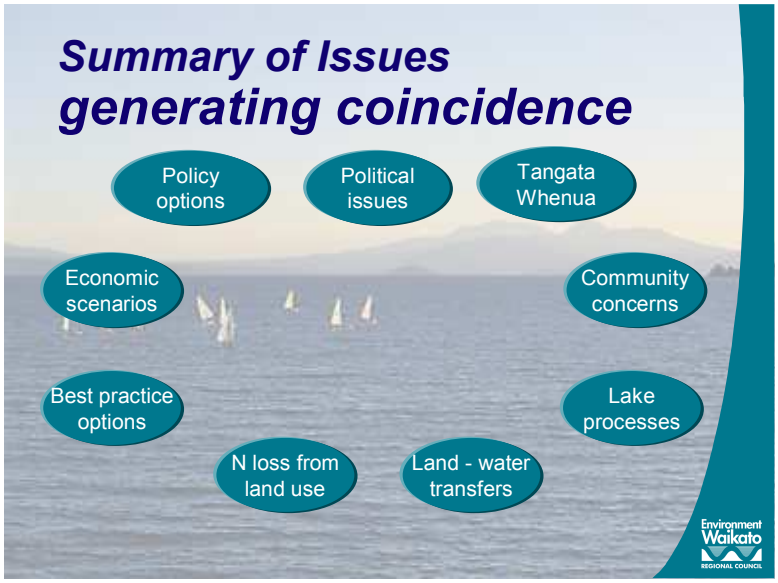
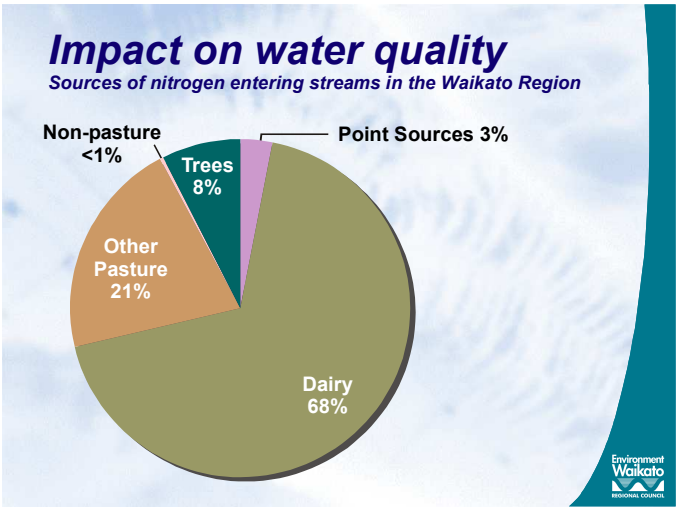


Figure 2

We need to get every one of the factors on *Figure 2* right. It is not just about the tools we use, that is only one of those buttons - policy options. We need to address each and every factor in order to get a durable solution. Environment Waikato considers the consultation and time spent on the process to have been an investment in the future and investment in our community around Taupo. It is an investment that has been well spent. We could have pushed it through faster, but if we had done so we would have been left with a plan that the community did not agree with and widespread resistance to implementation, and we would have been left with a community in Taupo riven by conflict between the parties and millions of dollars at stake and the potential for ongoing litigation. Instead we are now focussed on the future and how we are going to get there.



At this stage for Council the next priority is probably the Waikato River above Karapiro Dam. We had been hoping to advance policy work in this area quickly, learning from Lake Taupo and getting the conversations underway. We have been unable to do so due to the need to resource the Lake Taupo appeals process in the Environment Court.

Figure 3

We also need to have time to see how the Treaty Settlement process plays out because the Waikato River settlement is going to have a fundamental impact on the targets to water quality within this catchment. The driver here is the ongoing intensification of agriculture and the potential conversion of up to 70,000 hectares of beautiful flat land to intensive dairy farming over the next twenty years. It is important when you think about 70,000 hectares to remember that, in terms of the Waikato River, *Figure 3* shows about 70% of the nitrogen load from the river comes from dairying. If you increase the amount of dairy farming in that catchment you will have a huge affect. Even without the

conversions our scientists have been advising us that we will not be able to maintain water quality in the Waikato River over the next twenty years if nitrogen concentrations in the river, and its tributaries, continue to increase between 1 and 2% per annum, which is what they currently do.

If conversions on the scale that have been proposed were to occur we would have no chance whatsoever of maintaining water quality in the river, unless there were significant reductions in nutrient losses from existing farmers. These reductions might actually make many of those existing farming operations uneconomic.

Increases in nitrogen concentrations in the upper river would also have a significant implication for urban communities, and farmers in the lower river, due to rising water treatment costs and potential changes in river hydrology. Fortunately for us all the Emissions Trading Scheme and current economic conditions have put the brakes on the process of deforestation and this has brought our community some breathing space. There is a long way to go before the solution to these issues will be found.

From our Taupo experience we know that the science will need to be robust and agreed. We will need to understand the social and economic costs and benefits and the potential trade-offs that need to be made between all sectors of the community and between the economic well-being of the community in the upper catchment and the lower catchment. We know that firm targets will form part of this puzzle, but we are still uncertain what the new era of co-management that is being ushered into the Waikato River settlement process will mean for us and for our plan-making processes. We expect it to be a good thing and a good opportunity to move things forward.

What I am clear on is that the same issues will need to be addressed in the upper Karapiro catchment as were addressed in Taupo. To get a durable outcome that does not divide the community and undermine our economic well being, we will need to invest many years in the conversations and explore more fully the tools that are available to us.

I believe we have the tools but we need to have the patience, political will and vision to act. The tools are there if your community is ready to act, but we have got to remember Rome was not built in a day and the statutory process we have set up means that it will take seven or eight years to get to a final operative outcome, unless we make some changes to the way our processes work. National bottom lines, as Guy Salmon has advocated for, might speed up the process, but we need to remember we are talking about a fundamental change in the way that part of our society has operated. It will take more than a stroke of a Minister or Judge' pen to complete that process.

Thank you.

NEW ZEALAND POLICY AND LAW NUTRIENT SENSITIVE ZONES - DIFFUSE POLLUTION – SECTION 30 OF THE RESOURCE MANAGEMENT ACT 1991

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ABSTRACT

1. The focus of this presentation is on the scope of regional councils to address diffuse pollution (non-point source discharges) pursuant to their functions under section 30 of the Resource Management Act 1991 ("RMA"). The provisions of the RMA relevant to plan development are considered as are Sections 9(3) and 15(1)(b) of the RMA will also be addressed as they are key provisions of the RMA that relate to controlling land uses and associated discharges of contaminants onto or into land in circumstances where those contaminants may enter groundwater, streams, rivers and lakes.

2. These provisions of the RMA will be considered by specific reference to the approach adopted by Environment Waikato in seeking to control land uses (predominantly wastewater discharges and pastoral farming) and associated discharges in the Lake Taupo catchment via Proposed Waikato Regional Plan Variation 5 – Lake Taupo Catchment ("RPV5"). The Environment Court hearing of appeals in relation to RPV5 has just concluded. The writer was counsel for Environment Waikato. Although a decision is awaited, the key aspects of RPV5 are sufficiently settled to be the subject of commentary.

3. Specifically, the paper considers:

   3.1 The relevant provisions of the RMA and the key legal principles that apply to the development of such measures.

   3.2 Provide an overview of the key features of RPV5.

   3.3 Consider the key legal and policy issues that needed to be considered in developing the variation.

   3.4 Comments on issues which would need to considered elsewhere and the transferability Environment Waikato's experience to other catchments and circumstances.

1. INTRODUCTION

1.1 As the existence of this conference demonstrates, one of the key environmental issues facing New Zealand relates to the reduction in water quality of our lakes and waterways as a result of diffuse (or non-point) discharges of nutrients (particularly nitrogen). These nutrients accelerate algal growth, which impacts on water clarity and consequently results in ecosystem degradation.

1.2 The operation of the natural nitrogen cycle involves a constant movement of nitrogen through the environment. In natural systems, an ongoing balance is normally achieved and a reasonable level of water quality is maintained. A significant threat to water quality has arisen from the introduction into the environment of nitrogen from anthropogenic sources, including industrial development, wastewater discharges and, predominantly, farming activities.

1.3 The very nature of diffuse (or non-point source) discharges poses significant challenges for regional councils which wish to address this threat to water quality, both for enforcement and in terms of regional plan and policy development.

1.4 In the absence of a point source discharge which can be targeted in terms of treatment or prohibition, the only obvious means of dealing with such discharges is to focus on the land uses which result in nitrogen discharges, which are capable of being identified and managed. For example, it is well known that a very significant source of nitrogen discharges to the environment is from dung and urine patches associated with pastoral and dairy farming activities, which can typically result in discharges of nitrogen as high as 60 kilograms per hectare per year (kg/N/ha/pa) into the root zones of farms, much of which then enters groundwater and subsequently surface water in rivers, streams and lakes.

1.5 The functions of regional councils include not only "*the control of discharges into or onto land … or water*" under section 30(1)(f) of the Resource Management Act 1991 ("RMA") but also "*the control of the use of land for the purpose of…the maintenance and enhancement of the quality of water in water bodies ...*" under section 30(1)(c)(ii) of the RMA.

1.6 Key questions which arise in this context are:

(a) Whether such discharges can be adequately regulated and controlled via the machinery provided in the RMA?

(b) If so, how should regional councils approach the issue?

(c) What issues – legal, political or otherwise – are councils likely to face in implementing such measures?

Lake Taupo – Waikato Regional Plan Variation 5

1.7 Over the past eight years the Waikato Regional Council (Environment Waikato) ("EW") has been through the process of developing and shepherding through the First Schedule process Waikato Regional Plan Variation 5 ("RPV5"). A lengthy Environment Court hearing in relation to that measure concluded in July and a decision is expected in or after September.

1.8 RPV5 is a complex policy and regulatory measure by which EW proposes to restore and maintain the long term water quality of Lake Taupo in light of the recognition that there has been a small but discernible decline in lake water quality in recent years, predominantly as a result of land use changes in the last 30 – 40 years – and, in particular, the development of large areas of pastoral farming which have been identified as the source of 92% of the manageable load[1] of nitrogen entering the Lake.

1.9 EW's experience in developing RPV5 and the issues which needed to be grappled with in developing a workable measure provide a very good object lesson in dealing

[1] Manageable load is the total load of nitrogen leached from human generated sources (for example, pastoral farming) that can be reduced by controlling or changing land uses. An example of controlling a land use to reduce nitrogen leaching would be to require pastoral farmers to install feed pads and collect and treat the leachate from the feed pads. An example of changing a land use to reduce nitrogen leaching is converting pastoral farm land to production pine forest.

with the type of issues which arise in managing land use activities to deal with diffuse nitrogen discharges.

1.10 In approaching this topic, it is therefore proposed to use RPV5 as a real-life and early example of a policy and regulatory (and non-regulatory) framework designed to deal with diffuse discharges.

1.11 Because the Environment Court's decision is awaited, it is not appropriate to express a view in relation to the issues which the Court needs to determine. However, most of the major elements of RPV5 are no longer disputed. Where a disputed issue is the subject of comment, commentary will be restricted to issues canvassed at the public hearing – there is no wish or intention to influence the Court beyond the submissions and evidence presented during the case.

Scope of paper

1.12 Specifically it is proposed in this paper to:

(a) Outline the provisions of the RMA relevant to the regional council's functions and to the development of regional plan provisions to deal with diffuse pollution (Section 2).

(b) Summarise the situation in Lake Taupo which gave rise to concerns about water quality and the need to take regulatory action (Section 3).

(c) Provide an overview of RPV5 focussing in particular on the policy and regulatory issues and challenges (Section 4).

(d) Make some general observations about lessons from the RPV5 experience which may assist other regulators (Section 5).

1.13 In making these observations about RPV5 in the context of the Lake Taupo catchment, it is important to bear in mind that the circumstances applying to the Lake Taupo situation, and caution needs to be exercised in making any assumptions as to the general applicability of the provisions of RPV5 to other catchments or situations. Indeed, a "no precedent" clause has been included in RPV5 to make that very point (and to address concerns that the RPV5 provisions would, indeed, create a precedent for other catchments). It states:

> *"The Objective, Policies and implementation methods contained in Variation Five – Lake Taupo Catchment have been developed to address the decline in Lake Taupo water quality in the context of the unique set of circumstances which apply in the Lake Taupo catchment. In doing so the Waikato Regional Council does not intend to create a precedent, either direct or indirect, for any other catchments or water bodies and does not consider that any precedent is created.*
>
> *Issues of water quality decline in other catchments or water bodies in the Waikato Region will be investigated by the Waikato Regional Council as the need arises. If necessary, regional plan provisions and implementation methods will be developed that are appropriate for the specific circumstances of those catchments or water bodies, following appropriate community consultation and the consideration of efficiency, effectiveness, costs and benefits as required under section 32 of the Resource Management Act."*

1.14 Nevertheless, many of the issues which will need to be grappled with will be similar in any given case even if, ultimately, the regulatory or policy response may transpire to be quite different.

2. LEGAL REQUIREMENTS – REGIONAL COUNCIL FUNCTIONS, POWERS AND DUTIES IN RELATION TO PLAN DEVELOPMENT

2.1 We all know that there are measures available to limit discharges, such as the fencing off of streams. These type of measures can be required by district and regional plan rules or can be encouraged via non-regulatory means or voluntarily undertaken, e.g., the Clean Streams Accord[2]. The focus of this paper is on regulatory measures which can be required via the introduction of regional planning instruments.

2.2 If regional councils are going to tackle the issues posed by diffuse pollution, they need to have the legal power to do so, and the ability under the RMA to promulgate the type of controls that are going to be effective in addressing those issues.

2.3 Any regional plan measure which is introduced to deal with diffuse pollution must meet a number of legal requirements and pass through various legal procedures. In particular, section 63(1) of the RMA states that:

> *"The purpose of the preparation, implementation, and administration of regional plans is to assist a regional council to carry out any of its functions in order to achieve the purpose of this Act."*

2.4 The first point to note is that, to be valid, a regional plan is required to:[3]

(a) Be in accordance with the Regional Council's functions as set out in section 30, the provisions of Part II, and the Regional Council's duty under section 32 (see section 66(1)); and

(b) Give effect to any regional policy statement (see section 67(3)(c)).

Regional Council functions – section 30

2.5 Section 65(1) of the RMA confers power on regional councils to prepare regional plans "*for the whole or part of its region for any function specified in section 30(1)(c)*". The most relevant functions of regional councils in section 30(1) of the RMA for present purposes are as follows:

> *"(1) Every regional council shall have the following functions for the purpose of giving effect to this Act in its region:*
>
> *(a) the establishment, implementation, and review of objectives, policies, and methods to achieve integrated management of the natural and physical resources of the region:*
>
> *(b) the preparation of objectives and policies in relation to any actual or potential effects of the use, development, or protection of land which are of regional significance:*
>
> *(c) the control of the use of land for the purpose of*
>
> *...*
>
> *(ii) the maintenance and enhancement of the quality of water in water bodies and coastal water:*
>
> *...*

[2] Dairying and Clean Streams Accord, May 2003, ("Accord") between Fonterra Co-operative Group Limited, Local Government New Zealand, Ministry for the Environment, and Ministry of Agriculture and Forestry. The Clean Streams Accord provides a statement of intent and framework for actions to promote sustainable dairy farming by focussing on reducing the impacts of dairy farming on streams, rivers, lakes, wetlands, and groundwater. The Accord sets out a number of priorities, including ensuring that dairy cattle are excluded from streams etc, and time frames for achievement of the priorities. The Accord is available on MFE's website.

[3] *Geotherm Group Limited v Waikato Regional Council* (A 047/2006), paragraph 62.

(f) *the control of discharges of contaminants into or onto land, air, or water and discharges of water into water:"*

Scope of regional rules – sections 65 and 68

2.6 The scope of regional rules are linked to these functions. Section 68(1) states that:

> *"(1) A regional council may, for the purpose of—*
>
> *(a) Carrying out its functions under this Act (other than those described in paragraphs (a) and (b) of section 30(1)); and*
>
> *(b) Achieving the objectives and policies of the plan,—*
>
> *include rules in a regional plan."*

2.7 In turn, section 68(5) provides that:

> *"(5) A rule may—*
>
> *(a) Apply throughout the region or a part of the region:*
>
> *(b) Make different provision for—*
>
> *(i) Different parts of the region; or*
>
> *(ii) Different classes of effects arising from an activity:*
>
> *(c) Apply all the time or for stated periods or seasons:*
>
> *(d) Be specific or general in its application:*
>
> *(e) Require a resource consent to be obtained for an activity causing, or likely to cause, adverse effects not covered by the plan."*

2.8 Section 65(3) provides guidance as to the circumstances in which regional plans should be developed. It states:

> *"(3) Without limiting the power of a regional council to prepare a regional plan at any time, a regional council shall consider the desirability of preparing a regional plan whenever any of the following circumstances or considerations arise or are likely to arise:*
>
> *(a) Any significant conflict between the use, development, or protection of natural and physical resources or the avoidance or mitigation of such conflict:*
>
> *(b) Any significant need or demand for the protection of natural and physical resources or of any site, feature, place, or area of regional significance:*
>
> *(c) Any threat from natural hazards or any actual or potential adverse effects of the storage, use, disposal, or transportation of hazardous substances which may be avoided or mitigated:*
>
> *(d) Any foreseeable demand for or on natural and physical resources:*

(e) *Any significant concerns of tangata whenua for their cultural heritage in relation to natural and physical resources:*

(f) *The restoration or enhancement of any natural and physical resources in a deteriorated state or the avoidance or mitigation of any such deterioration:*

(g) *The implementation of a national policy statement or New Zealand coastal policy statement:*

(h) *Any use of land or water that has actual or potential adverse effects on soil conservation or air quality or water quality:*

(i) *Any other significant issue relating to any function of the regional council under this Act."*

2.9 Many of these considerations can be seen as arising in the context of diffuse pollution of waterways. Certainly subsections (a), (b), (e), (f) and (h) were seen to be relevant in the context of RPV5.

Legal basis for land use rules (section 9) and discharge rules (section 15)

2.10 As noted, the most effective way to deal with diffuse pollution is to address the cause of the pollution at source rather than the discharge itself. In other words, the starting point is controlling the land uses which are the source of the discharges that ultimately reach our waterways.

2.11 Section 9 of the RMA provides the legal basis for land use rules under the RMA and therefore needs to be seen alongside regional council functions under section 30(1)(c)(ii). The relevant part of the section states

*"**Restrictions on use of land***

…

(3) No person may use any land in a manner that contravenes a rule in a regional plan or a proposed regional plan unless that activity is—

(a) Expressly allowed by a resource consent granted by the regional council responsible for the plan; or

(b) Allowed by section 20A (certain existing lawful uses allowed)."

2.12 In turn, section 15 provides the jurisdiction to promulgate discharge rules, including discharges on to land in circumstances where they may ultimately enter water. In that regard, section 15(1)(b) states:

*"**15 Discharge of contaminants into environment***

(1) No person may discharge any—

(a) …

(b) Contaminant onto or into land in circumstances which may result in that contaminant (or any other contaminant emanating as a result of natural processes from that contaminant) entering water:

...

unless the discharge is expressly allowed by a rule in a regional plan and in any relevant proposed regional plan, a resource consent or regulations."

2.13 One of the key issues which arose during the Court hearing on RPV5 (and which the Court needs to determine) is whether the rules of RPV5 were promulgated purely as land use rules under section 9 of the RMA in reliance on EW's powers under section 30(1)(c)(ii) or whether the rules were hybrid and land use and discharge rules based on both section 9 and section 15 of the RMA which were promulgated in reliance not only on section 30(1)(c)(ii) but also on section 30(1)(f). The dispute arises from a concern on the part of national farming interests that labelling the rules as discharge rules implies that there are discharges associated with pastoral farming activities which require resource consents. I return to this issue in Section 5.

Balancing potential effects and consequences

2.14 The classic conflict which arises in this context is between the need to protect our waterways while still enabling economic activities to continue, especially farming. Water quality issues arising from farming activities could obviously be addressed by curtailing that activity, but that would have severe economic and social consequences which are also highly relevant in terms of section 5 and Part 2 of the RMA (see below). Indeed, this was the most fundamental issue that needed to be addressed in the Lake Taupo situation. The requirement to undertake a rigorous consideration of alternatives and the general issues raised by Part 2 of the RMA provide a context for these "big picture" matters to be considered.

Evaluation of costs, benefits and alternatives - section 32

2.15 Not only do regional plan measures need to fall within the scope of the regional council functions and powers to be valid, they need to undergo a rigorous evaluation under section 32 of the RMA. Section 32(3) and (4) states that:

*"**32 Consideration of alternatives, benefits, and costs***

(3) An evaluation must examine -

(a) the extent to which each objective is the most appropriate way to achieve the purpose of this Act; and

(b) whether, having regard to their efficiency and effectiveness, the policies, rules, or other methods are the most appropriate for achieving the objectives.

(4) For the purposes of the examinations referred to in subsections (3) and (3A), an evaluation must take into account —

(a) the benefits and costs of policies, rules, or other methods; and

(b) the risk of acting or not acting if there is uncertain or insufficient information about the subject matter of the policies, rules, or other methods."

2.16 The generally accepted formulation of the approach to be adopted in assessing proposed planning provisions with regard to using section 32 as a touchstone can now be found in *Eldamos Investments Limited*[4] in the following terms:

> *"We… propose the following measures for evaluating objectives, and for evaluating policies, rules and other methods:*
>
> *A. An objective in a district plan is to be evaluated by the extent to which:*
>
> *1 it is the most appropriate way to achieve the purpose of the Act (s32(3)(a));and*
>
> *2 it assists the territorial authority to carry out its functions in order to achieve the purpose of the Act (s72); and*
>
> *3 it is in accordance with the provisions of Part 2 (s74(1)).*
>
> *B. A policy, rule, or other method in a district plan Is to be evaluated by whether:*
>
> *1 it is the most appropriate way to achieve the objectives of the plan (s32(3)(b)); and*
>
> *2 it assists the territorial authority to carry out its functions in order to achieve the purpose of the Act (s72); and*
>
> *3 it is in accordance with the provisions of Part 2 (s74(1)); and*
>
> *4 (if a rule) it achieves the objectives and policies of the plan (s76(1)(b))*."

2.17 The Environment Court has confirmed[5] that it is appropriate to replace references to territorial authorities' planning functions with the equivalent regional council functions. For completeness, it is noted that the *Eldamos* test was reconsidered in a recent case[6] and a number of deficiencies were identified.

Part 2 of the RMA

2.18 Ultimately, any RMA measure is required to promote the sustainable management purpose of the RMA, as informed by the other important provisions in Part II. Section 5 sets out the purpose of the RMA as follows:

> ***"5 Purpose***
>
> *(1) The purpose of this Act is to promote the sustainable management of natural and physical resources.*
>
> *(2) In this Act, "sustainable management" means managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural wellbeing and for their health and safety while-*
>
> *(a) Sustaining the potential of natural and physical. resources (excluding minerals) to meet the reasonably foreseeable needs of future generations;*

4 *Eldamos Investments Limited v Gisborne District Council* (W047/05), paragraph 128. This case was recently reconsidered in the *Long Bay-Okura Great Park Society Incorporated v North Shore City Council* (A 078/2008) decision in which a number of deficiencies with the so called Eldamos test were identified.

5 *Geotherm Group Limited and ors v Waikato Regional Counci*l (A 047/2006), paragraph 68.

6 *Long Bay-Okura Great Park Society Incorporated v North Shore City Council* - A 078/2008.

(b) Safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) Avoiding, remedying, or mitigating any adverse effects of activities on the environment."

2.19 The correct approach to section 5(2) was recently stated by the Environment Court in the *Geotherm*[7] decision as follows:

> "*Our approach is to weigh the matters in section 5(2) in order to reach a broad judgment as to whether an objective, policy, or rule would promote the sustainable management of natural and physical resources. The values in section 5 have been variously referred to as "indicators" "guidelines "'directions", or "touchstones" for promoting the goal of sustainable management.*
>
> *The matters in section 5(2)(a), (b) and (c), are all to be accorded full and equal significance. Accordingly, they are to be applied having regard to the circumstances of each case. Applying section 5 involves a broad overall judgment of whether a proposal, or in this instance, the provisions of the proposed change and variation, would promote the single purpose of the Act. This allows for the balancing of conflicting considerations in terms of their respective significance or proportion in the final outcome.*"

Other Part II provisions

2.20 Section 6 matters must be "recognised and provided for". Whether any of these provisions are relevant will depend on the circumstances. The matters which were most relevant in terms of RPV5 were sections 6(a), (b) and (e):

> *"**6 Matters of national importance***
>
> *In achieving the purpose of this Act, all persons exercising functions and powers under it, in relation to managing the use, development, and protection of natural and physical resources, shall recognise and provide for the following matters of national importance:*
>
> *(a) The preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins, and the protection of them from inappropriate subdivision, use, and development:*
>
> *(b) The protection of outstanding natural features and landscapes from inappropriate subdivision, use, and development:*
>
> *…*
>
> *(e) The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga."*

2.21 "Particular regard" must be had to section 7 matters, which include general concepts such as:

> *"(a) Kaitiakitanga:*
>
> *(aa) The ethic of stewardship:*
>
> *(c) The maintenance and enhancement of amenity values:*

[7] *Geotherm Group Ltd and ors v Waikato Regional Counci*l (A 047/2006), paragraphs 74 and 75.

(d) Intrinsic values of ecosystems:

(f) Maintenance and enhancement of the quality of the environment:

(h) The protection of the habitat of trout and salmon:"

2.22 The principles of the Treaty of Waitangi are also to be taken into account pursuant to section 8.

First Schedule process

2.23 Once regional rules are promulgated they must undergo a process of public notification, submissions and hearings as prescribed in the First Schedule to the RMA. It is not necessary to address this process here other than to note that it involves:

(a) Public notification of the proposed measure.

(b) The ability to lodge submissions seeking changes or deletion of the proposal.

(c) Public notification of a summary of decisions requested in submissions, so that further submissions can be lodged supporting or opposing the decisions which have been requested.

(d) The hearing of submissions and further submissions via a hearing process, including the presentation of evidence, submissions, etc.

(e) The issuance of decisions and the right to appeal the decision to the Environment Court.

(f) The ability to lodge appeals on points of law only to the High Court.

2.24 Needless to say, this can be a very lengthy and complex process. The First Schedule time frames applicable to RPV5 were as follows:

(a) RPV5 publicly notified – 9 July 2005.

(b) Submissions closed – September 2005 (136 submissions lodged).

(c) Summary of submissions notified – 18 November 2005.

(d) Further submissions closed 19 December 2005.

(e) Staff report released – 12 April 2006.

(f) Hearing of submissions – May, June and July 2006 (total of 21 hearing days). Evidence and submissions heard from 69 submitters and further submitters.

(g) Public deliberations on evidence and submissions – July to November 2006 (total of 16 days in deliberation).

(h) Decision released on 24 March 2007.

(i) Period for lodging appeals expired around 14 May 2007. Nine appeals lodged by Ngati Tuwharetoa Maori Trust Board and Ngati Tuwharetoa forestry interests, Carter Holt Harvey Limited, Kaingaroa Timberlands, Environmental Defence Society, Federated Farmers of New Zealand Incorporated, Taupo Lake Care Incorporated, and Paul Trewavas.

(j) Case management programme, including technical witness caucusing, pre-hearing conferences, and evidence exchange – June 2007 to April 2008.

(k) Environment Court hearing – May to June 2008 (18 days of hearing).

2.25 Any regional council promulgating similar provisions should probably assume similar time frames and processes applying.

3. THE LAKE TAUPO SITUATION – OPERATION OF THE NIROGEN CYCLE AND THE NEED TO TAKE REGULATORY ACTION

3.1 Having considered the means available to regional councils to promulgate plan provisions to address resource management issues, including diffuse pollution, and as a precursor to consideration of RPV5 itself it is proposed to comment on the situation at Lake Taupo which gave rise to the need for EW to take regulatory action.

Rationale for RPV5

3.2 Summarised in brief and simple terms, EW's concern is that development and intensification of the rural and urban land surrounding Lake Taupo has resulted in increased levels of nitrogen entering Lake Taupo from non-point sources, as a result of nitrogen leaching from the land and entering groundwater via rivers and streams and directly as groundwater inflows. Nitrogen also enters the Lake from point source discharges including stormwater outfalls, wastewater systems and the Tongariro Power Development Scheme tailrace. This increased level of nitrogen promotes algal and phytoplankton growth in the Lake, which decreases the water quality of the Lake.

3.3 EW's concern is that, if left unchecked, these nitrogen inputs would have significant adverse effect on Lake Taupo's (near) pristine water in the future. In essence, RPV5 was developed to maintain the long term water quality of the Lake by addressing discharges to Lake Taupo from manageable (i.e., human induced) sources, it not being possible to address nitrogen from unmanageable (natural) sources.

Operation of the Nitrogen Cycle in the Lake Taupo catchment

3.4 More appropriately qualified speakers at this conference than I are addressing scientific issues relevant to the nitrogen cycle. It is only proposed here to put the nitrogen inputs into Lake Taupo into context.

3.5 It was necessary in the context of the RPV5 hearing to address the operation of "the Nitrogen Cycle" as it operates in the catchment in considerable detail. In order to put that evidence into context, EW's Water Quality scientist, Bill Vant, prepared an overview of the nitrogen cycle for the Lake Taupo catchment, i.e., the manner in which nitrogen moves through the environment and which was presented in a re-formatted form as part of Opening Submissions. In order not to spend too much time on this issue, Mr Vant's appendix has been reproduced as **Appendix A** to this paper, with straightforward diagrammatic representations below. In brief summary, it is clear that there are a number of human induced sources of nitrogen to the Lake which as a result can be managed (unlike, for example, nitrogen inputs from the rotting of native bush) and, therefore, that represents an opportunity to reduce nitrogen discharges by managing those sources.

Nitrogen budget

3.6 A nitrogen budget initially developed for the Lake by EW estimated that at the year 2000, 1220 tonnes of nitrogen was entering the Lake on an annual basis, of which approximately 650 tonnes represented the pre-development load from unmanageable natural sources and approximately 468 tonnes was from human induced manageable

sources. It is estimated that 92% of the nitrogen entering the Lake from manageable sources arises from pastoral farming within the Lake's catchment.

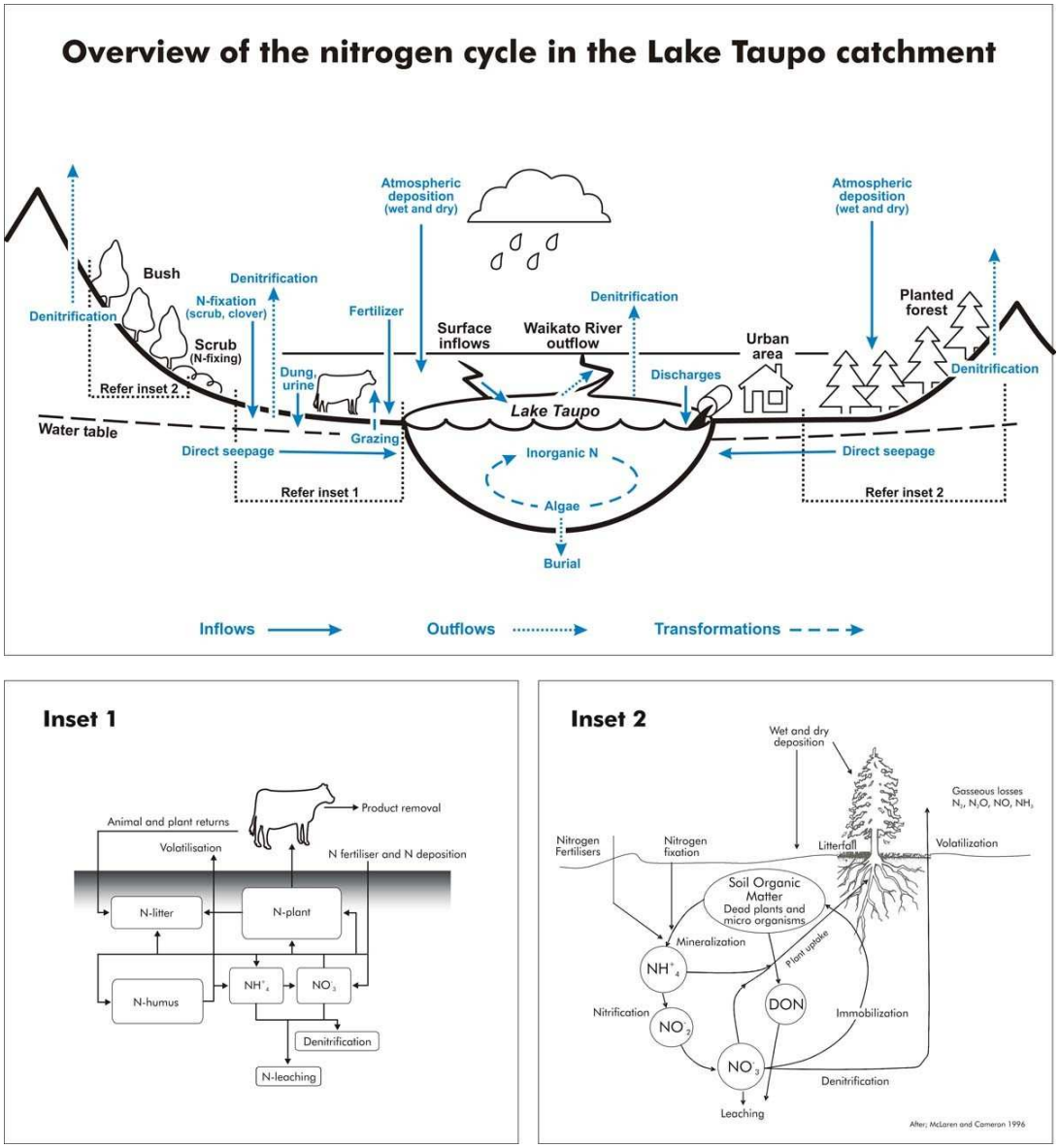

Figure 1: The nitrogen cycle in the Lake Taupo catchment.

3.7 The total and manageable loads of nitrogen entering the Lake were revised as a result of caucusing between technical experts for EW and some of the appellants. An Agreed Science Statement was prepared, signed by the technical experts, and filed with the Court. The revised figures in the Agreed Science Statement for the total and manageable loads were as follows:

(a) Total load – 1300 to 1320 tonnes per year.

(b) Manageable load – 535 to 555 tonnes per year.

3.8 These figures were further refined in Mr Vant's rebuttal evidence as a result of new information on leaching rates from non-farming land uses (pine forest, etc.) as follows:

(a) Total load – 1357 tonnes per year.

(b) Manageable load – 543 tonnes per year.

3.9 There is a substantial time lag (many decades in some cases) between nitrogen leaching from the land and it eventually entering the Lake. The upshot is that holding nitrogen discharges at current levels would not maintain water quality. Following the lodging of appeals, a key issue that was caucused very early between expert witnesses was the size of the load of nitrogen yet to be discharged to the Lake before equilibrium is reached (referred to as the "load to come"). The expert witnesses estimated this as between 160 and 230 tonnes per year and these figures were included in the Agreed Science Statement.

3.10 During the hearing these figures were further refined as a result of more technical witness caucusing to between 163 and 238 tonnes per year.

4. LAKE TAUPO VARIATION – OVERVIEW

4.1 Having identified the issue which had arisen in relation to the threat to the long term water quality of Lake Taupo, EW staff embarked upon an exercise of identifying what response the community demanded or desired in these circumstances, i.e. whether the water quality should be improved, should be managed in order that they remain the same or not to take any action. As a result of an extensive consultation exercise involving the circulation of a pamphlet to regional ratepayers and a number of public meetings, EW was able to ascertain that the regional community did not want to ignore the issue, but nor did they want to invest the resources to actually improve the water quality of the Lake – given that it is very high in any event.

4.2 Key aspects of the background to RPV5 can be broadly summarised as follows:

(a) Scientific recognition of the issue.

(b) Reports were commissioned in regard to the potential for large scale land conversion in the Lake's catchment, particularly dairy conversions.

(c) EW notified key stakeholders (the Crown, Taupo District Council, farming groups, Ngati Tuwharetoa etc) of threats to the water quality of the Lake and its intention to take action in late May 2000.

(d) EW published a pamphlet for landowners and interested parties entitled 'Protecting Lake Taupo - A Plan by Environment Waikato'. The pamphlet focused on nitrogen as the source of the water quality issue, actions that would limit nitrogen leaching, economic benefits of a clean Lake and the threat to water quality in the Lake of wide-scale conversion to dairying in the catchment.

(e) Public meetings were held at Taupo and Tokaanu in early 2000 then again in November the same year.

(f) In September 2000 a paper entitled "Issues and Options for Managing Water Quality In Lake Taupo" was prepared and circulated amongst stakeholders and the general public, seeking feedback on four different options for Lake water quality – better water quality, maintain water quality, slightly lower water quality, and do nothing.

(g) During 2001, in a Council resolution, EW decided to pursue Option 2 – maintain current water quality in Lake Taupo – by reducing nitrogen output from existing land uses and preventing further intensification.

(h) Numerous surveys were carried out to determine people's attitudes to maintaining water quality.

(i) Meetings and consultation with the Ngati Tuwharetoa Maori Trust Board, Ngati Tuwharetoa forestry and farming interests, Taupo Lake Care Incorporated,

Lakes and Waterways Action Group, forestry groups, Taupo District Council, and the Ministry for the Environment.

(j) Development of the 2020 Taupo-nui-a-tia Action Plan in association with Taupo District Council, Lakes and Waterways Action Group, and Ngati Tuwharetoa. The 2020 Taupo-nui-a-Tia Project aimed to clarify the roles and responsibilities of the different agencies and management groups involved in managing the Lake, and develop a process to identify the key values for the catchment. The project then went on to identify key 'new actions' to help protect and enhance those values which had been identified.

(k) Discussions with the Crown and Taupo District Council in regard to establishing and funding a trust to permanently remove nitrogen from the Lake Taupo catchment.

4.3 EW also closely assessed options available to achieve EW's objectives, including a comprehensive section 32 analysis.

4.4 Having considered the options open to it to address the issue and discussing the matter at some length with its partners in the project – the Crown, Waikato District Council, Taupo District Council and Ngati Tuwharetoa – EW decided to pursue a combination of regulatory and non-regulatory means for addressing the issues by:

(a) Controlling further land use intensification, thereby preventing an increase in the amount of nitrogen leached from existing land uses beyond that which was occurring in 2001 (known colloquially as "the nitrogen cap").

(b) Permanently reducing the nitrogen discharged from existing farming land uses and wastewater by 20% to offset the load to come (known colloquially as the "nitrogen reduction target").

4.5 It would theoretically have been possible to require farmers to reduce their discharges of nitrogen. However, the decision to adopt this two-pronged approach was to avoid a situation in which existing farmers would have to achieve actual reductions in nitrogen discharges associated with pastoral farming activities which would necessarily impact on farming operations and thus generate adverse social and economic effects, not only for the farmers but for the broader community.

4.6 The implementation of the regime for benchmarking nitrogen discharges, establishing NDAs, approving NMPs and overseeing trading requires a complex legal regime within which to operate. In that regard, RPV5 represents a highly complex suite of provisions. It is now proposed to provide an overview of the provisions.

Overview of RPV5

4.7 The strategy being implemented to achieve the objective of maintaining the water quality of the Lake involves a two-pronged approach comprising both regulatory and non-regulatory mechanisms. These can be summarised as follows:

(a) A regulatory component involves the promulgation of objectives, policies and rules via RPV5, the principal purpose of which is to achieve a cap on nitrogen discharges to the Lake from the catchment at historical (2001 - 2005) levels.

(b) A non-regulatory component (although recognised and provided for in RPV5), involves the establishment of a Public Fund to permanently remove 20% of the manageable nitrogen leaching from pastoral farming and wastewater in the catchment.

4.8 Both mechanisms seek to achieve the objectives of RPV5, especially Objective 1 which seeks to maintain the 2001 water quality of the Lake by 2080 as indicated by the following:

Water Quality Characteristic	Mean	Standard Deviation
Total Nitrogen (mg/m3)	70.3	19.1
Total Phosphorus (mg/m3)	5.57	1.4
Chlorophyll a (mg/m3)	1.18	0.6
Secchi depth (m)	14.6	2.7

Key provisions

4.9 RPV5 introduces rules to achieve the cap on nitrogen discharges from existing land uses within the catchment of the Lake. The summary below reviews RPV5 as at the commencement of the Environment Court hearing in May 2008. Given that the Court has to make decisions in relation to the final form of RPV5, it is not appropriate to refer to amendments that were agreed to by the parties over the course of the appeals hearing, nor is it necessary to do so for present purposes.

4.10 Rules 3.10.5.1 to 3.10.5.5 relate to nitrogen leaching land uses.

Rules 3.10.5.1 to 3.10.5.5 - Nitrogen leaching land uses

4.11 Rule 3.10.5.1 provides for low nitrogen leaching farming activities as permitted activities.

4.12 Rule 3.10.5.2 provides for nitrogen leaching non-farming activities as permitted activities. The rule permits planted production forestry activities and other 'non farming activities'. This rule includes conditions for the use of fertiliser on planted production forestry land.

4.13 Rule 3.10.5.3 is a central provision. It provides, as a controlled activity, for high nitrogen leaching farming activities, i.e., operations which involve more stock than the very low stocking rates set out in permitted activity Rule 3.10.5.1.

4.14 Farming interests argued strongly that farming should be a permitted activity due to sensitivity that pastoral farming per se might need a resource consent (as distinct from specific discharges, e.g., irrigation of dairy shed effluent, which already need resource consents). This is an issue which the Court will need to determine.

4.15 The cap on nitrogen discharges is to be achieved by using the OVERSEER® nutrient budget computer model to "benchmark" existing nitrogen discharges from farming operations. As per EW's decision, it was proposed that the benchmark will be based on the average annual amount of nitrogen leached from a farm between July 2001 and June 2005. However, EW agreed to amend this approach to allow the use of the single best year within the benchmarking period. This becomes the nitrogen discharge allowance (or "NDA") for that farm.

4.16 The farming operation needs to be undertaken in accordance with a nitrogen management plan ("NMP") prepared by the farmer and approved by EW.

4.17 Once the benchmark level is set, the farmer then produces a NMP to describe farm practices which will ensure that the NDA is complied with. This has to be approved by EW. Major changes to farming operations require the preparation of a new NMP and verification, via further use of the OVERSEER model, that the benchmarked NDA is

not being exceeded. The reasoning behind this approach is to assist EW in ensuring that the overall nitrogen cap for the whole catchment is not exceeded.

4.18 Pastoral farmers are entitled to continue to leach nitrogen at historical levels on the basis that EW does not wish to assign "blame" to these landowners, and to maintain the status quo. Landowners who were not farming as of the date of notification of the rule can only farm (or in fact undertake any activity which leaches more nitrogen than historically occurred on their land) as a controlled activity if they can obtain a nitrogen offset for any increase in nitrogen leaching from their land. They would otherwise require a non-complying activity consent.

4.19 It is contemplated that any allocated nitrogen leaching capability (represented by their NDA) which a consent holder does not require (through increased efficiency, alteration to land uses, etc.) will be able to be traded within the catchment. RPV5 contains provisions relating to trading or "offsetting" nitrogen which provide guidance as to how nitrogen leaching allowances can be redistributed between properties. For example, if an existing farmer were to convert their land to lifestyle blocks which would discharge far less nitrogen than pastoral farming operations, the excess NDA entitlement could then be sold or leased to a farmer who wished to intensify farming operations.

4.20 Rule 3.10.5.4 provides for nitrogen discharges from new nitrogen leaching land uses (provided those increases are offset elsewhere in the catchment) as controlled activities.

4.21 Rule 3.10.5.5 provides for land uses activities that do not meet the preceding rules as non-complying activities.

4.22 Viewed in the round, the effect of Rules 3.10.5.1 to 3.10.5.5 is to retain the status quo with respect to nitrogen leached from land uses within the Lake's catchment. This means, for example, foresters can continue to carry out their forestry businesses and farmers can continue to farm at the intensity/scale that they have in the past. The rules are designed to limit any increase in nitrogen leaching in the absence of compensatory nitrogen leaching offsetting as that would result in the nitrogen cap being exceeded. In this way, historical land uses are grandparented.

Rule 3.10.6 - Wastewater rules

4.23 RPV5 also introduced sophisticated and complex provisions relating to wastewater discharges in the Lake Taupo catchment. They relate to:

(a) Existing on-site wastewater discharges in the near-shore zone as permitted activities (Rule 3.10.6.1).

(b) Existing on-site wastewater discharges outside the near-shore zone as permitted activities (Rule 3.10.6.2).

(c) New advanced on-site wastewater discharges on properties greater than 5,000 square metres (or 2,500 square metres if subdivision consent is granted before 9 July 2005) as permitted activities (Rule 3.10.6.3).

(d) New conventional on-site wastewater discharges on properties greater than 4 hectares as permitted activities (Rule 3.10.6.4).

(e) New papakainga and marae wastewater discharges as restricted discretionary activities (Rule 3.10.6.6).

Public Fund and Lake Taupo Protection Trust

4.24 EW engaged with Central Government and Taupo District Council in relation to implementing land use change, including funding options, to achieve a 20% reduction in the manageable nitrogen inputs to the Lake. As a result, a joint public fund has been established to permanently remove 20% of the manageable nitrogen from the catchment through securing permanent change on individual properties to a lower nitrogen leaching land use. It is contemplated that this will be achieved by either purchasing pastoral and cropping land in the Lake's catchment from willing sellers and converting it permanently to covenanted low nitrogen land uses (such as forestry) or purchasing the NDAs from willing landowners and permanently removing that nitrogen from the catchment.[8]

4.25 The Public Fund is vested in the Lake Taupo Protection Trust, a council controlled organisation that has been established pursuant to the provisions of the Local Government Act 2002 and a deed of Trust between the Crown, the Regional Council, and Taupo District Council.

4.26 The policy of reducing manageable nitrogen inputs to the Lake by 20% by the year 2020 is also included in RPV5.

5. KEY LEGAL AND POLICY ISSUES – DISCUSSION

5.1 Against that background, it is proposed to identify some of the key issues which arose or needed to be considered in the development of RPV5, to see whether there are any useful lessons which can be drawn from the exercise and taken into account in other catchments.

5.2 As noted, I am constrained in some respects by the fact the Environment Court still needs to make a decision in relation to appeals on RPV5. Having said that, there is now a large measure of agreement in relation to the key elements of RPV5 so that most aspects of the variation are effectively settled to the extent that the provisions were not subject to appeal or agreement has been reached. Where an issue that warrants comment still needs to be determined by the Court, any comments will be confined to matters that were put before the Court at the public hearing.

5.3 The most important issue that is likely to need to be grappled with elsewhere is the issue of "allocation", so my comments will focus on that issue. Other issues are:

(a) Whether nitrogen discharges associated with plantation forestry should be regarded as manageable load and given entitlement via the benchmarking process.

(b) Planning issues (largely relating to activity status).

(c) Legal issues, relating to the legal basis for the rules.

5.4 All three of these issues still need to be determined by the Court and will therefore be the subject of only brief comment.

"Allocation" – grandparenting versus averaging or regulation

5.5 One of the key issues which EW had to grapple with when developing RPV5 was to arrive at a means of reducing man-made nitrogen discharges into the Lake Taupo catchment nitrogen cycle while balancing potentially adverse social and economic effects. It was a fear of causing such effects that led EW to favour a system whereby a "cap" would be achieved by restricting farming activities so there will not be any

[8] Page 38 of the section 32 analysis dated March 2007.

increases in nitrogen discharges without actually forcing farmers to reduce their discharges.

5.6 In that regard, EW was acutely aware in developing RPV5 of the need to appropriately balance environmental objectives in terms of the Lake (and the social and economic benefits associated with its pristine quality and iconic status) alongside the cultural, economic and social consequences associated with managing nitrogen discharges. In that regard, a key objective (Objective 4) of RPV5 is that:

> *"Economic costs of managing land use activities to achieve Objective 1 are minimised, and spread across local, regional and national communities. Social and cultural effects of managing land use activities to achieve Objective 1 are mitigated."*

5.7 The explanation to that objective states:

> *"Objective 4 recognises that intervention managing land use activities to achieve Objective 1 could make some existing rural land uses unviable if they were required to achieve reductions in nitrogen, leaving many people in financial hardship. If no action is taken to reduce the impact on particular sectors of the community, there will be significant adverse social, cultural and economic effects on those sectors. Flow-on effects to the wider community, such as decline in local business, may also result. The objective seeks to minimise these impacts and ensure costs are spread across local, regional and national communities. The objective also creates an expectation of a higher level of involvement in managing change between the regulatory authority and affected landowners than has historically occurred."*

5.8 Against that background, a fundamental philosophical underpinning of RPV5 is that farmers should be entitled to continue to carry on farming operations at the same level as they have historically undertaken – this level of activity being the "grandparented" entitlement. Any land use intensification must be achieved without affecting the overall nitrogen cap for the catchment. Farmers may intensify their operations without increasing nitrogen leaching by taking up new nitrogen management practices or by acquiring nitrogen from other landowners in the catchment who have generated surplus nitrogen by changing land use practices.

5.9 To that extent, the grandparenting approach recognises that existing farms and the plant and buildings on them represent the outcome of significant effort of individuals and families and significant investment in assets and infrastructure which represent "physical resources" that must be sustainably managed in terms of section 5 of the RMA. EW gave a great deal of consideration to these matters in developing RPV5, whilst being very clear about the need to preserve the Lake's water quality.

5.10 It is also important in that context to note that EW was not and is not seeking to assign "blame" for historical contamination of the Lake as a result of what were considered to be lawful and appropriate farming activities. In particular, it was not known at the time they were established that these activities (many of which were encouraged and even subsidised by Central Government) were having (or eventually would have) adverse effects on water quality.

5.11 It is for that reason that RPV5 seeks to achieve the 20 percent reduction in pastoral farming (manageable load) nitrogen discharges via the application of the Public Fund by the Trust, rather than imposing an initial nitrogen discharge allocation regime that would require farmers to reduce their nitrogen discharges. Those discharges, in the context of RPV5, represent a reasonable proxy for farmers' efforts, recognising that an actual reduction in the ability to carry out normal farming activities (and the nitrogen discharges associated with them) would cause significant social and economic dislocation which cannot be justified when more equitable and practical alternatives exist.

5.12 This was a key reason why any kind of allocation regime based on averaging (which carries a punitive element as far as existing farmers are concerned) was not favoured by EW and it remains the principal basis for EW's opposition to such an approach.

5.13 Although the relief was abandoned during the hearing, one of the key appellants to RPV5, Carter Holt Harvey Limited ("CHH") requested the implementation of a different regime for limiting nitrogen discharges, namely:

(a) Delayed averaging; or

(b) Alternatively, regulation without allocation or trading.

Delayed averaging

5.14 Under delayed averaging as proposed:

(a) An average value of nitrogen which may be leached, expressed in kilograms per hectare per year, would be derived for the entire catchment, (excluding Department of Conservation land)

(b) There would be no cap, allocation, or trading of nitrogen until 2015, which is when a cap would be imposed, allocation based on catchment-wide averaging would occur, and nitrogen trading would commence.

(c) From 2015 landowners in the catchment would not be permitted to undertake activities which would result in nitrogen discharges which exceed the catchment-wide average allocation unless they purchased or leased nitrogen credits from a person with a surplus of nitrogen credits.

(d) Prior to 2015, farmers would be required to implement activity standards (or what are more commonly known as management practices) designed to minimise nitrogen discharges, and foresters wanting to convert to farming could do so provided they complied with the same activity standard rules as farmers.

5.15 CHH supported delayed averaging for a number of reasons, including the following:

(a) It treats all land owners in the catchment equitably as they would all be allocated the catchment wide average nitrogen leaching rate.

(b) It provides for foresters to convert from forestry to farming or any other land use prior to 2015 provided that they meet the regulated "activity standards" or farming management practices and is, therefore, more consistent with the philosophy of having the freedom to exercise property rights so as to make profits in response to market signals.

(c) As past "polluters", farmers should be required to implement management practices to reduce nitrogen leaching so that they "trend down to" the catchment wide average prior to it being imposed.

(d) Grandparenting is inconsistent with the polluter pays principle.

(e) Grandparenting would set a precedent for other catchments.

(f) Given alleged scientific uncertainties (root zone leaching rates from land uses in the lake Taupo catchment, loads to the Lake, and accuracy of OVERSEER) underpinning RPV5, delayed averaging is preferable because it delays the implementation of capping, allocation, and trading and thereby provides time for more research and analysis.

5.16 Both EW and farming interests vehemently opposed delayed averaging as a means of allocating rights to discharge nitrogen, for a variety of reasons:

(a) At a philosophical level it is possible to argue that both grandparenting and delayed averaging are equitable. However, when the implications of grandparenting versus delayed averaging are considered, grandparenting is to be preferred both as regards EW's goals in terms of water quality in Lake Taupo and having regard to social and economic consequences – both highly relevant in achieving the purpose of the RMA.

(b) In allowing historical land uses to continue at the same intensity, but no greater unless nitrogen trading or offsetting occurs, grandparenting imposes an opportunity cost on all landowners as it places limits on what otherwise might have been the development potential of land in the catchment. To that extent, farmers and foresters are treated equally.

(c) By contrast, delayed averaging would result in a significant transfer of nitrogen credits (wealth) from farmers to foresters in 10 years time (as farming leaches much more nitrogen than forestry in the catchment) with the result that farmers would not be able to continue farming at historical levels unless they could purchase nitrogen credits to do so. This results in a significant transfer of wealth as existing operators seek to obtain credits and this creates windfall gains for the owners of forested and undeveloped land.

5.17 Ultimately, the matter did not need to be determined, but the issue may well arise again in other catchments. It is important to note that the relative merits of averaging versus grandparenting will be influenced by the pattern of land use in the catchment.

Regulation without allocation or trading

5.18 This would involve the imposition of a regulatory regime whereby farmers farm pursuant to a controlled activity consent that requires them to implement on-farm management practices to minimise nitrogen leaching. The regulatory regime would also allow foresters to convert to farming and comply with the same requirements as farmers.

5.19 EW was opposed to this relief on the basis that specific nitrogen abatement practices which are uniformly applicable across all landholders will have varying effectiveness and costs amongst different landowners. It would not cap nitrogen discharges, would allow intensification of land use in the catchment as foresters would be entitled to convert to farming land use, and the management practices proposed are ineffective, impractical, and uneconomic in the Lake Taupo catchment.[9]

5.20 Again, the matter did not need to be determined but may well be an issue in another catchment, in which case the specific measures available and their likely effectiveness would need to be considered.

Auctioning

5.21 Auctioning as a means of allocating nitrogen discharge allowances was also raised but this was not pursued.

Grandparenting with flexibility

5.22 As a footnote to the discussion in relation to allocation, it is worth noting that a variation on the grandparenting philosophy has been introduced to meet the specific needs of Ngati Tuwharetoa, who are the largest landowner in the catchment.

[9] Ledgard EIC, section 9 and rebuttal, paragraphs 3.17 and 3.19.

Historical factors have limited their ability to develop their land so most of it remains undeveloped and it was seen as appropriate to enable some flexibility to recognise these factors provided that it does not result in any more than a minor effect on the cap. Of particular importance is that the effect of providing this flexibility will have only a minor effect on the cap and small effect on Lake water quality if all of the potential development opportunity is realised.

Dealing with forestry leaching

5.23 When RPV5 was notified, forestry was assigned a leaching rate of 2kg N/ha/pa and that figure remained the same in the Decisions Version of RPV5. Part of the CHH appeal alleged that this figure was too low.

5.24 EW commissioned a team of experts to further consider this issue in light of the available literature and data primarily derived from the Puruki Pine forest in the Purukohukohu experimental catchment outside of the Lake Taupo catchment. As a result of this process, it was acknowledged that the leaching rates for pine forests planted into improved pasture and nitrogen fixing species such as gorse, broom, and tutu, were higher than 2 kg N/ha/year. It was also acknowledged that nitrogen leached from pine forest planted into improved pasture is manageable as there are management practices that can be used to reduce the leaching rate.

5.25 The experts agreed that the best estimate for the leaching rate of nitrogen fixing scrub is 23 kg N/ha/year, but they could not agree on the final figures for pine forest planted into improved pasture. Ultimately, this became a significant issue in terms of the evidence that had to be prepared and the hearing time that was required for that evidence to be presented, even though the range of difference was only 8 kg N/ha/year (EW experts) versus 12 kg N/ha/year for pine forests planted into improved pasture and the amount of such land in the Lake Taupo catchment is very small. There was also disagreement amongst the experts in relation to how long it takes for the leaching rate to trend down to a background level of 3 kg N/ha/year.

5.26 CHH have argued that forestry leaching should be dealt with by providing a deemed leaching rate of 12 kg N/ha/year for pine forests planted into improved pasture. The primary reasons for that position are as follows:

(a) It reflects a grandparenting approach that is consistent with how pastoral farming is proposed to be treated and reflects the amount of nitrogen likely to be leached from the land.

(b) It may take hundreds of years for the leaching rate to trend down to background levels of 3 kg N/ha/year.

(c) Assigning the deemed background leaching rate allows an offset which would allow farmers to increase stock numbers and, therefore, nitrogen leaching.

5.27 EW, Ngati Tuwharetoa and the farmers in the catchment have argued that pine forests planted into improved pasture should be given a deemed leaching rate of 3 kg N/ha/year. The primary reasons for that are as follows:

(a) The leaching rate will trend down to this background level over 2 to 5 rotations.

(b) It provides an incentive for farmers to convert pasture to pine forest.

(c) It avoids locking in a high leaching value.

5.28 This is an issue which the Court is required to determine and which will be addressed in its interim decision.

Activity status

5.29 A key issue which attracted a great deal of attention throughout the hearing was whether high nitrogen leaching farming activities under such a regime should be a permitted activity, commensurate with farmers' views that no resource consents should be necessary to undertake farming activities, or a controlled activity, as favoured by EW.

5.30 Farmers argued that farming activities should be accorded permitted activity status, largely on the basis of a philosophical position that they should not be required to obtain resource consents to undertake farming activities and because it is possible to craft permitted activity rules that enable nitrogen discharges to be controlled. A draft permitted activity rule was prepared as a result of caucusing. The rule contains detailed standards, conditions, and terms as it has to be a self contained rule with the required degree of certainty that sets out all of the necessary steps to benchmark a farm and ensure compliance on an ongoing basis. The rule covers 5 pages of A4 paper at single spacing and is the most draconian permitted activity rule I have ever seen. The rule was agreed to by the farmers and their planning consultant, albeit with some reservations about the legality of certain matters included in the standards, conditions, and terms of the rule.

5.31 EW does not support the permitted activity rule and favours a controlled activity rule on the basis that it is a much simpler approach and the actual rule is extremely succinct compared to the permitted activity rule. Further, EW's position is that the controlled activity rule enhances regulatory certainty and provides EW with a degree of flexibility to deal with the realities of farming in the Lake Taupo catchment. In addition to these matters, there are legal issues with the permitted activity rule in terms of certainty, comprehensibility, discretion being reserved to EW, and the ability to recover the fair and reasonable costs of monitoring under a permitted activity regime.

5.32 This is an issue which is likely to arise anytime this matter needs to be addressed.

Legal basis for rules

5.33 One of the key issues which arose during the Court hearing on RPV5 (and which the Court needs to determine) is whether EW was developing purely land use rules under section 9 of the RMA promulgated in reliance on section 30(1)(c)(ii) or whether the rules were hybrid land use and discharge rules based on both section 9 and section 15 of the RMA and promulgated in reliance not only on section 30(1)(c)(ii) but also on section 30(1)(f).

5.34 EW considers that the rules of RPV5 were developed in reliance on both section 9 (land use) and section 15 (discharge) of the RMA, due to the need for discharges to be "expressly allowed" in terms of section 15. However, national farming interests are concerned that they be labelled land use rules only, lest the implication be raised that pastoral farming activities involve discharges from stock that need to be authorised in terms of the RMA.

5.35 As a result of that concern, farming interests made extensive arguments that the RPV5 rules as notified were land use rules only, that the Court has no jurisdiction to make the rules hybrid land use and discharge rules, discharges from stock are not discharges within section 15(1)(b) of the RMA, and, in any event, it is not necessary to have hybrid rules as rules promulgated pursuant to section 9(3) of the RMA authorise any associated discharges of nitrogen.

5.36 EW's position is that there is an argument based on existing case law that discharges from stock are discharges within section 15(1)(b) and is concerned to ensure that the rules of RPV5 expressly authorise those discharges. In relation to the other arguments presented by the farming interests, EW's position is that the Court has

jurisdiction to determine that the rules are hybrid land use and discharge rules, the public notice for RPV5 made it clear that the rules were always intended to be hybrid land use and discharge rules, the notified version of the rules may only authorise discharges by implication (rather than expressly as required by section 15(1)(b)), and that it is necessary for the rules to be hybrid rules that expressly authorise discharges, particularly given that a Court may decide in the future that discharges from stock are discharges within section 15(1)(b).

5.37 The Environment Court has yet to rule on this issue so it is not appropriate to take the point any further at this point. However, it is probably safe to say that, in the absence of a ruling that diffuse discharges can be adequately authorised as a pure land use under section 9, it represents good practice for regional councils to assume that any rules dealing with discharges via urine and dung patches, etc., should be based on or referenced to both section 9 and section 15 of the RMA.

6. CONCLUDING COMMENTS

6.1 As noted, care needs to be taken in transferring the specific lessons from EW's RPV5 experience to other catchments, on the basis that the regime which is adopted to deal with "allocation" and the appropriateness of a specific rule regime will be heavily dictated by the pattern of land use in the relevant catchment and important socio-economic considerations.

6.2 Nevertheless, RPV5 provides a useful example of the issues that will need to be addressed and the challenges which will need to be faced. In the context of this conference, probably the most important matters to take away are that:

(a) Regional councils do have the power within the context of the RMA to develop effective policy and rules to deal with diffuse pollution, although there is room for clarification as to the technical legal basis for those controls (which will hopefully be provided by the Court in due course).

(b) The science associated with identifying sources of nitrogen can be difficult, but there can be no doubt that anthropogenic sources are affecting our waterways and need to be addressed.

(c) Difficult socio-economic issues will arise and early and effective engagement with key stakeholders will be important.

6.3 Thus, despite these challenges, a means to address diffuse pollution exists – if the issue is to be addressed, there is no reason why regional councils cannot effectively do so, at the same time being aware of the competing interests that will need to be weighed and balanced in developing an appropriate set of regulatory controls and the complex and lengthy procedures through which that measure will need to pass.

Simon Berry
August 2008

APPENDIX A

NITROGEN CYCLE – AN OVERVIEW[1]

W N Vant, Environment Waikato

1. To help reduce possible confusion, I have been asked to provide a simple overview of the nitrogen cycle. My intention is to help provide the overall context within which the expert statements that deal with particular aspects of the nitrogen cycle may be better understood. This section therefore deals with the nitrogen cycle as it applies to the Lake Taupo catchment as a whole.

2. There are a number of pathways by which nitrogen can enter the Lake Taupo catchment, including atmospheric deposition (e.g. via rainfall), nitrogen fixation by clover and other plants, and additions of fertilizer. These can be regarded as "inflows" of nitrogen to the system. Similarly, there are a number of pathways by which nitrogen can leave the system, or be otherwise made semi-permanently unavailable to it. These can be regarded as "outflows" of nitrogen, and include transport out of the lake down the Waikato River, burial in lake bottom sediments, export of agricultural produce outside the catchment and the return of nitrogen to the atmosphere by the process of "denitrification".

3. A fundamental principle of ecology is that matter, including atoms of nitrogen, is neither created nor destroyed within ecosystems. Even so, nitrogen in a given chemical form, such as the nitrate ion, can be transformed to different chemical forms by various chemical and ecological processes. For example, plants like algae and grasses can transform the nitrogen present in the nitrate ion into nitrogen contained within large, complex plant proteins; this process is called "biosynthesis". Conversely, certain bacteria can transform the nitrogen present in the nitrate ion into nitrogen gas (via denitrification), the simplest form of naturally-occurring nitrogen.

4. The nitrogen cycle of the Lake Taupo catchment thus involves the transport of nitrogen into and out of the catchment, together with the various processes of chemical transformation of individual nitrogen atoms. A convention adopted by several of the expert witnesses, including me, has been to use the term "attenuation" to refer to the removal of dissolved forms of nitrogen from groundwater, streams and the lake itself, via its transformation into nitrogen gases which are released to the atmosphere. The term also covers the conversion of nitrogen from forms that are readily-useable by aquatic organisms to other aquatic forms that are much less useable, and thus are effectively unavailable for further biosynthesis.

5. "Attenuation" thus refers to a subset of chemical transformations that together mean that a portion of the nitrogen entering the Lake Taupo catchment is not available for use in biosynthesis in the lake itself. The term thus allows us to distinguish between the nitrogen that is relevant to algal growth in Lake Taupo, and that which is not.

1 Overview based on paragraphs 2.4 - 2.16 of the rebuttal evidence of W N Vant dated 24 April 2008 presented as Appendix 3 of Opening Legal submissions presented by counsel for EW to the Environment Court on 5 May 2008.

6. Figure R1 (below) is a simple pictorial representation of the key concepts and processes of the nitrogen cycle in the Lake Taupo catchment. The upper part of the diagram does not show the specific details of the various flows and transformations of nitrogen. In particular, I have not shown the detail of the various chemical transformations (although I have outlined these in a number of cases, e.g. "denitrification"). However, the two insets, taken from the evidence of Dr Clothier and from the draft forestry leaching report,[2] respectively, serve to illustrate the general nature of some of the key chemical transformations. The details of these transformations are covered in the evidence of the other experts who individually deal with particular parts of the overall system.

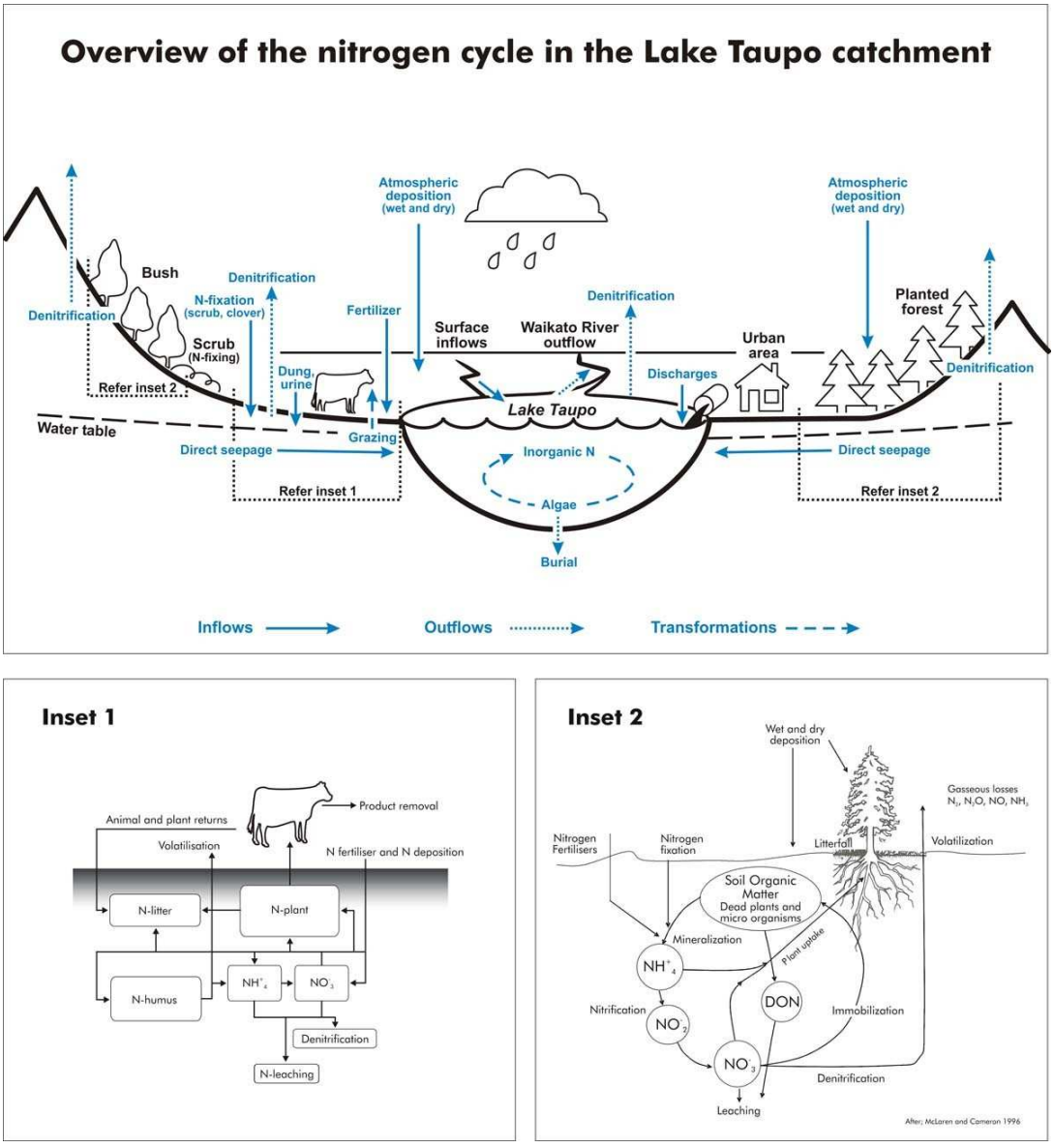

Figure R1: The nitrogen cycle in the Lake Taupo catchment. See text for details.

2. Davis, M.; Baisden, T.; Parfitt, R.; Magesan, G.; Vant, B.; Quinn, J. 2008: Nitrogen leaching from radiata pine and native forests, and undeveloped shrublands in the Lake Taupo catchment (draft). *Environment Waikato technical report (draft)*. EW, Hamilton.

7. I have used two colours in preparing the upper part of Figure R1: items in black represent key components of the biophysical setting, while those in blue refer to aspects of the nitrogen cycle. Solid blue lines represent inflows of nitrogen, dotted lines are outflows and dashed lines represent chemical transformations.

8. The inflows of nitrogen that I show in Figure R1 are atmospheric deposition, nitrogen-fixation by "leguminous" plants (e.g. clover, gorse and broom), deposition of fertilizer and animal dung and urine on pasture, and discharges from urban areas (namely stormwater and treated sewage wastewater). I also show nitrogen flowing into the lake via surface inflows (i.e. rivers and streams), and via direct seepage of groundwater. In these latter cases, the nitrogen transported into the lake by these routes has come from one or more of the various sources that I have already mentioned (i.e. atmospheric deposition, nitrogen-fixing plants, and so on).

9. The nitrogen shown in these various inflows is present in a number of different forms. For example, the nitrogen present in animal urine is dominated by urea, a simple organic chemical. By contrast, the nitrogen entering the system via nitrogen-fixation is generally present as the ammonium ion, a simple inorganic chemical (or "mineral" in the terminology used by some witnesses). The nitrogen in atmospheric deposition, urban runoff and sewage wastewater is usually a mixture of inorganic and organic forms. Much of the nitrogen in the surface inflows and in direct seepage of groundwater is present as the nitrate ion, a simple inorganic form.

10. The outflows of nitrogen that I show in Figure R1 include denitrification - loss to the atmosphere as nitrogen gas, and burial of dead and decaying algae in the bottom sediments of the lake. I also show nitrogen flowing out of the lake, and down the Waikato River. Most of this is "dissolved organic nitrogen", a biologically-unavailable form that is produced within the lake, partly as a by-product of algal growth, but mainly as one of the results of the decay of dead algal cells.

11. Figure R1 also identifies some of the processes by which nitrogen is chemically transformed. As described in detail by Drs Clothier and Ledgard, grazing animals consume organic nitrogen in the form of grass. Much of this is converted into animal products (e.g. meat, milk and wool), and exported out of the catchment, but some of the nitrogen is deposited on the ground as dung and urine (as I have already described in paragraph 2.11). As I describe below, the nitrogen entering the soil undergoes a series of transformations, resulting in some of it being available for further plant growth. Some, however, leaches below the root zone to groundwater, and a portion of it is eventually delivered to the streams and the lake, and is thus available to be used there in algal biosynthesis.

12. Similar processes operate in forest ecosystems, as described by Dr Baisden, but in this case grazing by large herbivores is much less important. Nitrogen enters the soil in these ecosystems via atmospheric deposition and nitrogen-fixation, and from there is taken up by plants and assimilated into plant tissue. Nitrogen also enters the soil following the breakdown of leaf litter and other dead plant material. The organic forms of nitrogen in this material are partly converted to inorganic forms by the micro-organisms living in the soil, and are thus available to be used again by the plants, or to be lost by leaching below the root zone. However, some organic forms of nitrogen do not break down readily, and remain as dissolved organic nitrogen. And some of the inorganic nitrogen is denitrified, and is thus lost from the soil as nitrogen gas (together with certain other gaseous forms of nitrogen).

13. The other important chemical transformations shown in Figure R1 involve the incorporation of inorganic nitrogen into algal tissue within the lake, and the subsequent breakdown of this organic nitrogen into a mixture of inorganic and organic forms (the latter including dissolved organic nitrogen, as I described in paragraph 2.13). The inorganic nitrogen resulting from the bacterial breakdown of dead algal cells is subsequently taken up by a new generation of algae to support their growth.

QUESTIONS

Gary Taylor, Environmental Defence Society: Just some quick points. Guy, I am not sure that you can blame the RMA for the poor quality of the National Policy Statement on Freshwater Management. I think it is poor drafting, poor advice and poor decision-making by the Minister. It is not an inherent fault by the RMA. Secondly, I would be concerned if people took you too literally when you said that the Board of Enquiry has limited scope. It doesn't. People should basically say in these submissions what they think should be in the National Policy Statement and not think that it is circumscribed in terms of scope. On the scope issue we are going to put legal advice about that matter onto our EDS website for people to refer to as soon as the Terms of Reference are out. But can I ask two questions.

Robert, why don't you show some leadership, such as you have done with Variation 5 and I commend Environment Waikato on it, and introduce a variation or a plan change to require consent for dairy conversions in the rest of the region? Attach some performance criteria in that variation so that you can control those adverse affects.

Simon, could I ask whether you agree that in the absence of a rule and a plan expressly authorised in discharge under Section 15, and in the absence of a resource consent enabling it, dairy farming is actually illegal?

Robert Brodnax: I suppose Council's decision-making in that regard was when we first came to considering this we needed to focus on the sub-region and the sub-catchment that was most at risk. Trying to advance a region-wide rule would inevitably be litigated to a maximum extent and had the potential to take so much time that we would not actually get the outcome we needed in the Upper Karapiro catchment. The question you asked is one that our Council has been asked to consider through this coming Long-Term Community Council Plan round as to whether it continues with its strategy of sub-regional plan changes or goes straight for a regionalised plan change. I know that is a conversation that is going around the Council table at the moment.

Simon Berry: Gary, the real question is whether discharges associated with pastoral farming, that are not expressly authorised or subject to a resource consent, are unlawful. Certainly there is a view available that is actually the case. Interestingly, quoting from the decision of the Environment Waikato committee that made the decision chaired by Professor Skelton, who is an ex-judge of the Environment Court, part of the decision says exactly this: "the committee accepts that in terms of Section 151B of the Resource Management Act, all discharges of nitrogen as a contaminant from land use activity from the catchment have probably been unlawful since the passage of that Act", probably long before the Resource Management Act, see Section 21 of the Water and Soil Act. The committee uses the words, "probably unlawful", because it may not be possible to prove an actual breach due to the fact that these discharges are non point source or disffused charges and thus difficult, if not impossible, to detect even if a large number of leachate samplers are installed and so forth.

So I think the short point is, as a matter of principle, unless there is a rule and a regional plan that authorises those discharges, they may be unlawful. There is one element of what Judge Skelton says: that it does not really matter, as long as you know what is going on with the land then the threshold in terms of the Act is only that it may enter the water. That is a very low threshold, but while we can draw an inference that those discharges are occurring, there are issues of proof.

I also have to outline a contrary argument that was put forward by national farming interests during the Hearing because this is an issue which the court is going to need to

rule on. I have to be careful what I say, but we essentially said that for the purpose of developing Regional Plan Variation 5 it was appropriate for the Regional
Council to assume that those discharges were unlawful, thus expressly allowing that farmers in the catchment will not be caught out if such a ruling is made.

But the countervailing argument was that Section 9 authorises land-use activity, and the discharge element associated with those land-use discharges is similarly authorised so there is no need for those rules to be discharge rules. There is an argument that says that they are not unlawful because Section 9 permitted**,** but my personal view is that they probably are unlawful, certainly for the purpose of developing land rules.

Guy Salmon: Just a response to Gary's comments. I certainly did not intend to suggest that the Resource Management Act should be blamed for the National Policy Statement. Obviously that is a failure of Ministerial advisers and Ministers, but I think there is a case for looking at the Resource Management Act Government System as a whole. That was really what I was getting at. We have set up a system which is a mix of all these issues to politicise and is not capable of generating specific environmental bottom lines. Part of the problem is that the advice given to the Ministry is that in drafting national policy statements they can not fetter the regional decision-makers of authority to decide those matters. If that advice is correct then we have an unworkable instrument and that is part of the problem with the National Policy Statement.

The solution to it is to address it with a legislative amendment and that is something that should be looked at. But the overriding message I want to leave is that we are making a mess of our Resource Management if we rely so heavily on these very vague, slippery statements of objectives and policies which we see not only in National Policy Statements, but also in many Regional Policy Statements and in many regional plans.

Rowland Burdon, Royal Society of New Zealand: Robert has made a case that between the Local Government Act and the Resource Management Act there is a pretty comprehensive toolbox, thus my question is "What is the risk of the court making a ruling on the basis that provisions in one Act may have the effect of negating important pieces in another Act? My understanding, for instance - and I was uncertain about it but some of the recent discussions seem to reinforce it - is that the Resource Management Act is in some respects quite weak on the Precautionary Principle. That being so, for any proposal within an established use there would be a strong onus of proof that it will have adverse effects, no matter how adverse those effects might be.

Simon Berry: It is difficult to conceive a situation in which one could trump the other in the sense that we often have the situation in which both pieces of legislation have some relevance and Regional Plan Variation 5 is a good example of that. Regional Plan Variation 6 which is the water allocation variation that Robert was talking about is also an interesting one. Often it is the case when you have district councils that in their capacity as infrastructure providers, for example, are wastewater operators, but you know they are often not very good in terms of their wastewater discharges.

But the decisions that have emerged from the Local Government Act procedure as to the level of investments that a district council is prepared to make in its wastewater infrastructure then gets tested by the Resource Management Act process via an application to the regional council. Now if the regional council does not like the level of treatment which the district council thinks it can afford, you have a situation in which potentially the Resource Management Act gets to trump the Local Government Act because the Resource Consents get declined. We do not normally see it in those terms but if one was going to trump anything in the hard edge of a resource allocation it is likely to be the Resource Management Act versus the Local Government Act.

Does that answer your questions? That would be the kind of context in which conflicts might arise but I cannot see beyond that other than the Long-Term Community Council process and the Annual Plan process that throw up community type decisions but will not necessarily dictate the environmental outcome.

Session Four – Should farmers in Nutrient Sensitive Zones make changes to protect the environment?

INTRODUCTION

John Green: Toby Curtis, Chair for this session, is widely acknowledged for innovative achievements in education, with specialist expertise in Maori, Polytechnic and University fields. He has been a teacher, principal, lecturer, researcher, administrator and senior academic in tertiary education. He is the Chairman of the Te Arawa Lakes Trust and Deputy Chair of the Rotorua Lakes Strategy Group.

SESSION CHAIR: Toby Curtis

I have just come away from the signing of the Government commitment to deliver their part of the bargain of $72 million towards the upgrading of the lakes, to hopefully return them to their pristine condition some time in the future. We hope it will not take too long. It has been a pleasure and a wonderful experience, not only for Tauranga, for Rotorua, for Bay of Plenty, I like to think for the nation as a whole.

THE CASE FOR THE ENVIRONMENT -
ECOSYSTEM SERVICES, WHAT WE ALL NEED BUT FEW MANAGE

Dr Morgan Williams
Immediate-Past Parliamentary Commissioner
for the Environment
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Morgan for ten years was the Parliamentary Commissioner for the Environment and focused his team on environmental sustainability in urban, marine, energy, water, farming, economic and governance contexts. He is currently an Adjunct Professor at the Universities of Canterbury and Queensland. His great interest is in how people think and relate to the natural world in terms of political, social and economic constructs in managing our natural capital and sustainable development.

ABSTRACT

In 1929 Albert Einstein said; “Imagination is more important than knowledge”. While I am a great advocate of seeking the physical knowledge needed to manage the complexity of resources on which we all depend, I am increasingly of the view that we need to apply a lot more imagination to the ways we organise ourselves to do so. What Einstein was implying is that no matter how complete we think our knowledge is - it is the knowledge of the now. Imagination on the other hand stretches our quest for knowledge away beyond the now to the ‘what might be possible’. This stimulates the quest for knowledge we don’t yet have.

An example of the way imagination can stretch the knowledge quest is President John F Kennedy’s early 1960s declaration that America would put a man on the moon by the end of the decade. His imagination inspired the training of thousands of new scientists, engineers and computer developers because NASA simply did not have the technology, or understanding of human physiology, to put men on the moon at that time. In this case Kennedy’s imagination inspired a generation and a nation, created an enormous body of

human capital and kindled a vast new array of knowledge that has made many things possible, on earth as well as in space. However it all started with one man's imagination.

In my address I will focus on the great dependence our communities and economy have for what we call ecological services. These are 'services' such as pollination, maintenance of healthy soils, waters that support an abundance of life, wetlands that filter our waters, retention of hill lands by trees etc. While we increasingly recognise how dependant we are on these services, increasingly we struggle to sustain their health. This is because the things that are threatening ecological services are mostly part of very complex 'wicked' systems issues, spatially and temporally. When it comes to nutrients, and their impacts on ecosystems, we are getting a grip on many aspects of the science, one dimension of the needed knowledge, but we are struggling to apply such knowledge via current property rights, frameworks and governance models. This is despite a lot of dedicated work by many individuals, groups and agencies in recent years in NZ, and internationally.

I will propose that we need leaps of imagination, into areas that could merit exploration, if we are going to make real progress sustaining the health of the Rotorua Lakes this century; a century when fresh water quantity and quality and our ability for feed 6.7 billion global citizens, will shape all our destinies.

TRANSCRIPT

It is a great pleasure to be here. I was given a general subject – The Case for the Environment, so I am going to focus on wider issues. I would like to start a little further out from the topic. In fact I am going to stay far away from the details that you have had today in an attempt to put it in a wider concept.

> *"Between 1968 & 1972 twelve men walked on the moon. They and their space ship crew members remain the only humans to have seen the earth in all its glory and fragility from deep in space. They were all profoundly moved by the experience."*

Why the hell would I start way out looking back at the earth? It is because we are living in a very closed system and I think that is what we have got to keep reminding ourselves. I saw a documentary a few weeks ago "The Shadow of the Moon", which of course was all about the journeys to the moon in the late 1960s. I would like to know a little bit more about this whole process as I went away absolutely profoundly moved about what had happened to those astronauts. The documentary is largely an interview with these guys, and they were all guys, now in their seventies. What had the most influence on them was seeing home from so far away. One said that they could put their thumb up and not see the world behind it.

They have all gone through the epitome in terms of the fragility of this place that we live in, called planet earth, and they are very, very passionate about managing our natural capital looking after this tiny, fragile, blue planet that hangs in space. If we could send all our politicians to space maybe they would get it.

Second question - Should farmers in Nutrient Sensitive Zones make changes to protect the environment? Well yes, but, and there are some big buts. The wider society must make major changes as well. It is what we need to think about more widely in the system which I want to run through today. I have prepared a framework of ideas (Figure 1) that are part of thinking about the bigger pieces of the system that come together when we are trying to deal with the 'wicked' problems that play out.

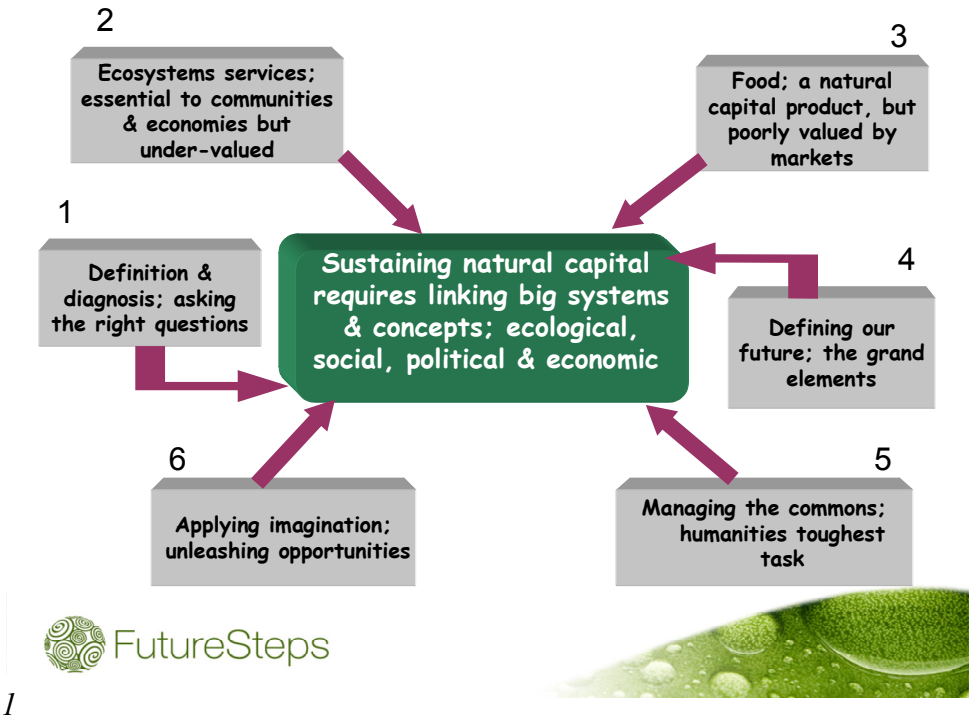


Figure 1

If we go simply to an individual lake, at the end of the day we are trying to sustain a natural capital system with ecological, social and political components. "Definition and diagnosis, asking the right questions"; I and my team, in the ten years I was Parliamentary Commissioner, spent a lot of time trying to pick out, and unpick, the question, because if you get the question wrong you sail off in the wrong direction. We see that a fair bit in political circles.

We are asking the right questions in terms of what we expect of water quality and a group like this is dealing with a lot of it in terms of our expectations and our immediate management. But what we are all as a society really having trouble with is asking the questions about the bigger piece of the system, this piece of action that our world is sitting in. It is some of those bigger pieces that I want to try and work through to see if we need to be pushing harder for changes at the global level. I am talking particularly about the effect of food production, and it does not matter whether it is in this basin or elsewhere in the world, it is our quest for food and our settlement patterns, particularly about food, which is having the biggest effect on our environmental qualities, our natural capital.

Lets look at it as a system in *Figure 2*. We have the farm system with its inputs and outputs and it flows out into a big chain of food and fibre which goes to very demanding customers from across the world, particularly in New Zealand's case. Also coming out of this system are foods going into the atmosphere, ground and surface waters and oceans. One of the other outputs which we expect of society is the ecosystems services; what we need in terms of the maintenance of water quality, the pollinating effect and the things that stabilise our climate. That is what we also get out of our managed landscape, as well as our protected landscape, but we do not pay for them. It is one of our absolute key challenges today.

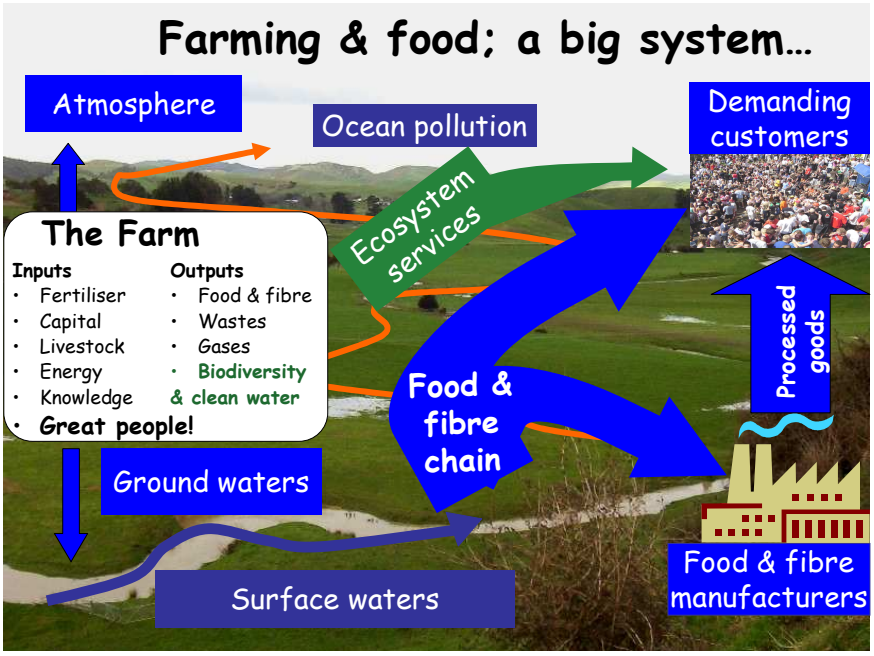


Figure 2

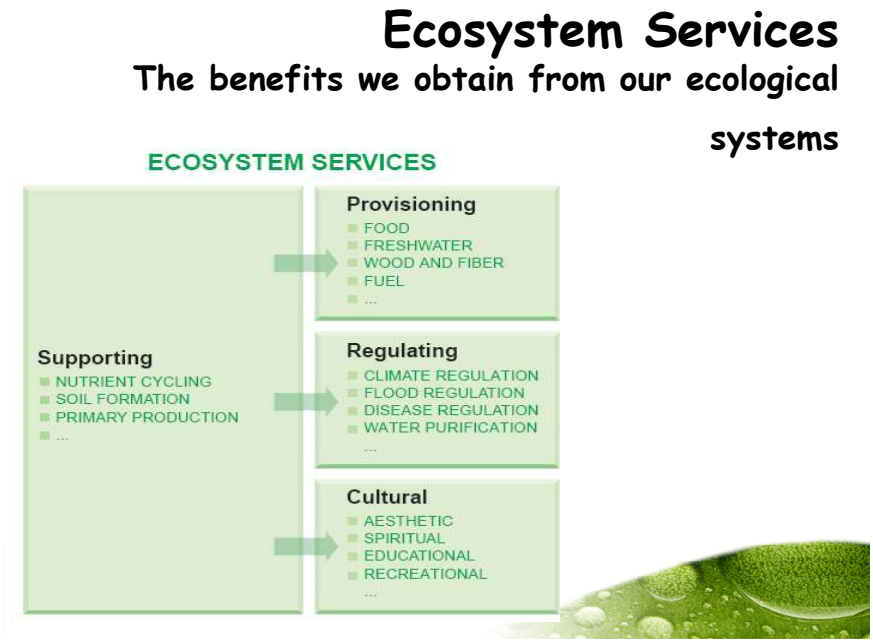


Figure 3

Look at ecosystem services in *Figure 3*, and what we know about them. Think about what is going on globally. You may be familiar with the Millennium Ecosystem studies, part of the United Nation's work done around the turn of the century which is on-going, absolutely brilliant stuff - bring it up on the website. From this study *Figure 4* shows the benefits obtained from our ecological systems - supporting, provisioning, regulating and cultural. Even more importantly it demonstrates what we are actually getting: constituents of well-being, day, after day, after day, and year after year, out of those ecosystem services.

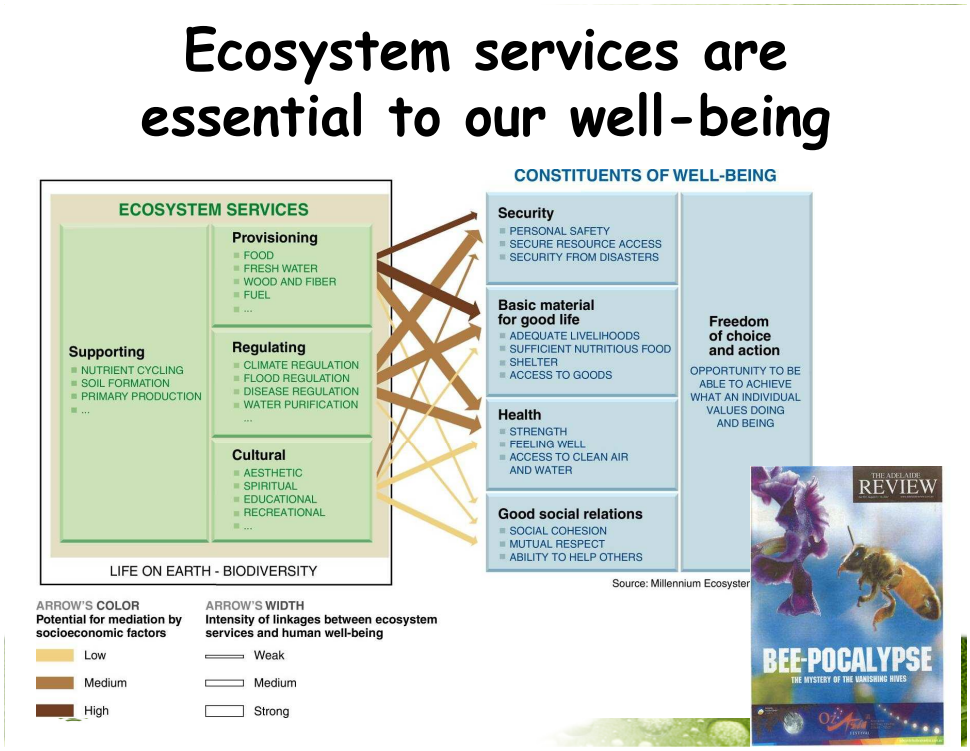


Figure 4

This is the sort of chart which people should have on our walls**,** at home and businesses. It also shows the leakages; look in particular at the arrows which are very wide, showing how important they are. The bottom line is there are lots of things that we need out of our natural environment, our systems, our natural capitals, which we absolutely depend on, but that are not part of our traded systems. Note in the corner what we enormously depend on in the food chain as pollinators, and pollinators around the world are in trouble. If they are having deep trouble, we are too!

Figure 5 is a snapshot of the situation across the planet at the moment. An arrow going downward means things are getting there. But all the other arrows are going the wrong way; in other words, they are drivers of trends which are causing problems. The dark colour means that the impact on biodiversity over the century has been pretty severe. We are degrading that capital very rapidly now and yet we know it is worth billions because it has been quantified recently.

Flip back to New Zealand now in *Figure 6*. We had lots of good stuff this morning about what is going on, and this is just another reminder that we are degrading it here in the Waikato basin.

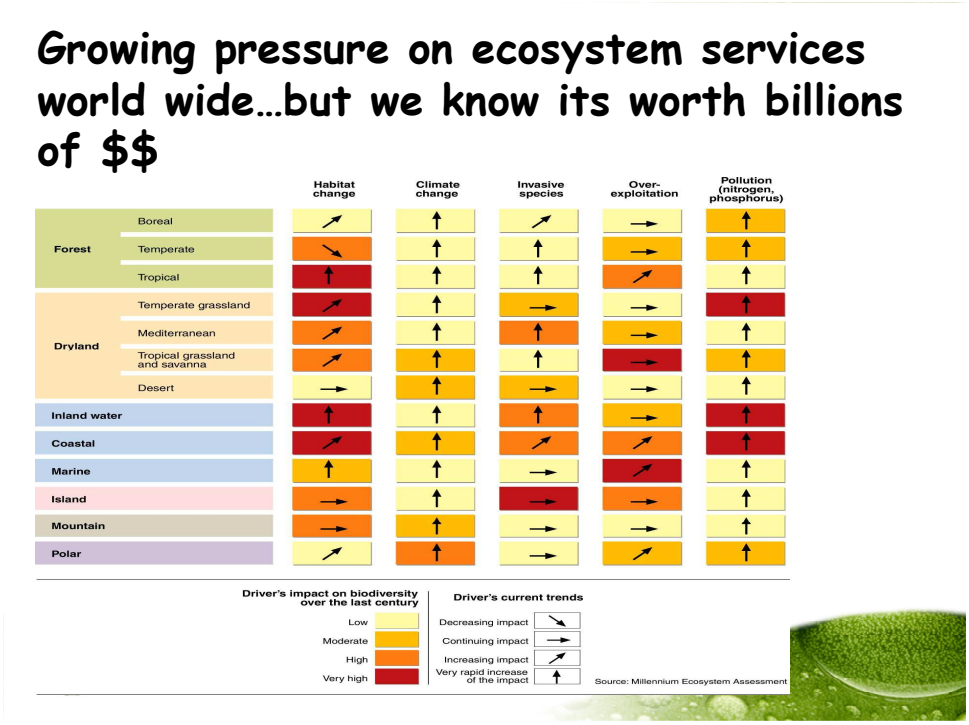


Figure 5

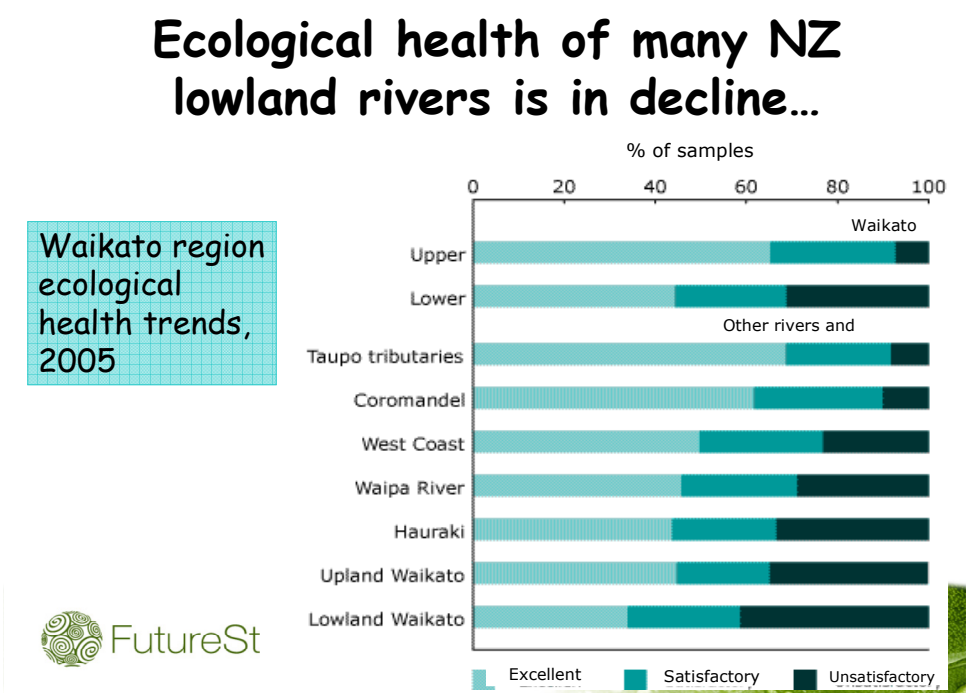


Figure 6

Nowhere in the world do we value food according to its ecological cost of production, whether it be a subsistance farmer in India or on the traded markets. It is soon to catch up with us. No doubt you have been watching the debate about rising grain prices, a part of George Bush's big subsidy on corn and ethanol production. (*Figure 7)* In reality it is

much deeper than that. If you read the Parliamentary Commissioner's Report, four years ago, on our study, *Growing For Good,* you find that Food Aid Organisation figures (as well as many others) show evidence that we are starting to meet limits of food production, in all sorts of ways. One of the most interesting points which is going to cause a political storm is that the amount of household budget we spend on food is rising. It declined for fifty years in Western countries, but that is changing.

As wealth rises the consumption of protein goes up, particularly in Asian countries. *Figure 8* shows the demand for animal protein from recent Food Aid Organisation figures. Most animal protein comes from farm production systems - pig, poultry and beef - and against the background of fish as a protein source worldwide in massive decline. There is big, big pressure on the advance of protein.

Figure 7

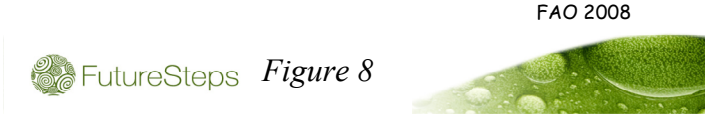


Figure 8

The other part of the very complex food picture is the fact that the power to distribute is aggregated in a very limited number of hands worldwide through what we call supermarkets - superpowers.

- Four supermarket chains in the UK (Asda-Wal-Mart, Tesco, Sainsbury and Safeway) control 70% of food and household goods sales in the UK. Two chains control most sales in NZ & Australia
- These chains have an iron grip on the supply chain – fresh and processed
- Their *modus operandi* is – reduce costs, increase quality, increase speed of supply
- Pressure on suppliers & systems right back to the paddock
- BUT they are changing tack as consumers become interested in the whole food chain, ethical matters, carbon and climate implications

The United Kingdom controls 30% of the flow and in Europe as a whole there are less than one hundred companies now controlling the bulk of food flows in and around Europe. A supermarket is the epitome of a retail or distribution model within our economic system which is very efficient, but also very efficient at putting pressure back on the producers to work on reduced costs, increased quality and speed to supply. That system goes right back to the paddock and has for some time put enormous pressure on the farms' systems around the globe.

There is now a growing consumer focus in many OECD countries on how and where food is grown and under what conditions. Knowing what kind of food you eat, where it came from, who grew it and how it was grown has become a status symbol in foodie culture USA. "Food ignorance" is disdained. Tescos is developing measures of, and labelling for, the carbon footprint of their products. The first 30, from light-bulbs to potatoes will be on their shelves soon. Nitrogen is part of the Carbon foot-print

Countries are starting to do a lot of work in terms of continuity of their production system, whether it is carbon or what else. However, even that is becoming a tough call, because despite that consciousness, a recent headline in the *Dominion Post*, August 7th 2008 by Jon Morgan said,

> ***"Recognition of a food's value is rising, but margins still slim for farmers*** *- Before farmers could feel too smug….(being paid $70.38/lamb) it was pointed out that it cost them $68.58 to produce the ideal Marks & Spencer lamb".*

These farmers grow their lambs to very demanding carcass specifications and farming methods - but were they paid for the true value of ecosystem services? Note the difference between the premium and the production costs was less than $3 a head. A tough margin, to put it mildly.

How do we value our local food. Andrew Fenton, *Horticultural New Zealand, Dominion Post*, August 7th 2008, said, "New Zealanders are going to have to get used to paying more if they want to buy locally grown fresh fruit and vegetables. The biggest challenge facing growers in New Zealand is to provide quality fresh produce at profitable rates, while facing an unprecedented assault from cheap and imported fresh and processed food from offshore." Our supermarkets are going offshore and buying fresh vegetables at cheaper prices, where somebody else is discounting the environment more than we are.

It is an almost daily tangle now about how we pay the ecological costs of food production. From a political point of view this is tough because food prices are going to rise. It is a very complex problem for our producers. We have got enormously competitive business models delivering food right around the world and very efficiently. But the fundamental problem is a gigantic systems clash –

- Competitive business models for the delivery of goods and services

VERSUS

- Farming systems for producing food, fibres and ecological services

> *"There are major differences in the driving forces and ultimate bottom lines which must be acknowledged and addressed at many levels".*
> *The End of Food,* Paul Roberts

Two systems that are of two worlds, one deeply in the ecological world, which will win eventually, and one entirely constructed of humans, in human economic systems.

Looking to the future, what we are grappling with is just one of the management issues around the grand elements. Carbon is getting all the attention at present because of the effects rising CO^2 levels are having on our global climate.

> *"Two of the largest glaciers in eastern Greenland…have both doubled their speed in the past two years to around 14km per year. ….the two glaciers are dumping 100 cubic kms of ice into the ocean every year."*
>
> *New Scientist,* 11 February, 2006

But behind that is this brute called the "grand elements" and considered the one that is basically going to define our trajectory as a species. It is nitrogen which is particularly interesting because most nitrogen is locked up in the atmosphere. But what we have been doing, as *Figure 9* shows, since about 1960 is release vast quantities of reactive nitrogen, that is nitrogen which works in the biological systems, through our ability to extract it from the atmosphere. There has been massive build up worldwide in total nitrogen in systems, but –

> *"Were it not for the invention of factory-based nitrogen fixation by two German chemists, Fritz Haber & Carl Bosch in 1899,a world population of only 3 billion could be sustained…. The availability of 'nitrogen from a bag' has allowed manycountries to escape their innate carrying capacities…"*
>
> Smil, V (2000), *Enriching the Earth*: Fritz Haber, Carl Bosch, and the *Transformation of World Food Production.*

What would the other 4.7 billion do? We are totally dependant as a species on our ability to extract nitrogen out of the atmosphere and grow food. That has got tough and is not stopping.

In *Figure 10* the latest figures from Food Aid Organisation show that world food consumption, to 2011-2012**,** particularly in the Asian region, is rising rapidly. We have got figures of 30 % in both cases and a similar story for P consumption.

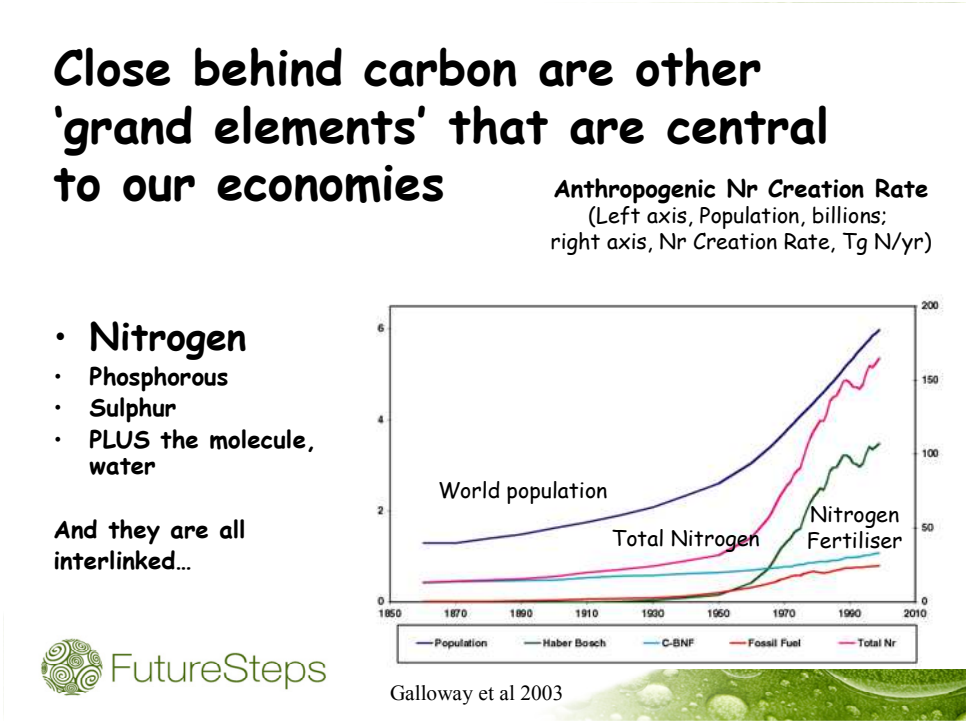


Figure 9

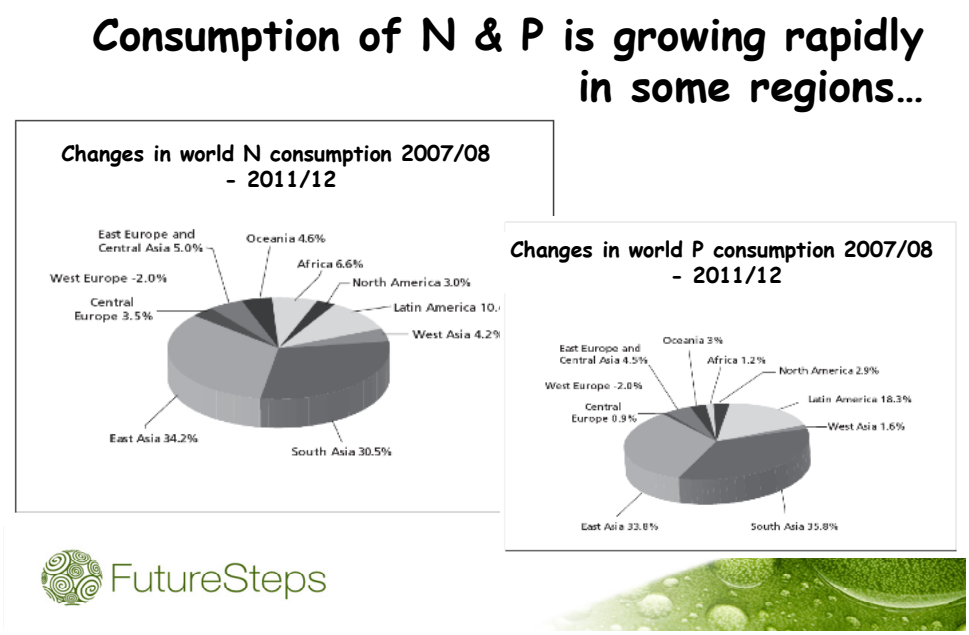


Figure 10

Coming back to what we saw this morning, is New Zealand on the European pathway? I think we are. *Figure 11* shows work by Louis Schipper from Waikato University, Department of Earth and Science, Hamilton, and his team, saying that in 2020, at our current production growth rate, we will not be able to produce any more feed on our land surface. We would then go to imported feed and we are way up there in terms of our leakage if we continue on this path. We are just repeating the Danish story.

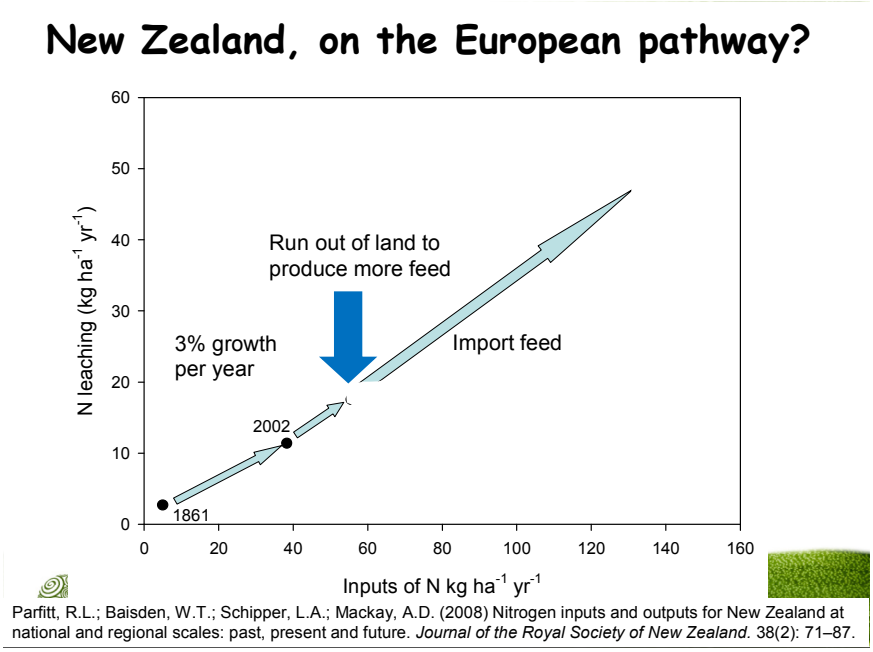


Figure 11

Then there is water -

> *"By 2025, economists say water scarcity will be cutting global food production by 350m tonnes a year. That is more than the current USA grain harvest and the equivalent of a loaf of bread every week for every person on the planet"*
>
> *When the Rivers Run Dry*,
> Fred Pearce, 2006

We were worrying about water quality at a global level. The challenge is a freshwater quantity one. It is a scarce resource. What we are talking about is managing the commons – humanity's toughest test.

> *"In an approximate way, the logic of the commons has been understood for a long time, perhaps since the discovery of agriculture or the invention of private property in real estate. But it is understood mostly only in special cases which are not sufficiently generalised".*
>
> *The Tragedy of the Commons,* Garret Hardin
> *Science, 162 (1968):1243-1248*

Hardin's work is forty years old this year but still amazingly relevent. Our atmosphere is the biggest commons, and proving tough to manage. Is managing reactive N primarily a management of the commons challenge? We have had some successors such as acid rain and CFCs. Management in our oceans is another big problem, fish stocks are collapsing world wide and oceans are acidifying. *Figure 12* shows the collapse of the oyster beds in Foveaux Straits. The black line is the production management of the oysters and the paler line is the collapse of the oyster beds from parasitic protozoan Bonamia.

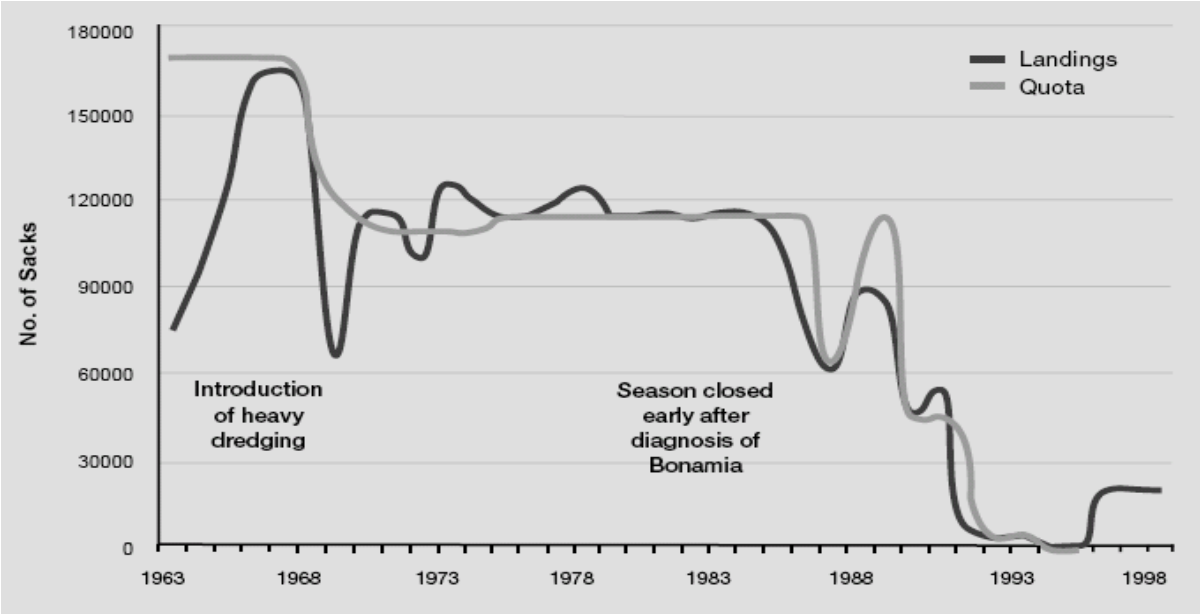


Figure 12 – Foveaux Strait Oyster Catch Statistics 1963 - 98

Figure 13 – the Rakaia River, Canterbury Plains

But most waters are a commons. Here in New Zealand, if ever there was a tragedy in the commons, it is playing out in Canterbury in places like the Rakaia River. I think our grandchildren are going to give us a beating over this one. We have over-allocated the commons' ground water at little cost to the acquirer yet giving them an economic benefit of over $5,000 per hectare. We have got to keep a better account of the equation.

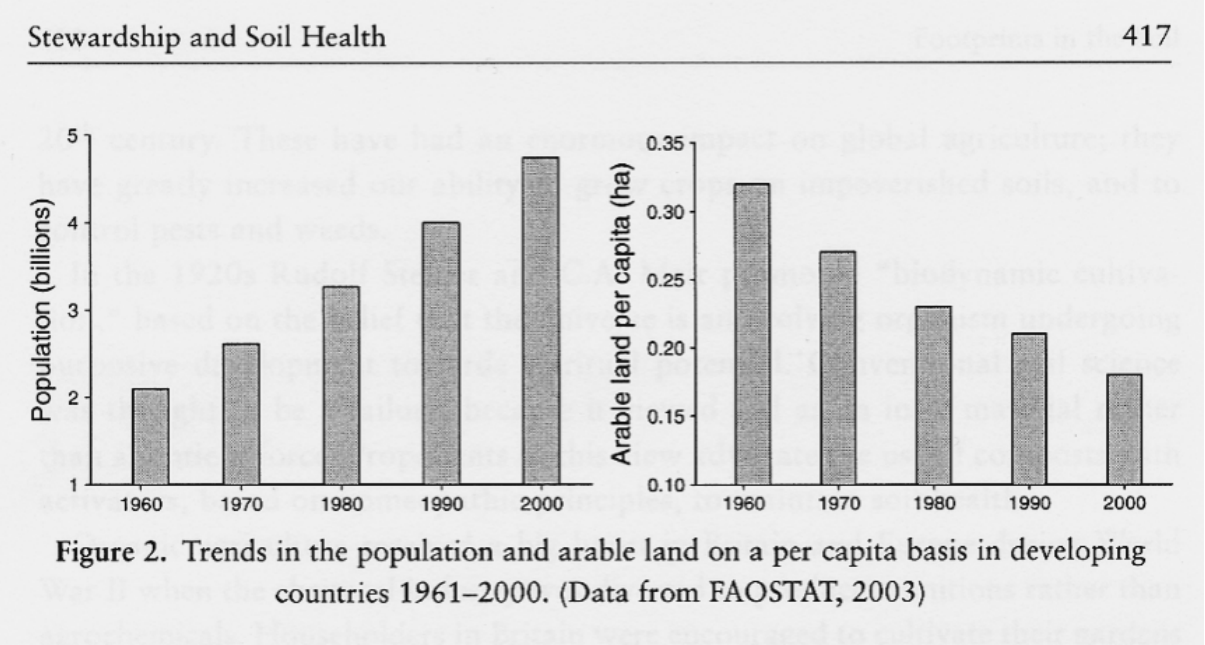


Figure 14 - Dependence on high quality land is increasing

It may be our soils that prove to be the toughest 'commons'. *Figure 14* demonstrates what happens as the population rises, in a proportion of land per capita worldwide. The very best land is becoming scarcer because there is no more. What are we doing in New Zealand? We happily allocate the best of our limited land to housing and lifestyle blocks, at the rate of somewhere between 35,000 to 40,000 hectares per year. We are simply pulling the rivets out of our landscapes.

Like water and air, soil is not efficiently traded in the market place, and yet we could not live without it. Books such as *Dirt: The Erosion of Civilizations* by David R. Montgomery have written about this. There has been a wake-up call recently realising that we have stopped sufficient research around the absolute fundamental base of life and living throughout human civilisation.

In the face of the gathering storm there are some key words

- Imagination
- Opportunities
- Partnerships
- Systems
- Limits
- Confidence
- Leadership

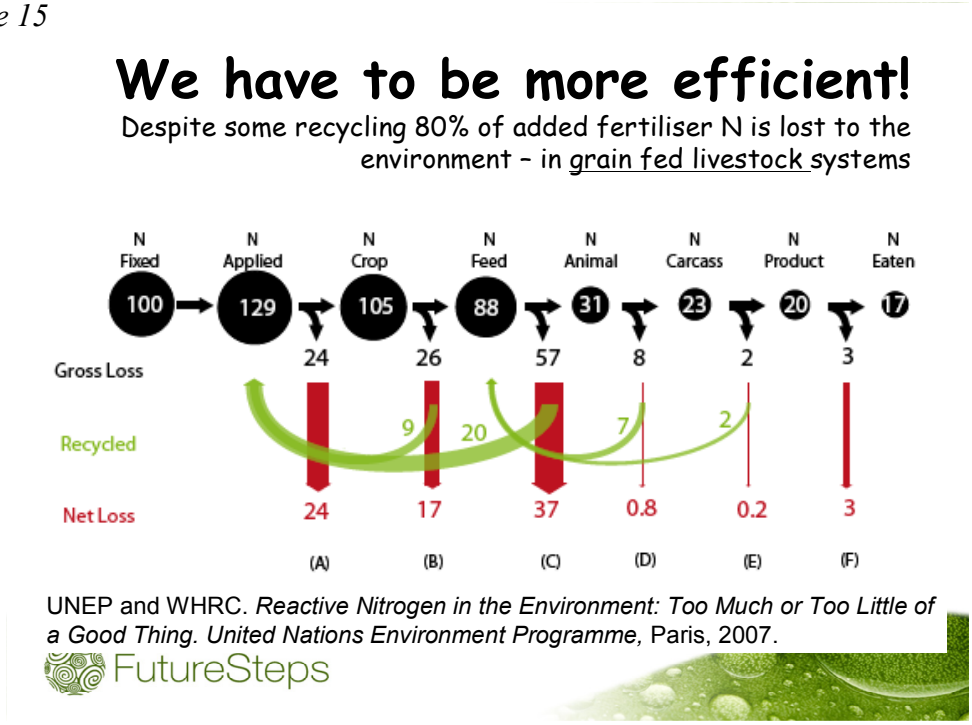
For New Zealand there are some enormous opportunities to rethink this relationship with the land and the way we do things in a production systems sense**.** I think that one of the problems is that it is just so bloody comfortable here. It is a relatively benign climate, we are relatively well off, we have got a nice chatty democracy and we only get pissed off with each other every now and then. There are so many things that are really not in our face. What we need to do is look into our imagination to get ahead. There are lots of opportunities out there which can solve our problems.

"We can't solve problems using the same kind of thinking we used to create them" Albert Einstein

Partnerships are very important between communities, but also with governments. Think systems, think limits, and be confident. In other words as a nation and as a people we can do something. Ultimately it is about leadership, and that is what I think this Society is really doing, you are showing leadership.

I want to talk about efficiency. *Figure 15* is for a grain fed livestock system. Look at the number of units you start with and how much you end up eating, 17%. We would probably do worse with a light bulb, an old incandescent one, so that just screams opportunity at me. These are the sorts of losses going on in New Zealand. As a nation we have an opportunity to redesign food systems. It is not just thinking about what will grow, its thinking about what we could do in an intellectual property sense and take elsewhere in the world, particularly with pastoral and ruminant systems.

Figure 15



UNEP and WHRC. *Reactive Nitrogen in the Environment: Too Much or Too Little of a Good Thing. United Nations Environment Programme,* Paris, 2007.

There are lots of areas requiring transformation in food production systems and having a renewed focus on the biological heart of farm systems & their efficiencies.

Areas for transformation:

WITHIN THE PRODUCTION SYSTEM

- Nutrient efficiencies; harnessing new understandings of plant & microbial bio remediation
- Root performance and resilience
- Soil nutrient and water mediation characteristics & capacity to manage
- Animal nutrient partitioning genetics; reducing losses via urine
- Water, energy & nutrients; more from less from the core 'currencies' of farming and food

IN WIDER SOCIETY

- Markets and marketing; full ecological costing of food production
- Natural capital reporting; getting our environmental capital in to national accounts - and not just every 10 years
- Valuing & pricing ecological services; a tax on all foods as we do fuel
- Capital gains taxes on land

It is in the wider society where the really big challenges lie. How do we get society to pay the full ecological cost of food production? I believe we need better environmental monitoring in New Zealand. We had an environment report a decade ago and one recently. How do you navigate on ten year wave warnings? With enormous difficulty - the price – the ecosystem.

One of the things that has intrigued me for several decades is why in society we require a licence to drive a car or fly a plane, but we have no requirement for any evidence that we can manage the most valuable piece of capital there is, a piece of land or farm. It really is bizarre that you can just go out there and do your thing. It is no criticism of farmers anywhere, but it is a very interesting reflection on the way we think about the land and the licence to operate.

To finish I say congratulations again for the effort put in to the restoration and management of this region, but we all need to recognise that the marathon is probably in its first 5 kms. The systems which we are grappling with extend way beyond the lakes, and that needs to be well realised. We need to start a bigger conversation about ecosystems being undervalued and services and food being traded for less than their ecological cost of production. At the heart of our efforts are the complexities of managing the commons. This is a really tough space, but on a local and global scale, we have got to be imaginative, and in a food and fresh water constrained world, we need leaders. Leadership is through tools and regulation and better pricing of the actual capitals. New Zealand should become the leader in very efficient ruminant pastoral systems.

It is communities working together that will provide much of the moral leadership in the years ahead, and ultimately it is a moral matter. I am not a particularly religious person, but the more I go back to the literature around commons and these issues, it seems to me that until we treat it as a deeply moral matter we are going to struggle. It is a beautiful world and it is the only home we have.

Thank you very much.

THE 21ST CENTURY CHALLENGE OF WATER GOVERNANCE IN NEW ZEALAND: REGULATION OR COLLABORATION?

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ABSTRACT

This paper appraises the 21st Century challenge for New Zealand to move towards collaborative[10] water resource governance at the catchment scale.

A collaborative approach to natural resource management and governance at the catchment scale is a strong theme in the recent environmental management and planning literature. In New Zealand, water resource management is undertaken by politically elected regional councils within the framework of a devolved, collaborative legislative mandate (the Resource Management Act 1991). To date, the regional councils have experienced difficulties discharging this role effectively. This is manifest by growing water scarcity in some regions and declining water quality.

A major reason for this failure is the predominant approach traditionally adopted by regional councils to discharge their RMA functions and duties. Notwithstanding the dominance of the discourse of integrated and participatory resource management within the RMA framework in New Zealand since the 1990s, an analysis of regional policy statements and plans reveals a strong reliance on top-down command and control type regulatory strategies to *allocate* water resources for extractive uses such as agriculture and to manage *point source* water pollution. The "first-come-first served" water allocation rules in most regional plans have been adequate to allocate water resources amongst users in catchments where significant freshwater resources are accessible and there is limited competition. Likewise, significant success has been encountered by regional councils in regulating point source water pollution.

In contrast, regional water plans tend to marginalise the imperative to address diffuse *non-point* source pollution caused by dominant agricultural land uses. The reasons for this negligence include a wide range of formal and informal institutional barriers and related political constraints including vested rural economic interests, adversarial science practices, capability and capacity constraints, professional and political conservatism and community and central government indifference.

The problems associated with the current predominantly top-down approaches to water resource management have been magnified in recent years by increasing development pressures, a quantum leap in water resource use due to changing land use practices, and increasing understanding of regional climate change variation. Arguably, second generation environmental problems (or "wicked problems") such as diffuse water pollution are difficult to address using regulatory instruments alone compared to first generation environmental problems such as point source pollution.

[10] The term 'collaborative' signifies collaboration within the inter-governmental sector as well as with the wider civic society and stakeholder groups. This usage is akin to the concept of network governance.

In order to harness the potential of the RMA as a lever to change rural land use practices in New Zealand from a "business-as usual" mode towards sustainability, the Act should be used as a catalyst to engender transformational social learning in addition to just being used as a regulatory planning instrument as understood conventionally. This is a tall order and calls for a fundamental shift in the focus of regional councils from regional *government* to regional *governance* in the manner they exercise their twin devolved planning mandates under the RMA and Local Government Act 2002. This also calls for a re-alignment of the RMA juridical planning system including the roles of institutions such as the Environment Court.

TRANSCRIPT

Introduction

Thank you Ladies and Gentleman, I feel very obliged and honoured to be invited to join this conversation. I bring greetings from Canterbury, "land of milk and honey" but where we have serious problems with water allocation and water quality and are trying very valiantly to deal with those issues. This symposium is a valuable opportunity for me to come and see what is happening in your neck of the woods and to be part of the conversation up here. I think we really should be having more of these kinds of opportunities to talk and compare experiences.

What I want to do today is reflect on how we manage water resources in New Zealand, and what we should be doing in terms of dealing with the water issues of the 21st century. Basically, what I am going to argue is that there are two major approaches to deal with water issues. One is the top-down, hierarchical approach, which is regulation either by an international organisation like the European Union, national government or regional and local government - that is the traditional approach we are used to. But increasingly in the resource management literature and talking to environmental practitioners in other parts of the world, there is strong advocacy for a "bottom up" approach to complement the so called "command and control" approach. A bottom up approach is a more deliberative, collaborative, communicative approach, based on building partnerships, as Dr Morgan Williams was talking about earlier. My view on the question that we are pondering at this seminar - how we deal with the nutrient problem in the Rotorua lakes and rivers – is that we need a multi-pronged, multi-scalar approach.

We need regulation, and we do need to plan for this reason - but regulation on its own is not enough. We need to make regulations more robust through a more participatory deliberative approach, and I see the Taupo Regional Plan variation as an example of a model that potentially could be replicated in other parts of New Zealand.

So, I would like to begin with by identifying two issues. First of all, I want us to think about the causes of the current water problems and how well we manage our water resources. NZ water resource management institutions are stretched to the limit and desperately struggling to manage water resource sustainability. Why? By water institutions, I mean not just regional councils, but also local and central government, and the Environment Court (the policy and judicial frameworks) – but there are also *informal* institutions, made up of societal norms and expectations.

I think many now agree that we have a water crisis in New Zealand. There are still some sceptics who argue that we don't have a water problem and that the only problem is that water happens to be at the wrong place at the right time! But I think increasingly there is agreement throughout New Zealand, more so in some regions that others, that there is a water crisis and that this is something we need to attend to urgently and that we cannot afford to live in a state of denial. Before we can attend to this crisis, we need to understand what are its causes.

The second issue that I want to focus on is the sustainability imperative - what changes do we need to make to our water institutions to make them resilient and robust, and able to deal with the challenges of the 21st century?

Defining the Problem

What is the scope of water problems in New Zealand – what are the basic causes? The basic cause of the water problem is that in terms of its governance and management, we have treated water as an *open access*, "free for all" resource based on the assumption that it is plentiful in supply. As a result, we have witnessed a tragedy of the commons unfolding in regions such as Canterbury in the last 20 years. Some now argue that water should be privatised using market based approaches to allocate and manage it. While water markets may have a role, in my view, water should be managed as a *commons,* rather than as an open access resource or as a tradable commodity, such that everyone's needs are met (including future generations) in an environmentally sustainable and socially just ways.

Let me elaborate my argument. Even though we have the Resource Management Act as a *de jure* regulatory instrument to regulate allocation and management of water, *de facto* the Act is in reality being used to manage water as if it were an open access resource or a privately owned commodity. As a result, water is being degraded in quality, it has been over allocated, and equally important from a long-term stance, it is being commodified and privatised. Under the RMA, water is supposed to be common property - it belongs to all New Zealanders. That is the legislated position, but in reality water permits have been allocated as (private) property. Arguably, some of the decisions by the Environment Court also take this stance.

What are some of the things we have done well under the RMA? We have done two things well in terms of water management. Firstly, we have addressed the problem of *point source pollution* reasonably well, using regulatory tools. Secondly, using the prior allocation rules, water allocation has been managed reasonably well in those catchments where there is a surplus of water available. So regulation has worked reasonably well in those two respects. However, listening to some of the speakers today, and reflecting on the implementation of the RMA over the last twenty odd years, one wonders whether in New Zealand we went too far with devolution - the RMA is a devolved planning mandate, devolving responsibility to Regional Councils, District Councils, and the local communities to manage water resources. I wonder whether we have gone too far. There is insufficient national guidance.

What are the major deficits in terms of water management under the RMA? There are two major problems. One is the problem of managing *non-point source pollution*, and secondly the problem of water allocation in catchments that are approaching full allocation. What is the reason for these deficiencies?

My view is that these shortcomings are not because of problems with the RMA *per se.* The problem is not with the Resource Management Act, the problem is us, as humans, in terms of how we understand the RMA, in terms of how we relate to each other formally through our institutions, and informally in terms of our personal and community level interactions, in the context of implementing the RMA.

It has been relatively easy to address under the RMA what I call first generation water problems – these were point source pollution and water allocation in a situation where water is abundant. Those are relatively simple, straightforward problems, and regulation has dealt with these issues reasonably well.

However, the types of water issues we are facing now are second generation problems or issues. Second generation problems are non-point source pollution, and water reallocation in a situation where water has been fully allocated. These problems are much more complex or *wicked*, and are much more challenging to deal with via regulatory tools. So we need to think about alternative tools to deal with these problems.

Why are second generation environmental and water problems difficult to deal with? The reason for this is because our current societies are characterised as risk societies. Risk societies are characterised by change, complexity, uncertainty and conflict. These are the attributes of water problems that we face presently - we therefore need institutions that are adept and sufficiently resilient to address these problems.

What are some of the institutional barriers that prevent us from addressing these problems effectively? There is a range of factors. For example, we still live in a state of denial - as I said in the beginning, many of us don't admit that there is a water crisis in New Zealand. It is analogous to the climate change debate - there are many who do not think there is a problem. Secondly, we have to function within globalised markets, and New Zealand in the global scheme of things is a peripheral economy, dependant on supplying bulk commodities, and bulk agricultural products to a market at the other end of the world, in the northern hemisphere. The global economy has been deregulated, and there is a lot of competition, with pressure on farmers to be competitive in order to outbid other producers from countries such as South America, where production costs are relatively lower. That is a fact of life. That is the system within which we have to work.

Current procedures for allocating water have led to privatisation and commodification of water. For example, it is possible for a company which wants to invest in a new dairy farm in South Canterbury, to spend millions of dollars to buy science in order to get resource permits for water extractions - because the profit from that dairying activity will justify the investment. The resource consent process is gladiatorial – adversarial expert gladiators battling in Environment Court hearings to contest resource consents for the client.

The "Effects Management model" - a legacy inherited from Simon Upton in the 1990's - I think put us back by ten to twenty years in New Zealand, in terms of effective implementation of the Resource Management Act. The Effects Management model saw regional councils responding to water demand in a reactive fashion – there was little strategic planning at regional council level to focus was on end use of water resources.

There is also an information problem. We do not have enough information about water resources, to adequately inform the adversarial dynamic above. We operate in a low trust environment. In Canterbury, for example, trust is very high within groups of individual stake holders, but trust is very low between different stakeholders groups. Until recently, there was little dialogue, and an unwillingness to talk to each other face to face.

There is a problem of collaborative capacity building in Canterbury. Until recently we did not have local leadership which could provide moral leadership to address water issues. Finally, there is the issue about Maori values and the question about Treaty rights – which is an issue that still comes up now and again when talking about water allocation issues. So there are many different examples of institutional considerations that have prevented us from using the RMA as an effective tool.

Where do we go from here?

I think the challenge is to reinvent our water institutions so that they are resilient, and can effectively deal with second generation environmental problems. How do we do this? Water management is an example of a collective action problem, and local government

deals with collective action problems. The reason why we have government is the need to deal with collective action problems.

There are basically two approaches to deal with collective action problems such as water management – Adaptive Management and Adaptive Governance. The former focuses on improving effectiveness of management methods and tools to deal with water issues based on feedback from monitoring and research. Adaptive governance is the improvement of our institutional arrangements – both formal and informal institutional arrangements - to improve water management administration.

The Rotorua lakes science research we heard about this morning was about adaptive management. How can we develop better information, and better understanding, about our environmental ecological system to deal with water issues? That is very important, we need that kind of knowledge, but in order to use that knowledge effectively we need resilient institutions. Adaptive governance is about institutions that can learn from their environment and can respond to the changing needs of those environments. That is an area where I think we have let ourselves down. It is good to see science research funding through the Foundation for Research Science and Technology being invested in the kind of research that we heard about this morning. But, in my opinion, not enough funding is being invested in understanding how we can improve the governance of water resources in New Zealand.

Regulatory governance fits well with the electoral model of democracy. The electoral model of democracy is that we elect leaders to make decisions on our behalf. The leaders are advised by advisors who make recommendations to them, and then it is up to elected officials and advisors to implement policy solutions. Regulatory governance places emphasis on strong government and the role of science. That model of electoral democracy works well with first generational environmental problems, but as I explained earlier, the second generation environmental problems are much more difficult to deal with, because they are much more complex and they involve a wider array of stakeholders.

So the traditional model of water resource management, as practised under the RMA, is shown here (*Figure 1*), where you have a local authority, and the local authority deals individually with different stakeholders.

The adaptive model of governance is a flat model of governance rather than hierarchical. It is a network model of governance whereby there is a lot of collaboration, there is discussion, there is deliberation, and communication between different stakeholder groups in society. The adaptive model brings together users, elected members, experts, organised interests, and other interest groups, to elicit mutually advantageous agreements (*Figure 2*) – social learning and the development of social capital are part of this process.

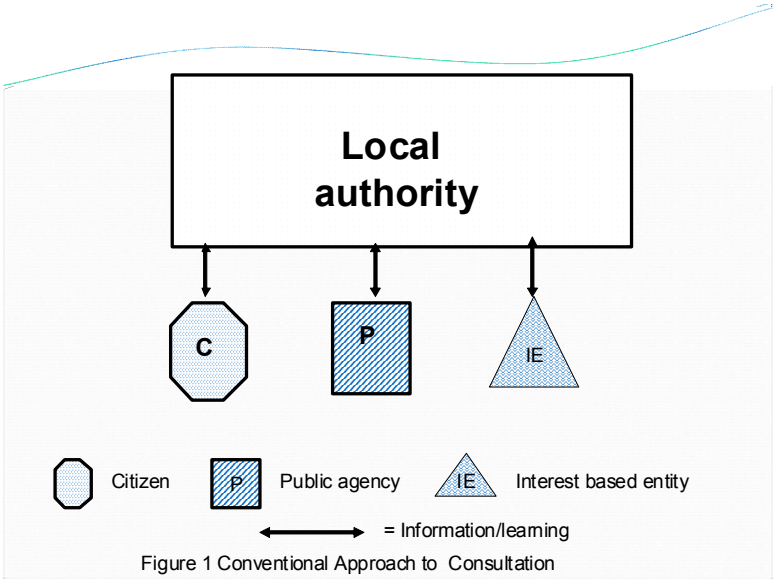
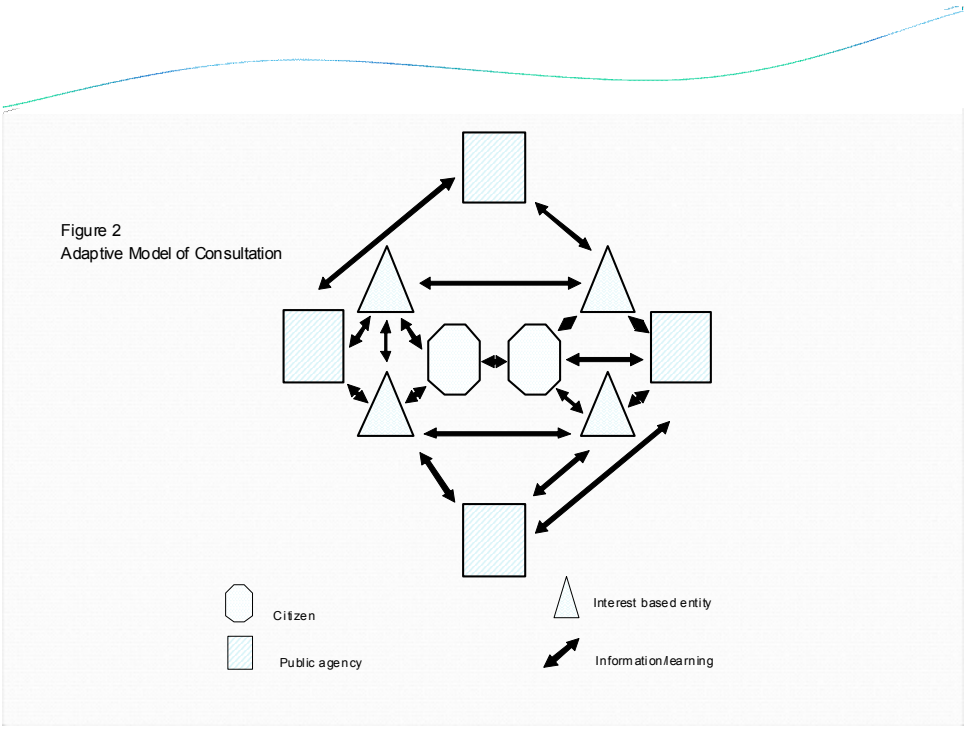


Figure 1 Conventional Approach to Consultation



From the little that I know from talking to my colleague Peter Skelton, it seems that the Taupo variation was developed based on the Adaptive model - and it is the Adaptive model that I believe we should now be using to develop water strategies at the national, regional, and local levels.

Collaborative adaptive governance is characterised by

- greater use of networks to support hierarchical relationships
- more focus on outcomes than detailed specification
- cooperative relationships between parties

- the explicit goal of building more trust
- a more complex and nuanced behaviour model that views deterrence as only one of many mechanisms to influence behaviour, and not the preferred option

There is a lot of literature on how we should develop these kinds of collaborative approaches to address water and environmental problems. The issues are –

- representation (who should be involved)
- decision process (how can authorities and stakeholders reach policy agreements which serve them well).
- scientific learning (how can policy makers develop and use knowledge effectively)
- social learning (how can resource users and the public develop common understandings for consensual policies and policy processes)
- problem responsiveness (how well do decisions achieve the natural resource management goals of sustainability, equity and efficiency)

I have had the opportunity in the last few years to network with my colleagues in the USA, in the Western States. And because Americans are very cynical about the ability of government to do anything, they rely a lot more on their own resources to achieve things. It has been a learning experience for me to see how they have forged solutions to complex water problems - similar to the sorts of issues that we are facing in New Zealand - and then these solutions become enshrined in statutory documents. So we are not starting up anew on this, there is experience out there that we can draw on.

I now want to conclude with my thoughts on what action we can take to improve things in New Zealand.

Firstly, I think we focused too much on using the RMA as a regulatory tool – it is preferable that, in addition, the RMA is utilised as an instrument for social learning. Transformational social learning is the process alluded to by both Morgan Williams and Guy Salmon. Secondly, we need to address the issue about Maori property rights over water – this is a major issue. Thirdly, we need to recognise that water is both a human right - everybody is entitled to water as a basic necessity – but also as an economic good to produce wealth, for which we should pay in the same way that we pay for other things. Fourthly, we need to recognise and enshrine in some kind of moral document (equivalent to a Pakeha Treaty of Waitangi) the qualities we value as a New Zealand society – such as a public expectation to be able to fish and swim in clean water. So we need some kind of accord that can be used to inform decision making at both levels of government.

More sustainable land use practices may result in a net economic cost in the short term. Acceptance of these economic costs requires a rebuilding of trust and understanding, particularly between rural and urban New Zealanders. This rebuilding process is currently hindered by uncertainty surrounding human versus natural effects on ecological systems and their interactions. Quantification, reduction and communication of this uncertainty (adaptive management) needs to focus on more clearly illuminating potential paths to sustainable practices.

We need to talk to each other in communities, within regions and nationally, to bring about these changes. There will be winners and losers and we must agree on how to address that issue – the issue about compensation for example.

The approach to RMA plan making should change from a predominantly hierarchical, top-down approach to a more collaborative and deliberative approach including:

- Regional council prioritisation and support for development and implementation of integrated stream and lake management plans for individual catchments or groups of

spatially contiguous catchments. I think regional councils should put more emphasis on preparing integrated catchment or lake management plans. For example, Environment Canterbury put all its resources into developing a big regional water plan, which took up a lot of its resources and time, and there was very little opportunity to deal with the real issue of catchments under pressure. I think regional councils need to deal with both aspects.

- Legitimate rural land use planning
- Regional council prioritisation and support for mutually beneficial practices such as riparian fencing and enhancement, and sub-catchment audited self-management initiatives for water transfer and irrigation restriction prioritisation combined with defensible (i.e. scientifically robust and created by stakeholder collaboration) accountability mechanisms such as water metering, maximum nutrient loadings and stocking ratios.
- Non-adversarial opportunities at all levels for stakeholder engagement that is facilitated and supported by a range of expertise.
- New Zealand is a property owning democracy and it is appropriate that property rights are secure to provide a degree of certainty. The private property rights protection ideology is deeply embedded in New Zealand's planning jurisprudence. This is reflected in decisions where the Courts have accorded higher priority to private property rights compared to public interest. This may have been appropriate in the past. How appropriate is excessive reliance on this planning ideology for the 21st Century?
- Arguably excessive reliance on planning case law to interpret the RMA. To that extent, we are prisoners of the past. This becomes problematic in situations where government is reluctant to provide policy guidance. Government reluctance hitherto to provide policy direction, leaving this to the Courts by default.

Finally, some comments about the role of the Environment Court. We need to rethink the role of the Environment Court in the RMA context. Should the Environment Court change its conduct akin to that of a commission of inquiry? My concern is that the judicial planning system which has developed in New Zealand, and the case law which has developed under the RMA, is very much biased towards protecting private property rights. I agree it is important that property rights are protected and that we need to provide certainty. However, in some of the Environmental Court decisions – at least in the South Island - judges seem to pay too much attention to private property rights. I wonder whether that kind of ideology is appropriate for the 21st century. I believe there is far too much reliance on case law and precedence to resolve environmental issues. We need to be looking forward, and need to set new precedents - the Environment Court does not seem to do that. The Environment Court is not a court which advocates on-behalf of the environment – it is purely there to resolve disputes between parties. Should the jurisdiction of the Environment Court be limited to resolving disputes over planning applications and is it more appropriate that disputes over plans are better resolved through the political process?

So, because Councils do not do their jobs properly when making plans, Environmental Courts become de-facto planning agencies. To me that is not right. To me plans belong to the community, plans should be made by the community, and the Environment Court should have no role in the plan making process. The role of the Environment Court is to resolve disputes that arise during the implementation of a plan. Disputes during plan making should be resolved through the political process at local government level, and then maybe subsequently at national government level.

Thank you very much.

COMMENT FROM THE CHAIR

Thank you Professor Ali Memon. You may be interested to know that the meeting next door is discussing this very question with regard to the Treaty, Maori traditional relationships with the water, and so on. It is a matter that is very much at the top of our minds as well, and we need to do it in such a way that water is regarded as a national treasure. I am not too sure that we are achieving this by leaving administration to local bodies. If water is a national treasure it should be administered by a national body. However, that is just my thoughts.

FEDERATED FARMERS DAIRY PERSPECTIVE

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Gifford is the President of the Rotorua/Taupo Branch of the Federated Farmers. He has a dairy farm at Reporoa and has chaired a number of committees in this region including the Waiariki Institute of Technology.

ABSTRACT

Achieving better lake water quality together

Farmers, as part of the community, are recreational users of the lake and want to improve lake water quality too. Notwithstanding that New Zealand dairy farming has very low environmental impact by world standards, farmers are working on solutions and have identified areas where further investigation could happen. As owners and managers of land resources farmers believe a partnership approach is the only approach that will be sustainable in the long-term. With a robust and open processes to find a range of solutions the whole community will have confidence to move forward together to achieve the outcomes all desire. Let's stop facing off, instead let's work together for solutions. Don't we all want the most cost-effective solution in the shortest timeframe?

TRANSCRIPT

I represent Federated Farmers here today. I am a dairy farmer at Reporoa which is halfway between Rotorua and Taupo, in the Upper Waikato catchment. Farmers in this area have baches on the shores of the lake, they have boats, kayaks in the water and they swim and fish just like the rest of the people here at this Symposium.

Remember New Zealand's position is not all doom and gloom. New Zealand farmers, because of their grass-based system have a very low environmental footprint compared to the rest of the world. That is a real fact I am not making up, supported by the 2002 OEDC report rating New Zealand's waters as the third best after Norway and Sweden. It is a huge advantage and we should not lose sight of that fact in the decision to do something about our water. We do not want to adopt things that are going to make it worse.

We all care

To give you a local example of the effects of agriculture on water quality, the Waikato River after it has run through the biggest dairy catchment in New Zealand, the water at the Tuakau Bridge, where Auckland draws its water from, is 0.7 parts per million nitrogen; the same in the Thames, from a report from 1997 I must admit because I can not get a newer one, is 5 parts per million – so that is 7 times better. So we are saying that we have something good, protect it.

We all care; we want to establish common ground. Like you, farmers care about the environment, and like you, they want better water quality. I would also like to assure everyone that farmers remain committed to a clean environment. Clean water is essential in the farming business. Farmers are passionate about their farms and they need to use their resources effectively and efficiently.

The next part of my talk is about what we have done locally. When this issue came up in Taupo we knew it was just a matter of time before it came to Rotorua, so we set up the Rotorua Lakes & Land Trust with the LakesWater Quality Society, Te Arawa Foma and Rotorua/Taupo Federated Farmers. We were not happy with the science that had been going on and we believed there would be too much concentration on making regulations and not enough on finding solutions. That is what I have heard today. I do not hear much about solutions. I hear a lot about regulations which are simply systems; I want some solutions.

Figure 1

Wooden sills and grass filter strip

Successful in reducing phosphate loss

Here is a very good one. (*Figure 1)* It was done by an Australian scientist, Matt Regan, who came here – he has gone back unfortunately. It came about after we had tried something else which I will touch on in my speech later. He had a 5 hectare catchment and it was up in the hills and he flattened out the area. The effect was that it took all the phosphorus out that was going through, both dissolved and particle phosphorus. That is

the sort of thing that can be built on any farm, but they are not being built on farms yet because we have not decided what exactly is going to be done.

One of our members decided it would be a good idea to put straw bales across a gully and the soil builds up behind it and it is a way of catching the soil going off, so we put these straw bales in. Unfortunately we ordered straw bales which are made mainly of stems and are very long lasting but they put in hay bales which are made of leaf and soft stems. After about two months there was more nitrogen coming out of the hay than coming down the hill. So $300,000 per pop.

Nitrogen trials looked at three wintering systems used by dairy farmers. (*Figure 2)* Nitrogen loss can be high during the winter grazing period and research has studied the effects on farming practises. Wintering systems are the way farmers graze their cows over the winter season. The first system is grazing cows on a farm, the second system was wintering the cows off, the third system was using nitrogen inhibitors to reduce nitrogen loss. The results showed wintering off farms had a positive effect. It transferred deposits to other catchments as has already been mentioned today. The use of nitrogen inhibitors can have a positive effect but the results are variable depending on the rainfall, soil temperature and soil type.

Now the next was our watercress experiment. (*Figure 3)* I have some difficulty with regional councils and what they have done about acknowledging the problem; again I come back to their spending time looking at systems and not solutions. The watercress experiment came out of the work that NIWA did and Clive Howard-Williams at the Whangamata stream at Taupo. The stream has been measured for about twenty years and showed, when it was a land survey paddock with black cattle standing in it, the nitrogen went straight through. They fenced and planted it up, filled it up with watercress and after about three years it started stripping all the nitrogen out of the water every summer. This continued until about year 11 when the watercress was shaded out and stopped having that effect. So the Rotorua Lakes & Land Trust decided that we would reciprocate that experiment.

Figure 3 shows two troughs; the short 24 hour trough which took 70% of the phosphorus and nitrogen out of the water. But part of the trouble was we thought it was a small biomass in there doing the nutrient stripping, but either birds or somebody took all the watercress out halfway through the trial so we had to start again. So it was another $300 down the tube and it slowed us up a bit. But already we are looking at places where we can put these things in.

Because nitrogen is a long term problem in this kind of soil, to control farming and not do anything about the industry issues, seems to me not being responsible. I am not very happy about it but that is how life goes around.

Elsewhere there are other research projects in the catchment initiated by Federated Farmers and funded by Dairy New Zealand and other industry companies for farm benchmarking.

Figure 2

Nitrogen trials

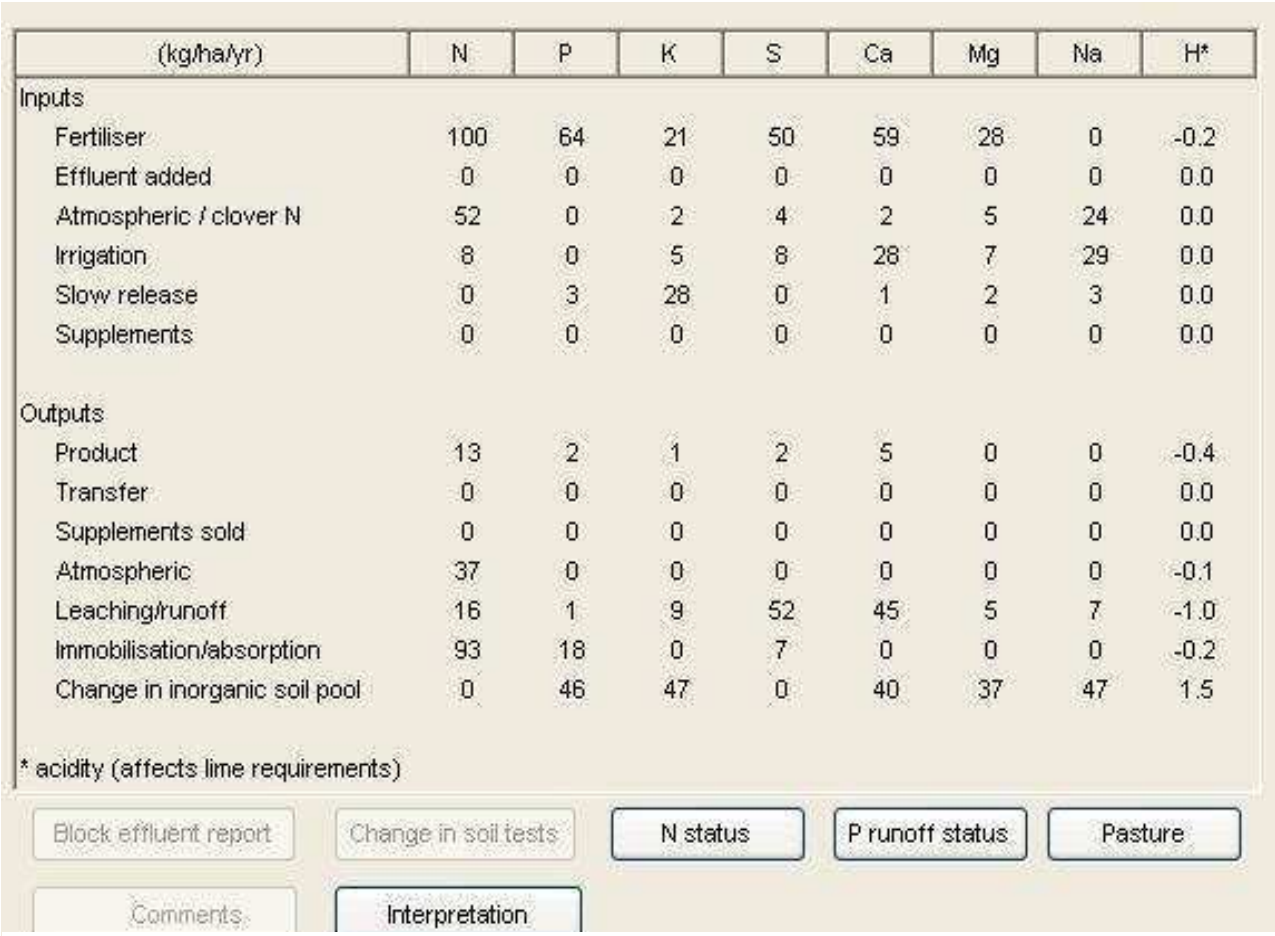
Herd homes are one of the wintering system tools

Figure 3

Watercress experiment

Removes up to 60% of phosphate and nitrogen

All the dairy farms and three sheep farms in the Rotorua catchment did full nitrogen budgets for Overseer and an economic analysis was done. They benchmarked the current practice and looked at the options available to farmers to allow practices to reduce nitrogen loss. The twelve practices included wintering off, nitrogen inhibitors, optimised stocking rates and optimising effluent disposal systems. The environmental and economic effect of any change for analysing brought it back to farming, allowing farmers to look at various options that work for them. *Figure 4* are local examples but nationally dairy farmers are also looking at a strategic approach to managing phosphate, nitrogen on their farms.



(kg/ha/yr)	N	P	K	S	Ca	Mg	Na	H*
Inputs								
Fertiliser	100	64	21	50	59	28	0	-0.2
Effluent added	0	0	0	0	0	0	0	0.0
Atmospheric / clover N	52	0	2	4	2	5	24	0.0
Irrigation	8	0	5	8	28	7	29	0.0
Slow release	0	3	28	0	1	2	3	0.0
Supplements	0	0	0	0	0	0	0	0.0
Outputs								
Product	13	2	1	2	5	0	0	-0.4
Transfer	0	0	0	0	0	0	0	0.0
Supplements sold	0	0	0	0	0	0	0	0.0
Atmospheric	37	0	0	0	0	0	0	-0.1
Leaching/runoff	16	1	9	52	45	5	7	-1.0
Immobilisation/absorption	93	18	0	7	0	0	0	-0.2
Change in inorganic soil pool	0	46	47	0	40	37	47	1.5

Figure 4 – Overseer Programme

Dairying does have a strategy for environmental research as a direct investment of dairy farm levies of more than $8 million a year. It might not seem much against the profits of Fonterra but it is $8 million more than any other section is putting in. Various farmers are adopting these options for technology, often in a regulatory environment which some regional councils are permitting. Current regulations such as Rule 11 in the Rotorua catchment and Variation 5 in the Taupo catchment are causing uncertainty in the future for farming in these regions.

Farmers are hesitating to invest in new technology that costs money because they do not know whether they will be able to continue farming, let alone recoup their investment, and that is a real problem. What are you going to do to encourage me to improve my environmental practices, which are already very good by world standards, if you are telling me that in five year's time I going to have to close down and walk out of my farm with about a third of the value. If you are going to send us to the works, we may as well have the fight right now. We are not cooperating in something like that. If you want to talk about what Morgan Williams talked about - sustainable farming, yes we want to talk about that and we have some really good ideas about how we can go about it. But the idea that farmers are just unlucky and they are going to have to bear it, you might have to lose a generation of farmers and sometimes you are going to get hurt. It is not very encouraging for cooperation; we need positive things. Would you like to be purchasing a new Range Rover 4WD and then have a law passed saying you can only use it every second day or you have to sell it for half of what it is worth and trade down to a smart car?

Today's symposium is about further regulations and Federated Farmers' view is that ill-considered regulation is not achieving the community's goal. Federated Farmers believes there is a better way and the community must identify sensible and effective solutions before regulation is commonplace. What has been proposed here today are regulations not solutions. Federated Farmers predicts the result will be inappropriate and ineffective regulation that will discourage farming. The unintended consequences of these regulations is that all technologies and solutions will not be adopted or even developed to the same extent.

I was very pleased to hear the last speaker talking about adaptive government; that's exactly where we hope to go. Federated Farmers says encouraging good practices and good environmental behaviour makes it easier for farmers to achieve the environmental outcome. What solutions can farmers look to doing in the future? Farmers want to focus on the solutions and to do that they have to have confidence in the regulatory process and also confidence that they have a future.

Farmers will always push for an adequate cost benefit analysis and proposals to ensure that these effects are of benefit to society. For example, any solutions that will cost money for a positive result is when the benefits are greater than the cost. The trouble, however, is more often than not that any solution costs are met by the individual and the whole community benefits. The opposite of good-time capitalist and bad-time socialist, it is more like bad-time capitalist and good-time socialist. Sensible solutions are ones that have overall benefit without creating unfairness. All too often when the word sustainable is being used, economic and social wellbeing is forgotten, which just slows the process of achieving the capital solutions that have a benefit after cost.

Farmers, and particularly the Rotorua Lakes & Land Trust, because they are the most experienced in this area of New Zealand, believe the following areas are where the solutions to environmental problems in farming will be found. They are not in order of importance or political attainability: -

- Animal biology – the reduction of nitrate in urine. AgResearch is working on animal biology to reduce nitrogen in urine. The research is still many years away from completion and genetic modification and rumin bacteria may allow faster development in this area.
- Nutrient harvesting - the trials of watercress.
- Phosphorus trials and harvesting the grass off and recycling it. Small well managed areas where plants were harvested and solved many problems in the past with both nitrogen and phosphate.
- Soil biology – some evidence suggests the depth of the soil has increased. Plant and animal life with soil will not only reduce nutrient loss, it will also have a huge benefit on carbon sequestration. In theory it should have a positive effect on carbon balance and improving water quality. More research needs to focus on the benefits of increasing top soil in the effort towards a solution.

Farmers will continue to take results of scientific information and incorporate them into their farming systems. However farmers need to have confidence the investment will not be wasted by regulation. I have adopted a philosophy of doing that. I adopted it because a friend of mine had a urea silo pack, leased off the fertiliser company, and if you have one it means you are using a lot of urea. They used this product for one year and built up the soil molecules to an extent that they sent their silo back. That was enough for me; I have only been on it since April, about a month or two after the rain stopped and this spring it is noticeable that I have a lot more growth in the latter part of July and I am not using anything like the amount of artificial nitrogen and urea that I used in previous years. So we will research this product further and see how good it is and if it turns out that what is promised, happens, I have high hopes for it.

- In-Lake Action - Farmers like the rest of the community want in-lake action to be evaluated based on effectiveness and likeliness to succeed. Examples of these are aeration of bottom waters, dredging and capping of sediment. Oxygenation of lake waters is a proven and effective way to solve problems with algae bloom. There are many aeration methods employed around the world and some of these technologies are becoming very cost-effective and can be used to improve our lakes. German technology that maintains oxygen in lower water levels looks very promising and indications that it would be successful for Lake Rotorua with the capital cost of about $1 million.

- Sediment capping and dredging technology is dealing with the leaching of your grandma and granddad's poo and I do not subscribe to the theory that farming in Lake Rotorua is going to stop it getting better. What stopped it in its tracks was sixty years of grandma and granddad's poo – 'it wasn't me mate".

So these are the options that are available to the community. Solutions that are as cost effective as these need to be taken seriously by decision makers to be fully open and evaluated. Surely it would cost the community less to employ solutions like these than close down the dairy farms in the catchment. Farmers advocate for a robust process of disclosure to have confidence in the outcome. I am sure you will agree we all want to have the maximum effect for the limited money available.

How can we work together to improve water quality? Farmers and managers of land resources believe a partnership approach is the only approach that will be sustainable in the long term. Regulations to the district and regional plans will ensure the best land use to protect the food production income for New Zealand, while at the same time allowing for land use change to improve the environmental and economic outcome. Farmers are willing to continue to engage with plans and policy people to get a sensible outcome. As this speech has highlighted there are many and varied potential solutions. What is needed is an analysis of all the potential solutions available to restrict algal growth in lakes and rivers. The analysis cannot be limited to just phosphate and nitrogen loss off the land, but all options to find the best things to target. A full cost benefit analysis of all the potential options needs to be carried out in full consultation with the resource owners. From that analysis will emerge a list of the most cost effective and efficient solutions that maximise benefit to society.

Looking forward for solutions

The next question that has to be asked is how much can the community and the country afford to pay? What are the resources available to pay for the work? The only study that Federated Farmers is aware of is a report done here about three or four years ago that asked city residents how much they were prepared to pay for improvements in lake water quality in Lake Rotorua. The community answered '$18 per household or 35 cents a week'. This will need to be looked at in the future but it must be appreciated that communities do not have unlimited resources. With a robust and open process to find a range of solutions, the whole community can have confidence

to move together to achieve the outcomes we all desire. The outcomes must be community solutions, with shared costs and benefits. The community can continue to prosper if the lake water is to improve. Instead of facing off, we want to work together to reach solutions. We want the most cost effective solutions in the shortest possible time frame.

Federated Farmers asks that before any regulation is considered, the full extent of solutions are discussed and in the future acted upon. The regulations should be used to bring the tardy few into line, and there are "tardy fews" in every group. We have not got there by ourselves but I am amazed at the number of farmers who say to me, "tell us what to do and we'll do it". Water quality is just another issue they have to deal with and they want to deal with it and move on to other issues. There is no support for farmers who are environmental vandals; there is no support at all. Federated Farmers is confident the approach of a focussed solution will have the best outcomes for the whole community.

Thank you.

QUESTIONS

Charlotte Cudby, Nimmo-Bell & Co Ltd: I have two questions, both about systems. The first one is about recognising that the public …. almost like a system in themselves, and I am quite interested in the discussion over the debt to government and whether there could be a more efficient way of dealing with our policy problems. It seems to me we have talked a lot about economic cost benefits but we do not really take into account the economic costs of all the time it takes to deal with these problems and if we could find a better way it would be better for all of us. Essentially that may sound like getting everyone in the community to put in their own input and take some of the pressure off the nutrients that are in the system. So my first question is how do we do this? Because it seems to me that by calling for this institutional change, it is almost like if you take a courtroom situation and putting the accused in as the judge and having the lawyers as the defendant, how on earth would we get an outcome in that case.

My second question is just about the current approach that we are taking in terms of incorporating efforts and services into the economic equation. We are trying to fix our problems by stopping the bad on an *ad hoc* basis and what Morgan was talking about was we really need to incorporate a lot more of the positive services into the equation and essentially we need to start with positive aspects. How do we stop chasing our tails and dealing with the bad on an *ad hoc* basis and actually start incorporating those positive services, so that people can make good decisions? Thank you.

Morgan Williams: The only question that we could get there – apologies it might just be something to do with our age, but how do we stop chasing our tails – was that the question? I know there were several there. It is very hard to hear sitting here, I do not know if was our speaker system here, but it was extremely hard to pick up anything out of that.

Charlotte Cudby: Essentially I am saying that we seem to be just trying to address the problems we have got from history, and it is great that we are doing that, but in order to get the right incentive for us to have that system change you talk about in the PCM report, we need to start looking at how we actually reward positive behaviour. We are putting a lot of effort into addressing the bad and in the meantime people are getting on and making investment decisions. The current approach is focussing on how we fix the bad things happening, and there are a lot of good things happening out there. I did not hear much about forestry apart from saying that by taking an averaging approach they will get a windfall gain. One of the things I was trying to say was if you look back to the 1990's what

they have done with SEC?, that was a pro-active approach from forest industries that really showed their customers the positive things they were doing.

Morgan Williams: Okay so what you are asking is how do we get time to understand the nature of the problem and then how do we get to craft our way forward?

Charlotte Cudby: Well it is really a question that was asked this morning, how do we actually factor in environmental costs and benefits, more of the benefits into our decision making. We are focussing a lot on the costs …….

John Green: What we will get you to do is type the question out and we will focus on it tomorrow afternoon so that the speakers can actually read the question, because it is quite a complex one that you are asking.

Morgan Williams: I think to be fair, if I am hearing you, we all get somewhat exasperated with how we define and characterise the nature of issues in society and we seem to deal with some better than others. Think for a minute about one that is very different which we are struggling with because it is a contextually useful one, and that is obesity. We have done all sorts of things with the way we live our lives, what we eat and how we eat them, and we are generating a problem which is going to be an enormous burden on society. We need to be in one of those spaces where – it is a bit like a possum in the headlights and I am going to get it; in other words we are the possum and we do not quite know which way to jump. With many of our environmental problems and challenges here in New Zealand we are still in an element of denial and yet on the global stage we know it is becoming a very, very big and complex issue.

Why cannot we get more on the front foot and talk about average water quality in New Zealand which is good. Of course it is, because we have a third of New Zealand in conservationist state and it is in the mountains. Water quality in New Zealand is going downhill fast and that is actually not smart from a competitive advantage point of view – to put it purely into economic terms. How do we get our head around thinking in an imaginative way about these problems?

Gifford McFadden: What I understand your question to be was everybody wants to go to heaven and nobody wants to die, because that is what you are saying. If you can not get somebody to pay for it, nobody else is willing to. Morgan just brought up about lowland streams. Everybody can talk about how everybody saw it coming 40 to 100 years ago. But in the public conscience it has only been 10 years, and it has taken that time to get research going. Research has only been going on specifically for solutions for farmers for less than 6 years. Now at some stage New Zealand is going to have to make some choices and if you want to make the choice of closing dairy down then go for it; but there are an awful lot of people out there who are not dairy farmers who are going to suffer.

So we have to find solutions and that is why we are talking about finding solutions. But I cannot say to you that you are going to get a pristine stream because you are not. Pristine streams exist in native bush, so unless you are going to put all New Zealand including urban areas into native bush, we are not going to have pristine streams. We have to have a debate and an agreement on what levels of services we can have in the environment. That is the answer. Now how we do that - well we are negotiating with the iwi over the Upper Waikato and have not come to any conclusion, and we have not even started the negotiations. But there is a lot of goodwill there and I put the same thing to them – that I cannot give you pristine streams but I can give you good water quality.

Federated Farmers has a project going called Upper Waikato Community Consultation. And we had Forest & Bird, Fish & Game, energy people, forestry converters, forestry people – and what Federated Farmers put on the table was drinkable, swimmable and

fishable water. Most of it comes down to nitrogen but it was interesting that Robert Brodnax told us about the work going on at Taupo – it has got so much arsenic in it that it is only about two points below the World Health Standard. The water will always have to be treated in the Waikato because of the arsenic and the nitrogen and it has got Giardia in it. Now they are environmental disturbances that exist already, so all we have to do is agree on what is an acceptable level to the community, and we can take it from there and see what we can achieve. But I can tell you, where I farm in the Upper Waikato we intend to anticipate that and we are already well into it, well before Environment Waikato regulate. We think that the large and adaptive government model is a real sweetie because that is what Environment Bay of Plenty has done here and in my view it has been very successful. We argue like cats and dogs and not everything comes out sweet, but there is a great degree of trust between us and a great degree of agreement between us. And among the farmers tidying it up because we were shut out of the science and we want to re-evaluate some of that stuff, but we are interested in closure. That is what the farmers want – we want closure.

Ali Memon: I have been listening to the speaker this morning about the Danish way of doing things and I feel very envious about it. But each country is different and has to decide for itself how best to deal with the issues that it is facing. In New Zealand we are very well placed to develop an approach for sustainable agriculture that can be the world's first. We are a relatively small country, reasonably well endowed with resources and we do not have deep divisions within our society. Not as bad as some other parts of the world. We have a real opportunity to do something that is distinctive and will carry on into the 21st century in a sustainable kind of way. But we need leadership for that, which must come from the farming community. Farmers can be team makers in New Zealand if they take on board the things that we are talking about and are of concern to us. Hopefully it is starting to happen as we heard from the previous speakers.

Gifford McFadden: We can not do it alone, that is what is good about the EBOP model. We need your support, your understanding and we need you as a check and balance. If you looked over at us and said something is going to work, the public will accept that. So that is why we want to work with all of you.

Colin Smith, TracMap: My question is to Morgan around the role of the supermarkets in setting some of society's standards around those commons. Gifford talked about farmers wanting to come up with solutions and move on, but there are costs which society has to pick up on – there is the local cost and maybe some international costs. Morgan talked about the fact that we can import food into this country from countries who have lower environmental standards. What I am wondering, Morgan, is how much are we going to see the solution coming from the fact that the supermarkets are going to reflect society's values around those commons of atmosphere and soil and water; and that will result in a premium coming back to our farmers for delivering better results than farmers in other countries?

Morgan Williams: The evidence at the present time is that some of the big supermarket chains are starting to lead what you could call the 'moral debate'. I heard one of the chiefs of Marks & Spencers in Auckland recently and that came through very clearly. Are they doing it for altruistic reasons? No they are not. They are being very smart and listening very carefully to their customers. They are going to struggle to reflect what customers are really asking for in many of our current systems, but the fact that they are having hard debates about "do we buy fresh grown beans from Africa and support small communities that have got a good product, but we have to fly them", or "do we grow them in greenhouses in the middle of England where there are more carbon costs", and "do we build another nuclear power station to heat the greenhouses". Having those conversations around the world with suppliers shows they are looking for solutions.

In summary some of those big supermarket chains are in fact going to lead where governments and wider societies are struggling. But finally the real issue here back in New Zealand is in managing commons and there is a very simple way we could do it, to vastly increase our investment in a whole series of areas of research, we can do that around agriculture and wider without incurring the wroth of WTO and other such organisations who will talk about subsidies. I am not talking about simple production research, I am talking about vastly bigger increases in research around the operational aspects and biology of our soils and soil systems and so on. Right across the western world we have run down that capacity quite dramatically at enormous cost.

Ali Memon: To add to what Morgan has said, maybe the real cure for us in Australia and New Zealand in terms of changing our farming systems will come from the consumers in Europe. We heard this morning the kinds of changes that are taking place in Denmark and other countries and once those changes have been put into place, I think it would be quite logical for European consumers to insist that goods that come from outside Europe meet the same standards as their home country; and maybe that will force us to change our systems. So leadership and direction will not come so much from our national government but from international agencies like the European Union.

Gifford McFadden: We are right now in the world on the cusp of an extreme change and nobody knows where it is going to come out, and the best thing New Zealand can do is maintain its grass-fed agriculture because of its costs. The European systems are not sustainable in a high cost environment, in a fuel shortage environment. What is going to happen over that I do not know, but my picking is that if we want to talk about green stuff, and people are going to buy green and environmentally sensitive stuff, we want to be there, but the problem is that people buy on price. I was in England recently and at the hotel I had fruit for breakfast and there was a big hairy kiwifruit with a Zespri sticker on it. Now we can have anything we like but people are going to rip us off. It is how we maintain the goods that we do. It is not simple enough that we meet the world or we define high standards, we have to get paid for it, maintain the money and get the money back to us. It is a horrible commercial imperative to do it but if you want a good environment you have to pay, and I do not think that is unreasonable. At best you will be assured of getting a good environment to pay – money is a really good motivator.

Toby Curtis: Thank you Gifford. From my perspective there was one real salient point coming through and that was the matter of morality, where we have to be moral in terms of decision making and we need moral leadership. On your behalf would you like me to speak to Winston Peters?

Session Five - Solutions and a Change of Mindset

SESSION CHAIR: John Cronin, Chair, Environment Bay of Plenty

John Cronin is currently Chair of Environment Bay of Plenty and a member of the Rotorua Lakes Strategy Group. He is very experienced in Regional Council policy development and implementation, and is a strong supporter of our Rotorua Lakes Protection and Restoration Programmes.

BARRIERS TO CHANGE

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This presentation was prepared by Geoff Kaine, Department of Primary Industries, Victoria, Australia who for the past twenty years has served as an adviser to the Queensland/New South Wales and New Zealand Government on the design and implementation of a range of policies to manage water allocation, water and air quality. Because of illness Justine replaced Geoff as the presenter. Justine worked for Geoff on the Lake Taupo water quality issues. Since 1998 she has been employed by Waikato Regional Council (WRC) as a policy advisor responsible for the formulation of WRC policy with respect to land and water quality including the Waikato Regional Plan (WRP). During that time she worked on the water quality module of the WRP from Council notification to decision. In 1999, she assisted with reviewing policy to address Lake Taupo water quality issues, and this role grew as WRC undertook further scientific investigations and consultation. She was involved in setting up and facilitating the consultation process with individuals and groups in the Taupo catchment and directly responsible for the team drafting policy on Waikato Regional Plan Variation 5 – Lake Taupo Catchment (RPV5) and managed the First Schedule process.

ABSTRACT

A proposed tradable emissions market for controlling nitrogen entering Lake Taupo is nearing implementation. The proposed market will include diffuse source emissions from pastoral agriculture. We discuss some of the critical nutrient cycling and equity issues that have influenced the design of the market. We will focus, in particular, on how the setting of a standard for water quality influences the distribution of adjustment costs between landholders and the rest of the community, while the allocation of emission rights influences the distribution of adjustment costs among landholders.

TRANSCRIPT

Tena koutou, tena koutou, tena koutou katoa. Some explanation further to that introduction – I have been providing project co-ordination and policy advice to the project over the last eight years. Yesterday we heard quite a bit about this project. There were five years of consultation, technical information gathering and negotiation about public funding before the plan was even notified and it has been a variation to the Regional Plan or, as Simon Berry terms it, RPV5 (that trips off your tongue after a while), with the past three years of RMA process since public notification. It is a long time to be involved in any project and on reflection, with the Environment Court case only completed six weeks ago, I am at a stage now of figuring out what it is we have learnt over that time. Today I will

draw out the lessons that might be useful for anyone embarking on, or in the process of considering, water quality and land use change.

I will start by describing the policy context, the social, biophysical and institutional forces that resulted in the management of nitrogen emissions emerging as a policy problem in the Taupo catchment. I will then describe briefly the design of the cap and trade market and discuss the relationship between market design, the allocation of emission permits or if you like, the allocation of the rights to discharge nitrogen from non point sources over a whole property and the relationship between market design, the allocation of emission permits and the fairness in sharing adjustment costs. I will finish with some conclusions about this relationship.

Speakers yesterday talked about the context and description of Lake Taupo, and Simon Berry, in particular, named quite a few people in the audience today who are experts in their various fields and can answer some of the technical questions here. Suffice to say, Lake Taupo is an internationally renowned lake for its scenic beauty and trout fishing. It is a cultural icon for the New Zealand people, both Maori and Pakeha. What did not come out yesterday is that Ngati-Tuwharetoa are by far the largest landowner in this catchment and there is significant Government ownership of rural land.

David Hamilton yesterday described the current state of Lake Taupo, so I will not go into that, except to say that one does not really get a sense of how incredible the clarity of this lake is unless you are right there looking down into the water. (*Figure 1*) The house we were living in was just down from the control gate where the Waikato River drains out of the lake and I was astounded one day to realise that I was looking at the bottom of the river and it is very deep and hugely flowing.

The policy context of the lake took into account a number of factors:

- Farming produces nitrogen emissions and there are highly permeable volcanic soils that allow N to leach into groundwater and transported through the groundwater and streams into the lake which reduces the water quality
- Reducing water quality and clarity means more weeds and thereby reducing the scenic, recreational and cultural amenity of the lake
- Consensus within the community that water quality in the Lake should be preserved
- Water quality will continue to deteriorate unless nitrogen emissions are reduced
- Support for tourism, recreation, resort and lifestyle development and cultural amenity of the Lake
- Continuing intensification of livestock production and potential conversion of forestry to dairy farming raises the possibility that nitrogen emissions would significantly increase into the future.
- Resource Management Act imposes a legal obligation on Regional Councils to protect environmental assets
- The Act also requires that the social consequences of taking action to protect the environment must be considered

We are talking about a potential threat rather than an actual degradation in the same sense that we have seen in some of the information about the Rotorua lakes in the last day.

Figure 1

Figure 2

There are two key things here in terms of the policy context. Environment Waikato needs to be confident that the emissions restricted now, and in the future are sufficient, because if they are not, the incredible water quality in this lake will not be protected. Robert Brodnax mentioned yesterday that in terms of the science and assessment of what is needed, it was estimated that emissions must be reduced by 20% to preserve the current water quality. There are also issues of time lag - water that is already in transit in the groundwater from past land use. Environment Waikato wanted to maximise the value created for the community from nitrogen emissions that would be allowed, this meant there had to be flexibility for nitrogen emissions to shift between different uses over time

The second point is that it is important to recognise that land owners want managerial discretion in deciding how they reduce emissions or live under the cap. This catchment is essentially dry stock farming or sheep and beef farming and in the absence of technologies for easily and inexpensively reducing nitrogen emissions from livestock production, a 20% reduction may reduce income making farming unprofitable and put at risk the livelihoods of many producers.

A critical part of the policy context in designing the eventual change to the regional plan was that emissions from agriculture in this catchment vary depending on the type and numbers of livestock, the type of soil, topography and a range of other factors. That difference in ability to reduce nitrogen is very important in the type of regulation or policy intervention. Reducing emissions is different for different land holders, depending on their circumstances and context, and had to be taken into account in setting the policy context.

The other thing to note in this catchment is that landholders are not just farmers but also owners of forestry land. There is a huge amount of production - forestry, indigenous lands, conservation reserves - and land which has not yet been developed. Interestingly, landholders with lower emissions are not necessarily more community minded, more motivated to protect the lake or better land managers. It could be considered an accident of history. Yesterday you heard Simon Berry talking about this issue of “blame for past actions” that was raised through the consultation process.

What options were considered? A voluntary code of practice for a start. When considering the two aims of certainty for the long term, and landholders being able to choose their own ways to manage emissions, it does not provide surety that they will reduce to the target level nor provide discretion for landholders. It does not provide a mechanism for allowing people to transfer nitrogen amongst each other.

What about regulating farm practice? For instance, why not say all land owners should do x, y and z; and there are some regional plans considering that this might be a viable option. However that cuts right across the managerial discretion principle. It does not guarantee that the emissions will be restricted to the target level, because you can set the actual practices but not know if the target level will be met. It does not allow transfer of emissions easily between land uses and therefore does not maximise a return to the community and impose additional abatement costs on landholders and the community generally.

This is also an issue with regulating simply by capping and requiring resource consent and restricts managerial discretion. Simple regulation without allowing people to transfer nitrogen amongst each other creates a barrier to doing that and may impose additional abatement costs. For instance, a regulation that freezes everybody at a particular level, some people may depend on the context that can reduce nitrogen more cheaply than others, capping will not allow that to happen.

Figure 2 shows the amount of work that has already been done in the catchment, the reserve along the edge of the lake and enormous amount of production forestry in the catchment.

These considerations resulted in the identification of a cap and trade market in emission permits as the most suitable method for controlling nitrogen emissions in the catchment. The cap constrains emissions (not trade) creating certainty that emissions are reduced.

The basics of the design:

- Trading allows emissions to transfer between the land uses depending on relative net benefits thereby allowing the maximum return to community and minimising abatement costs
- Emissions are estimated using a model. Stewart Ledgard talked about Overseer, what it does and why Environment Waikato had no choice of not using a model
- While modelling resource use is new, models have been employed before to estimate the supply of a resource, such as fisheries
- Average annual rate of emissions estimated using factors that influence emissions such as type of livestock, stocking rate, soils, topography (control)
- Factors provide basis for monitoring compliance
- Trading at any time but requires updating of discharge rights which are issued by Environment Waikato
- Model updated over time (new info on parameters, new technology)
- Cap reviewed in fifteen years (life of discharge right)

An important point to remember here is Overseer can be updated to allow for any practice or innovations which a land owner wishes to use. This was an issue of debate and contention through the Environment Court process and a lot of money was put into Overseer to make sure that it is able to keep up with innovation and good farming practice.

The cap is based on the assimilative capacity of the lake, the amount at which any further increase would cause a long-term deterioration in the water quality of the lake. It is based on the 2001 level and the objective in the Regional Plan Variation is very specific about what the parameters for water quality in 2001 are, and the definition of the target is critical to a policy intervention such as this. The Overseer model used to define the nitrogen discharge right, or the NDA (nitrogen discharge allowance) which Simon Berry mentioned, is the average annual rate for nitrogen leaching, and is ascertained through a process of benchmarking.

The entire implementation team for the Lake Taupo catchment is at this Symposium and last night we discussed the issues and difficulties faced implementing this course once the Environment Court process had finished. The rule has been in place since notification in 2005 and there is a huge job facing implementation of this regulation.

I want to talk a bit more about the design of the market and wealth distribution, and the reason why it is important for people to think about the allocation of the discharge rights that create such a fraught and conflicted series of discussions started as introductions from 1999 when Environment Waikato took action. Not surprisingly, one of the key reasons was that when you allocate rights to leach diffused sources of nitrogen over a whole farm, you are essentially redistributing wealth amongst land owners. The key thing is that nitrogen leaching from agricultural systems and farming is at a much higher level than nitrogen leaching from forestry or indigenous vegetation. Imposing a cap reduces the potential for future emissions and imposes costs on land owners.

What are those costs? Firstly it is reduced future production – what would have been done if the cap had not been in place. Secondly the costs associated with reconfiguring activities to stay within that cap, and thirdly the loss of potential earnings because, similar to the first, you can not simply ban production unless you purchase nitrogen discharge rights from somebody else. This applies to a forester who is capped at a particular level and a farmer who is also capped.

One of the key decisions which Environment Waikato had to make, in the interest of fairness of preserving the landholders' existing income and ensuring that everyone faced the same costs into the future. 'Polluter pays' was mentioned in passing yesterday; if you cap nitrogen at a particular level, it is making the future leaching of nitrogen and earnings which are made into the future as a landholder. The argument in the Environment Court about whether or not, was 'polluter pays'. By setting a cap, farmers pay into the future and we hear about the cost imposed in this foregone opportunity if one increases the emission.

Environment Waikato estimated the total discharge rights, took the total amount of nitrogen entering the lake, gifted it all to land owners and the 20% reduction is the aspect that the Lake Taupo Protection Trust is going to cover. They are purchasing 20% of the discharge rights from the land holders using taxpayer and ratepayer funds.

I mentioned Taupo District Council and should have said that the Government has a large amount of ownership in the Lake Taupo catchment. The specific context for the catchment led to the design of this system. The Variation caps nitrogen discharges at historic levels or 'grandparents'; the Lake Taupo Protection Trust is purchasing 20% of nitrogen from existing land owners to account for the nitrogen which is in transit, in order to protect the long term water quality. That means the cost of reducing emissions is shared between the land holders and the wider community. There is a potential to gift nitrogen using an averaging mechanism which was very contentious right from the beginning. There are all kinds of ways which you can average nitrogen; by sector, by taking averages of nitrogen leaching from each hectare in the catchment and then giving everybody a standard amount.

What does this do in terms of the transfer of wealth? If everyone has the same volume it creates an immediate loss for people who are above that average. If the average is say, 6kg of nitrogen per hectare per year, the farmer who is leaching say, 12kg – immediately is in deficit and has to purchase. At the same time an averaging mechanism transfers wealth from livestock and dairy famers to the foresters and does not preserve the income of all the land holders. We can not assume that people who are above average are 'bad' and below average emissions are 'good' land holders. This depends on a variety of factors in the farm context – topography, soil, and history - as well as land use of the land owner.

Environment Waikato agonised over this and it was a discussion which went round and round for the five years it took from the time of deciding that something needed to be done to the time of notifying the Variation in 2005. Gifting on the basis of historical emissions was the only allocation method which would preserve the existing activity or existing incomes for all landowners. Another way of putting it: it was the only allocation that did not redistribute wealth amongst the land holders, and treated all land holders similarly in regard to opportunities to increase emissions in the future; that opportunity is one which can be realised through the purchase of nitrogen discharge allowances once all land holders have been benchmarked and a consent process is in place.

The key thing that needed to happen in this process to make an informed decision was an understanding of the equity issues and creation of a market to discharge nitrogen in the Lake Taupo catchment. Essentially it is a social and political judgement about the merits

of the policy intervention. Having been involved in the consultation and discussions amongst the Councillors, I can tell you that this was extremely challenging for everybody. When I was sitting here reflecting on the process that I have been involved in over the last eight years and thinking about some of the challenges which the speakers were raising, in particular the Albert Einstein quote from Morgan Williams, "*you can not solve a problem using the same thinking that you used to create it*", I reflected on the next challenge for Environment Waikato. Robert Brodnax spoke of the tools Environment Waikato has at its disposal as a Regional Council and the ability to take action, depending on where in the region, and what the issues are for the community.

What is needed for the future? As Morgan Williams posed - imagination, opportunity, partnership, limits, confidence and leadership. How many of those aspects were present in the eight years of the process that I have been involved with in the Taupo catchment?

- Considerable in terms of leadership from the Regional Council and partnership of the funding discussions and eventual public fund that was put together
- Limits - definitely in setting the targets and defining long term parameters for water quality in the lake
- Confidence, an interesting one because there were times where, because of the barrage of need for finding technical information, there was a loss of confidence. Environment Waikato chose to seek further technical information and interestingly, we did not need to have a lack of confidence in whether or not there was a reason to take action and define a water quality target for the lake, because it was definitely the initial thinking about targets for the lake and the need to take action. We heard yesterday, getting a second opinion meant that some of the early thinking was confirmed and therefore we could finish with more confidence than we had – a good thing
- Partnership is also an interesting one. Ali Memon yesterday posed the question to us about talking between partners or stakeholders. There were mechanisms set up and partnership meetings called that involved the central Government, the two local governments and Ngati Tuwharetoa and key stakeholders, forestry and farming interests

Something to learn for the future was that we did not take enough opportunity to get people to have those conversations with each other. My reflection on the Environment Court process was that the Court directed people to go into caucus with the experts in the room and nutted out the technical issues, come to an agreement and sign what they agree and do not agree on; it was not until that process was forced upon people that something meaningful was found that they could all live with.

As I said at the beginning, I have not figured out on a personal level what I have learned out of this process, but I suspect one of the things is being able to have those conversations in the depth that they need to be had, and they are very uncomfortable, that is for sure.
Thank you.

PLAN FOR THE FUTURE:
ORGANIC FARMING IN LAKE CATCHMENTS

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Neil is the recently retired founding Director of the International Global Change Institute, (IGCI) an Interdisciplinary Research and Teaching Institute Focusing on the Human Dimensions of Global Environmental Change, Waikato University. His research interests are human response to natural hazards and climate change, governance and environmental management and resource planning. It has involved developing and applying methods for evaluating the quality and effectiveness of environmental plans in New Zealand, evaluating cooperative and coercive approaches to environmental management and governance in the United States, Australia and New Zealand with particular reference to natural hazards.

ABSTRACT

The Resource Management Act's "plan for the future" is for individuals and groups to minimise adverse environmental effects when using and developing natural and physical resources. To do otherwise is to pass the resulting environmental costs on to others. If this Resource Management Act ethic was accepted by all, and they had sufficient knowledge and wherewithal to act responsibly, there would be no need for national, regional and local plans. Resistance by many farmers to Resource Management Act planning focuses on its presumed intrusion on individual property rights, but fails to acknowledge that poor use and development of resources intrudes on the rights of others. How can this mindset be changed?

The Resource Management Act has within it a hierarchy of policies and plans that enable councils to implement rules and other methods, like incentives and education, aimed at coercing or encouraging individuals and groups to comply. At a higher level, the Resource Management Act is a devolved and cooperative mandate which assumes local government is willing to comply, but may not have the capacity to do so. It also assumes that Government will build capacity in local government, such as through technical assistance, like providing national policies guidance and methods for helping councils to identify matters of national importance. Without this support throughout the 1990s and beyond, 86 councils were left to develop solutions to problems for themselves -- a rather wasteful approach to implementing the Resource Management Act ethic.

Lack of capacity building by Government in both central and local government for Resource Management Act planning resulted in far too many first generation plans and their implementation being of poor quality resulting in a lightening rod for damning the Resource Management Act. The on-going controversy has made changing the mindset of farmers that is much more difficult. Beliefs and attitudes are hard to change at the best of times because there are many competing personal and situational factors that limit environmentally friendly choices. Bringing about a change in attitudes requires on-going and salient messages through information and education programmes aimed at encouraging environmentally sensitive behaviours. They include building strong and meaningful images of the future using scenarios of desirable and undesirable outcomes. These programmes are costly to develop, implement, and sustain over the long-term, which is perhaps why councils find refuge in regulations. While regulation forces behaviour change with the hope that desirable attitudes will follow, for many they simply

build resentment that only lessens over time if personal benefits accrue. Individuals need information about not only the problem, but also how to help solve it. But most important, they require the means by which they can act effectively. Moving from conventional to organic farming in the catchments of the Rotorua Lakes highlights the importance of these imperatives.

PRESENTATION

This paper highlights the main features of the RMA (*Resource Management Act*, 1991) as the nation's plan for its environmental future. Resistance to the RMA ethic and effects-based plans is traced, in order to show the great challenge facing organisations committed to promoting environmentally friendly farming in lake catchments. The difficulties in changing attitudes are highlighted and a multi-method, multiple means approach is put forwards as a solution to changing the mindset of farmers, and their support industry, away from conventional and towards the organic farming that is implied in the RMA.

RMA Planning for Our Environmental Future

The anti-planning; anti-regulatory mindset accompanying the 1980s central and local government reforms, spilled onto implementation of the RMA in the 1990s. This mood was bolstered by the neo-liberal economic reforms. The RMA was the nation's plan for our environmental future, its ethic underscoring the need for environmental responsibility by having people minimise the adverse environmental effects of their use and development of natural and physical resources. To do otherwise would be to pass the resulting environmental costs onto others, including future generations to deal with at considerable cost. If this RMA ethic was accepted by the users and developers of natural and physical resources, there would be no need for national, regional and local plans. But it is not, which is why we have regulatory planning.

The RMA was trumpeted as a devolved and co-operative mandate. Environmental decision-making would be devolved from central to local government and where communities are best able to deal with local problems. This would be done through inter-governmental co-operation across central, regional and local councils.

What was not trumpeted at the time, nor have many acknowledged since, is the assumptions that underpin devolved and co-operative mandates. First, it is assumed that local government is willing to comply with a national mandate, but may not have the capacity to do so. Second, it is assumed that Government will build capacity in sub-national government through funding and technical assistance via its implementing agencies.

For the RMA this would include the Ministry for the Environment (MfE) developing for Government guidance through national policies and methods to help councils identify matters of national importance -- matters which mostly affect smaller resource poor councils. This did not happen. Without this support throughout the 1990s and beyond, 86 councils were left to develop solutions to problems for themselves -- a wasteful approach to implementing the RMA ethic.

MfE tried hard to provide advice to councils on how to develop the new effects-based RMA plans, but could do little more than review and give advice on draft plans as they emerged. This was because Government funding cuts reduced staff numbers by half in the five years after the RMA was enacted in a period when district plans were tumbling out of councils for review (*Figure 1*). Without Government capacity-building in MfE and councils, the resulting plans were not of high quality (Ericksen, Berke, Crawford and

Dixon, 2003). In-spite of extensive public consultation over objectives and policies in district plans, too often this was not carried through to consultation over methods to be used in the plans, which too often had debatable rules, rather than other methods.

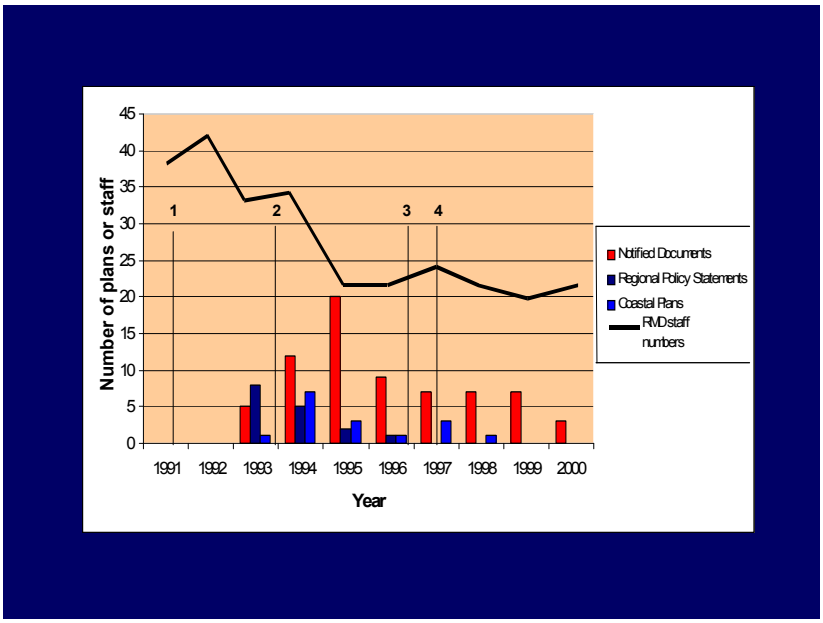

Figure 1. Ministry for the Environment: comparison of trends in number of notified documents (regional policy statements, regional coastal plans, and district plans) with total number of staff in the head and regional offices of the Resource Management Directorate 1991-2000 (Source: Ericksen, et al., 2003).

Farmer Resistance to RMA Planning

A consequence of poor capacity-building was that many constituents in rural based councils, often led by farming lobbies, vigorously protested against RMA plans resulting in significant plan-variations. In one case, the whole plan was thrown out and the process started again. Too often, local politicians pressured staff into early notification of plans, and then forsook ownership of them when protesters marched on town-hall (Ericksen, Berke, Crawford and Dixon, 2003).

The RMA has within it a hierarchy of policies and plans that enable councils to implement rules aimed at coercing individuals to comply with the mandate and other methods, like incentives and education, aimed at encouraging them to do so. Regardless, good information is required, in order to successfully employ regulations.

When introduced, the RMA was said to be the most intrusive instrument on individual rights after taxation (Treasury, pers. com, 1996). Many property developers big and small seem to agree with that judgement. While many farmers, and others, resist RMA planning due to its intrusion on property rights, it is a view that was bolstered, not only by poor quality plans, but also rules requiring them to protect or conserve resources on their land judged to be of national or regional importance -- without compensation (Ericksen, Berke, Crawford and Dixon, 2003). The option of methods other than rules in RMA plans led to a rallying cry by many councillors around the country in the early 1990s to “educate don’t regulate”, a theme to be returned to later.

Nevertheless, appealing to property rights in resisting RMA rules fails to acknowledge that where farmers use and develop resources in a manner that results in adverse

environment effect or externalities -- such as nitrification of water bodies -- it is an intrusion on the rights of others. These others bear the aesthetic costs and eventually the financial cost of clean-up. Given the difficult history of the RMA, how can mindsets be changed?

Changing Attitudes and Behaviour

Lack of capacity building by Government for implementing the RMA resulted in a plethora of problems. These formed a lightening rod for damning the RMA. The on-going controversy has made changing the mindset of farmers that much more difficult, as councils dealing with lake-catchment land-use management problems can no doubt attest.

Beliefs and attitudes about an object of interest (e.g., lake-catchment land-uses) are hard to change because there are many intervening personal and situational factors that limit change, such as towards adopting environmentally friendly behaviours. Bringing about a change in attitudes requires on-going and salient messages through information and education programmes aimed at encouraging the environmentally sensitive behaviours the RMA mandate seeks.

Information and education programmes are costly to develop, implement, and sustain over the long-term. They require a team of specialists, just like those employed by councils for storm water, or waste water, or roads. Perhaps that is why many councils find refuge in regulations, in spite of the early rallying cry of "educate don't regulate." Clearly, there is a need for both.

While regulation forces behaviour change with the hope that desirable attitudes will follow, for many people they simply build resentment that only lessens over time if personal benefits accrue. Where information and education programmes are effective is in helping people realise goals to which they are already favourably disposed.

But even if education changes attitudes so that they align with desired goals, this may not lead to appropriate behaviour because individuals may either:

- lack knowledge on how to act;
- have knowledge, but lack the ability to act; or
- have knowledge and ability, but be constrained from acting through social (including political) and/or cognitive factors (Ericksen, 1986).

With respect to organics, a conventional farmer might see organics as an option, but not have good information about it. Or his/her bank manager may not see going organics as an option -- even if sympathetic to organics -- because he/she is not prepared to risk funds on conversion. It could be that the prospective organic farmer has no farm adviser with organic expertise to draw on while making the transition. Another constraint could be the lack of an outlet for the organic milk, and so on. All of these impediments to change need to be considered when developing an organic programme for minimising the adverse effects of conventional farming on lake systems.

An Organic Future

Gaining a collective image of the merits of organic farming requires multiple methods and multiple means. One means is to build future images by using the scenario method (Ericksen, 1975; 2005). Scenarios use scientific information and decision-making knowledge about the past, in order to forge likely futures. They allow analysts to compare alternative futures, which can then be presented publicly for debate. For example, a scenario (or "what if") based on a business-as-usual approach would project past patterns of behaviour into future outcomes, which for the lakes EBOP shows to be grim. This could

be compared with a scenario based on a change of land-use from conventional farming to organic farming projecting the future outcomes, which results in healthy lakes and all that flows from that. In this way, comparative scenarios build strong and meaningful images of undesirable and desirable futures for individual and collective action.

Two years ago, a local dairy farmer explained to me the EBOP plan for saving the lake, which involved constraints on his farming habits, especially the use of nitrogenous fertiliser. He fretted about going out of business. After showing me his fertiliser of nearly $100,000 for the year, I suggested he could save that yearly by conversion to organics. Emboldened by his flicker of interest, I volunteered that two of my colleagues would come over and talk to a group of dairy farmers in his area about the organic option – gratis. Weeks later, the farmer let me know there was no interest from his neighbours and the matter lapsed, for reasons alluded to above.

What might be the benefits from going organic? Research 15 years ago matched pairs of organic and conventional farms in New Zealand and evaluated them on many dimensions ranging from soil and animal health, quality and quality of milk, input costs, and profits. Organic farming ranked better on most dimensions and was not lower on any, including profitability (Reganold, Plamer, Lockhart, and MacGregor, 1993; Reganold, 1995).

More broadly, there are at least three benefits that might derive from conversion to organic dairy farming in the lake catchments of Rotorua.

- Ceasing use of NPK fertiliser (and pesticides) saves a lot of money and has an environmentally beneficial effect.

- Using aerobic cow-shed waste treatment would have an initial cost for the farmer, but have an environmentally beneficial effect.

- Using biogas from an anaerobic bio-digester could be harnessed for energy needs, providing a saving to the farmer.

What means would be necessary to encourage farmers to join an organic programme in our lake catchments, assuming the soils are suitable for such an approach?

Focused Innovation

The best way to achieve rapid and universal uptake in the lake catchments would be to require farmers to adopt organic techniques through *regulation*. That option would, however, require careful ground work to ensure that support systems were in place well ahead of the requirement to conversion from chemical to organic-based farming. It would require information and education programmes, and having in place the organic specialists for providing on-going advice to farmers on conversion and beyond. Also required would be the support industries, including green technologies for dealing with cow-she wastes. Clearly, regulation by itself is not enough.

In a liberal democracy, a less command-driven approach would be more desirable, one that aims to encourage farmers into organics through *education and incentives*. This would also include having a range of information about not only the problems associated with conventional farming (much as EBOP has already done), but also how to help solve it (which EBOP has partly done). More important for our organics exemplar, farmers would require the means by which they can act effectively and efficiently when moving from conventional to organic farming, including loss of production during the 3-year transition period. That requires input from many other players, in order to counteract influences on farmers into continuing with conventional chemical-based farming (fertiliser companies,

conventional farm advisers, bankers, etc.). What might some of the elements be in this *integrated approach* to organic farming programme?

Decades ago, research focussing on the *diffusion of innovations* showed how they spread from specific points spear-headed by the "leaders or innovators" slowly outwards to the "laggards" (Rogers, 1983). Think of the herring-bone cow-shed of the 1950s or the later rotary cow-shed. How can innovation, in our case organics, be facilitated to get more universal uptake in the catchments of our lakes?

Elements that seem essential to such an *integrated programme* are –

- Diffusion of innovation: leaders and laggards
- Facilitating innovation:

- ✓ Develop partners for change
- ✓ Identify farmers predisposed to change
- ✓ Provide incentives to adopt
- ✓ Provide salient on-going education
- ✓ Build networks with other farmers

First, it is essential to build partners for change. This could include: Fonterra, Federated Farmers, the alternative technology industries (e.g., aerobic systems), Rural Banks, EBOP, RDC, Te Arawa Trust, and Lakes Water Quality Society, and so on. Farmers who are predisposed to change need to be identified and to meet with farmers who already practice organics, thus strengthening the farmer network (Gillatt, Coats, Kenny, and Robertson, 2003). Incentive both financial, and others, should be provided for the initial farmers, because they would be taking risks associated with new technologies on behalf of others. Salient and on-going information and education needs to be provided to not only the innovator farmers, but all others in the lake catchments. This should involve on-going face-to-face consultations with expert advisors in organics and associated technologies. This, too, would help to strengthen the network of prospective organic farmers.

Conclusion

Changing the mindset from conventional to organic farming, in order to protect lake quality is a tremendous challenge. Technical issues aside, this mindset is in part caused by a poorly implemented RMA mandate that embittered farmers and others towards implementation of its environmental ethic. Regardless, attitudes are hard to change due to the many intervening personal and situational factors and the object of attitude.

Even where people are predisposed to change, it is unlikely to happen due to lack of knowledge on how to act; and/or lack of ability to act; and/or social and cognitive constraints on acting.

Recognising these difficulties, the "solution to changing the mindset" is not to regulate for change, but to develop an integrated programme of action that uses multiple methods and multiple means aimed at lifting the constraints. That is what is suggested for conversion to organic farming (and/or other green techniques) in the catchments of the Rotorua lakes.

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CAN WE PREVENT NUTRIENTS CAUSING WATER QUALITY PROBLEMS?

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Kit is an engineer with 30 years experience in research and consulting on the prediction of water quality in rivers, lakes and estuaries. He has been involved with Lakes Rotorua and Taupo since the early 1970s with the Ministry of Works & Development, DSIR and NIWA and has published widely on mathematical modelling, trend analysis and mixing as it affects water quality.

ABSTRACT

Adding nutrients such as nitrogen (N) and phosphorus (P) to waterways increases the growth rate and biomass of plants and the organisms that consume them. Some nutrient input is unavoidable and beneficial but excessive inputs have undesirable effects (e.g., reduced water clarity, oxygen depletion, macrophyte infestation and/or algal 'blooms').

Three important management tasks are: (1) to quantify the sensitivity of rivers and lakes to nutrient load, (2) to quantify each nutrient source and assess the cost and effectiveness of mitigation measures, and (3) to determine whether the nutrient load with cost-effective mitigation in place achieves the desired water quality targets. This approach is illustrated from recent studies at Rotorua and Taupo. Lakes are sensitive to their external (viz., rainfall, groundwater, catchment runoff, sewage and urban stormwater) and internal (viz., nutrient recyling from lake bed sediments) loads. Removing sewage nutrient inputs (e.g., diversion of Rotorua City sewage to Whakarewarewa Forest in the early 1990s and more recent reticulation of lake side communities) and geothermal (e.g., current trials at Tikitere) is obvious, costly, but successful (although nitrogen leaching from Whakarewarewa Forest remains an issue). Diverting high volume flows is more innovative (e.g., the Ohau Diversion and the Hamurana Springs proposal). Trials have been conducted in Lakes Okaro and Okareka plus the Utuhina Stream to remove nutrients chemically, and further trials are planned on 'capping' lake sediments in Rotorua to prevent phosphorus release. To date no significant adverse effects on lake ecology have been detected from these trials although there are some unanswered questions about the effects on lakebed denitrification, the release of a rare-earth and the cost-effectiveness of 'capping'. Nevertheless 'capping' remains a potential management option especially when used in conjunction with reduced external loads.

External nutrient loads depend strongly on the intensity of land use. Farming practices that reduce nutrient generation are discussed by others at this meeting. Additional on-farm mitigation measures that have the potential to trap nutrients and prevent them from reaching the lake include: stock exclusion, filter strips, and wetlands. Their cost-effectivness has recently been summarised[1]. Lake edge wetlands are currently being trialled at Lake Okaro to reduce the impacts of agricultural runoff.

[1] McKergow, L.A., Tanner, C.C., Monaghan, R.M. and Anderson, G. (2007) Stocktake of diffuse pollution attenuation tools for New Zealand pastoral farming systems. Prepared for Pastoral 21 Research Consortium. NIWA Client Report HAM2007-161. December 2007.

A range of tools and models are available to help managers set water quality targets for rivers and lakes, and predict whether a given scenario of land-uses and mitigation measures is likely to meet these targets, together with an assessment of uncertainty. Nitrate is especially mobile, finds its way into groundwater and may take decades-centuries to reach the lake – such 'lags' must be accounted for by management. Where a receiving water is very sensitive to increasing nutrient load (e.g., a pristine lake such as Taupo) it often transpires that intensive land use even with the best available mitigation measures will not meet the desired water quality targets – suggesting that the only option is less intensive land use. It would seem sensible to re-direct intensive land use into catchments whose receiving waters are less sensitive.

TRANSCRIPT

Thank you, John, for the introduction and to the Lakes Water Quality Society for the invitation.

I am an engineer interested in the question: can we prevent problems from happening? In my opinion the answer is: in some lake catchments – absolutely, but in others – no. A common problem is where we have: (1) water quality targets that the community has endorsed and (2) proposed land uses that threaten those targets. In some instances after running all the scenarios it is clear the proposed activity together with the available mitigation will not reach the target. To me a nutrient sensitive zone is where this conflict is obvious and where we can identify pretty early on that we have a problem.

What we do about it? We should not pretend that we can always have intensive land use plus mitigation and pristine lakes. We should be signalling to stakeholders what are, and what are not, acceptable activities in catchments where high water quality is the target. The other side of the coin is that we should identify places that are less sensitive, and make signals to stakeholders about where they should focus their attention.

Figure 1 is the model we work with. Imagine we have a lake with agreed water quality targets. Agreeing targets is not an easy process but we know how to do it. In the catchment we have land uses that produce nutrients, and these enter the lake. Some of them come in via the groundwater and the model shows an arrow coming out of the bottom of the landuse box which is what Bill Bayfield calls "…the nitrogen load to come…". As shown we are currently meeting our lake targets but the proposal is to do something else in the catchment that increases the load. Can we bolt mitigation onto that proposal and still meet the water quality targets?

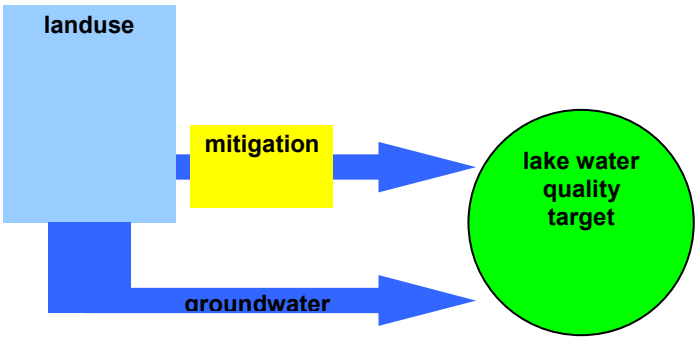

Figure 1 – Catchment model

We have a toolbox of mitigation measures which includes: point source control, grass filter strips, riparian buffer zones, constructed wetlands, natural wetlands and capping lake sediments. There are several others missing off the list – for example Gifford McFadden yesterday talked about watercress. As Stewart Ledgard reminded us yesterday, some of the list are now in Overseer, such as filter strips and constructed wetlands.

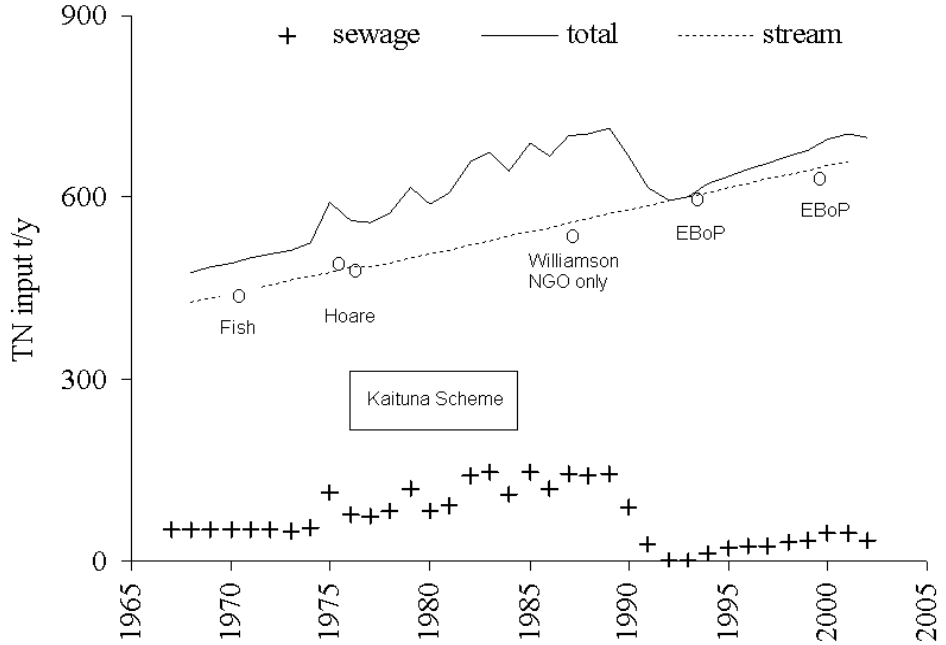

Figure 2 – Sewage - Rotorua

Figure 2 is a slide that likes coming to this meeting, but it is worth bringing out again. When I first started work on Lake Rotorua we found that nutrient loads increased between 1975 and 1980 because of sewage going into the lake and that lake water quality deteriorated. We put one and one together and got three, believing that it was all associated with the sewage nutrient. After a few false starts, the decision was made in the 1990's to invest ratepayer's and Central Government's money taking the sewage out of the lake. The sewage load decreased significantly and the total load on the lake also dropped. For the first few years things looked good. However, all this time the stream load (which is the dotted line) had sneaked up on us. It is now obvious that increases in nutrients in the streams have negated the beneficial effects of sewage diversion.

Should we have seen it coming? Geoff Fish had measured stream loads from 1968-1970, and Ray Hoare from 1977-1978. At that stage there was no evidence of an increasing trend in the streams. The first inkling we got was when Bruce Williamson and others looked at the Ngongotaha Stream in the late 1980's. But it was not really until we included the results from EBOP monitoring in 1996 and 2003 that it trends became clearly evident. We all know now that the trend in streams is partly the result of legacy nitrogen loads and partly more recent land use intensification. The Kaituna Catchment Control Scheme, which did a lot of riparian plantings in the late 1970s and early 1980s, was not able to successfully mitigate those effects.

In terms of point sources, in Rotorua at the moment we have the on-going reticulation of septic tanks around the lakeside communities. The rural equivalent of septic tanks are dairy sheds and effluent ponds. Recent studies have looked at ways to improve traditional two pond systems that have been around for a long time. Rupert Craggs' work on advanced pond systems[2] shows that they typically take out another 50% of the nitrogen. You can offset the costs of doing that by harvesting biogas – putting a membrane over the top and capturing the methane. You can also put a constructed wetlands on the end of a two pond system, and Chris Tanner's work[3] shows that this will strip out another 15-35% of nutrient. There are guidelines available which include an assessment of how much it costs.

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[3] Dr Chris Tanner, NIWA, Hamilton, c.tanner@niwa.co.nz

Lucy McKergow has recently published the results of her work on contour filter strips[4]. What are these? You go up onto the hillside, run an electric fence around the contour, run another electric fence around the same contour say 10 m downslope and let the grass grow. When you get overland flow it goes through the grass and the particulates stay behind. Lucy has run trials in collaboration with some of the people in the audience on farms at Rerewhakaaitu (with Rotomahana mud soils where there was a lot of surface flow), and Kaharoa (on ash soils that were much more permeable). The take-home message is that contour filters can work. There must be good grass cover and they only remove nutrients when you have surface flow. This does not happen much at Kaharoa because the soil is so permeable but it happens a lot more on the Rotomahana soils. These are the sorts of percentages of nutrients that can be taken out of the surface flow: Rerewhakaaitu – 35-87% and Kaharoa –15-54%. Filter strips are one tool in the toolbox and a moderately cheap one – you can have the strip in place for as long as you want then take down the electric fences, graze the vegetation, and put the fence somewhere else.

Figure 3 – A riparian buffer

Figure 3 shows an example of riparian buffers in Taupo. Thirty years ago Environment Waikato did a lot of fencing-off of streams, for soil erosion purposes, with the expectation they would also remove nutrients. Fleur Matheson[5] has gone back thirty years later and installed rows of peizometers between the edge of the paddock and the stream. She found that there are significant reductions in nitrate concentration in the ground water as it moves towards the stream to the point where, on the edge of the stream, there are very low concentrations indeed. If you add up all the other nitrogen compounds, however, the total dissolved nitrogen concentrations are no different. Some nitrate is being denitrified but much is taken up by plants and stored. When the plants die, they decay and release dissolved organic nitrogen. Not all the dissolved organic nitrogen released is bio-available. Nevertheless, there is evidence that riparian buffers do not remain effective in the longterm if they are simply fenced off and then forgotten. There is evidence buffers work much better when they are young. We may be able to improve nutrient removal through

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[5] Dr F.M. Matheson, NIWA, Hamilton, f.matheson@niwa.co.nz

biomass harvesting – the aim should be to get the biomass out so it does not rot and release nitrogen.

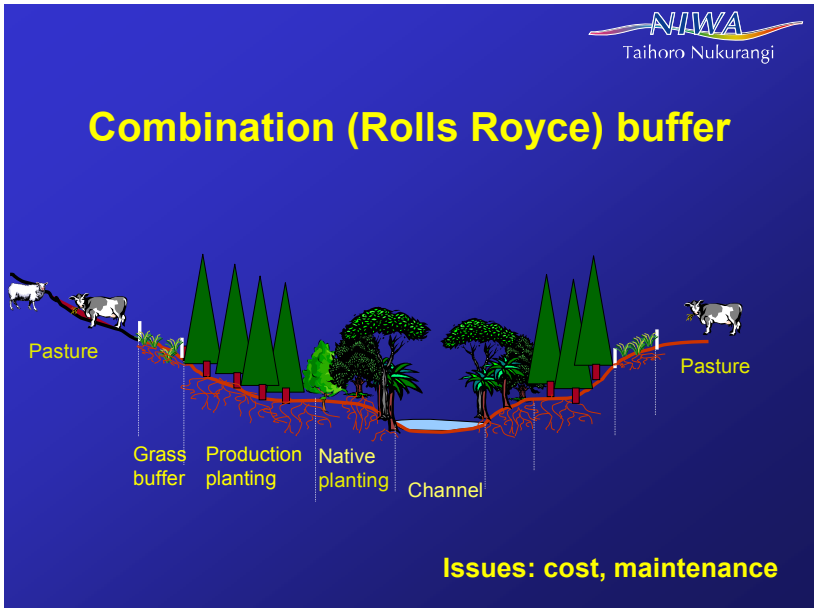

Figure 4 – Combination (Rolls Royce) buffer

Figure 4 shows the Rolls Royce of buffer-strips with grass on the outside capturing particles from overland flow, trees which are harvested providing a cash crop and removing nutrient, and then native plantings that provide ecosystem services, and shade to the habitat along the stream. Such buffers are not cheap but are something to aspire to.

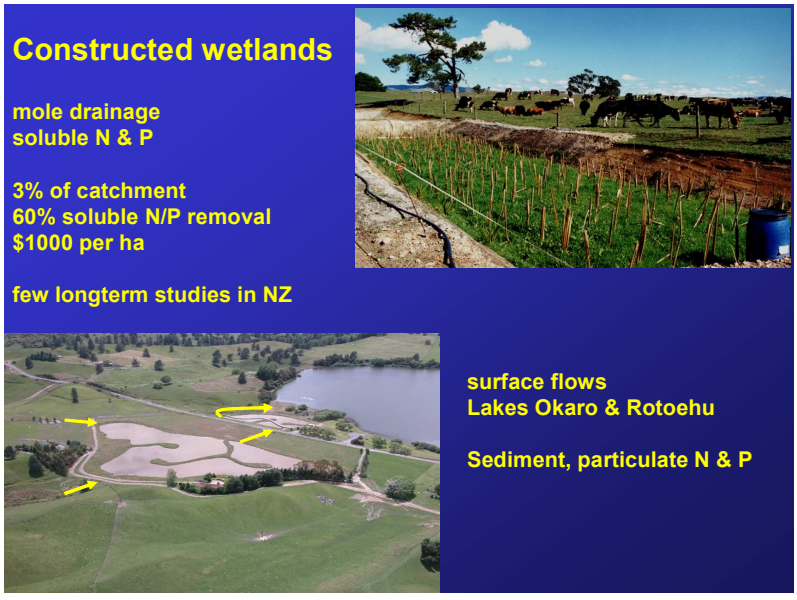

Figure 5

Figure 5, on the bottom left, shows the constructed wetland at Lake Okaro. Stream flow passes through the wetland which traps nutrient, reducing the load on the lake. The other system is a small constructed wetland which treats outflow from a mole and tile drainage system. The drainwater is collected and instead of putting it into a stream or ditch, it is put through this wetland. Again there are issues about sustainability – such systems work well when the plants are growing vigorously, but as the plants get tired they do not work quite so well. Nutrient removal is also low when flows fluctuate. Constructed wetlands are not cheap at $1,000 per hectare of land treated, and they do not remove all the nutrients. For

this system to be effective it needs to occupy at least 3% of the catchment area and then there is about 60% nitrogen removal.

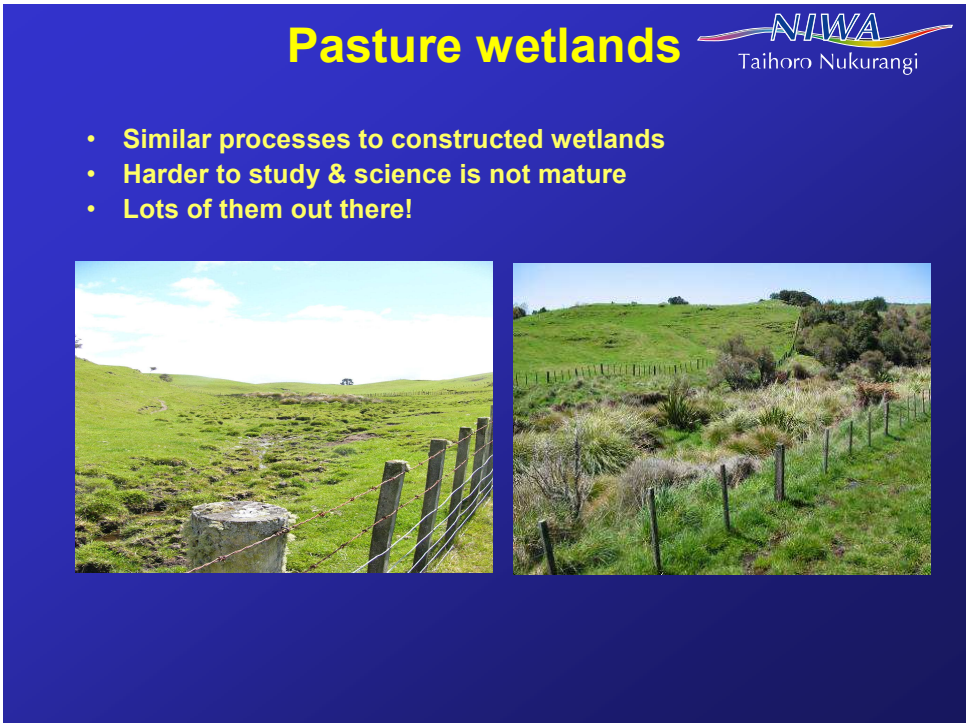

Figure 6

There are lots of pasture wetlands or "boggy bits" in the environment (*Figure 6*) which we are currently doing field work on. The processes are similar to constructed wetlands, but the science is less mature. On this Taupo property (*Figure 7*) the nitrate concentration decreases quite dramatically along the flow path through the pasture wetland, from 225 at the top to 12 mgN/m3 at the bottom. We know that a lot of denitrification occurs in wetlands like this. Denitrification represents permanent loss to the atmosphere which is "good" provided the loss occurs as nitrogen gas, but "bad" if it occurs as nitrous oxide, a greenhouse gas. Some nitrate loss is almost taken up by plants that eventually die and decompose. Maybe the solution is to fence these pasture wetlands off in the winter, and when dry in summer let the stock in – they will do the nutrient export for you. However, we need to do more work on this topic.

(Figure 8) How abundant are pasture wetlands? Lucy McKergow has surveyed a catchment in north-west Taupo and found that wetlands occupy 5% of the total area[6].

[6] McKergow, L.A.; Gallant, J.C.; Dowling, T.I. (2007). Modelling wetland extent using terrain indices, Lake Taupo, NZ. Presented at the MODSIM 2007 International Congress on Modelling and Simulation., Christchurch, 10-13 December 2007.

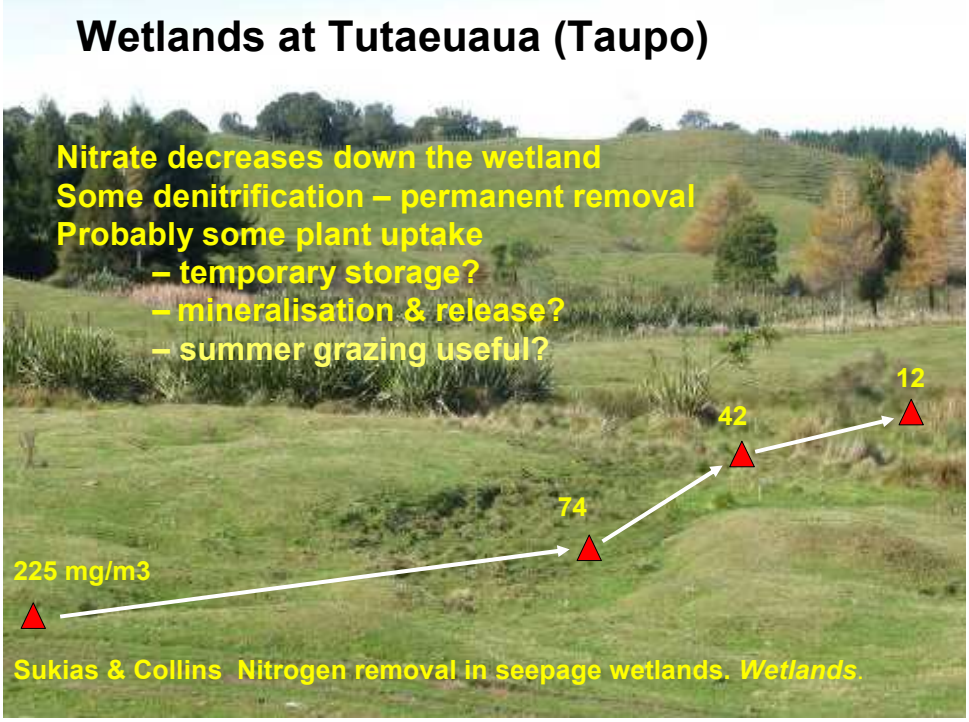

Figure 7

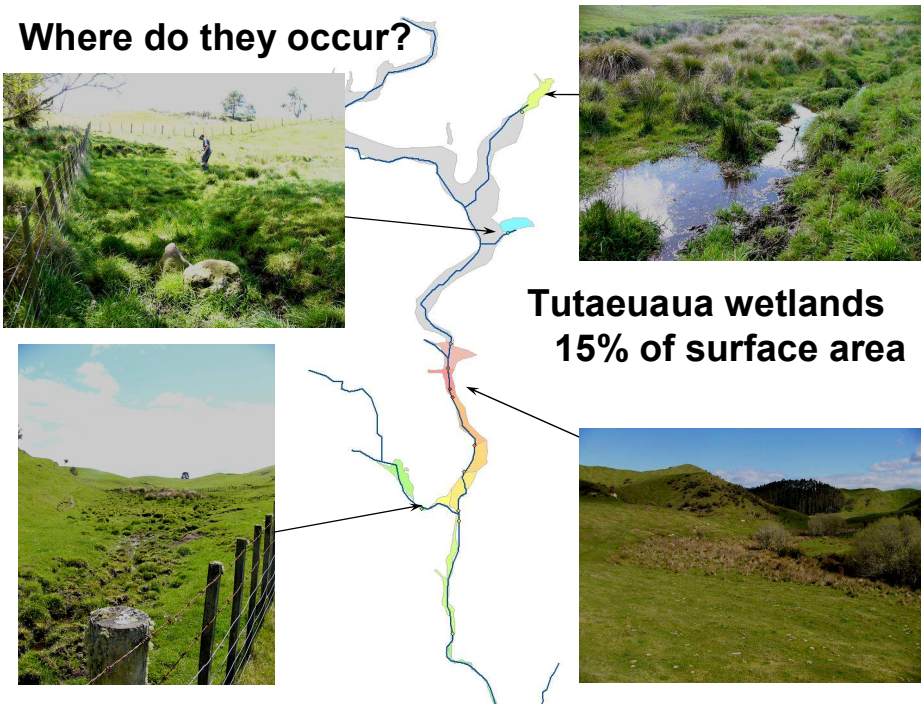

Figure 8

Previously we had thought Taupo was well-drained with few such wetlands. Possibly in other parts of Taupo they are less abundant –the Mapara catchment in particular seems to be a lot drier.

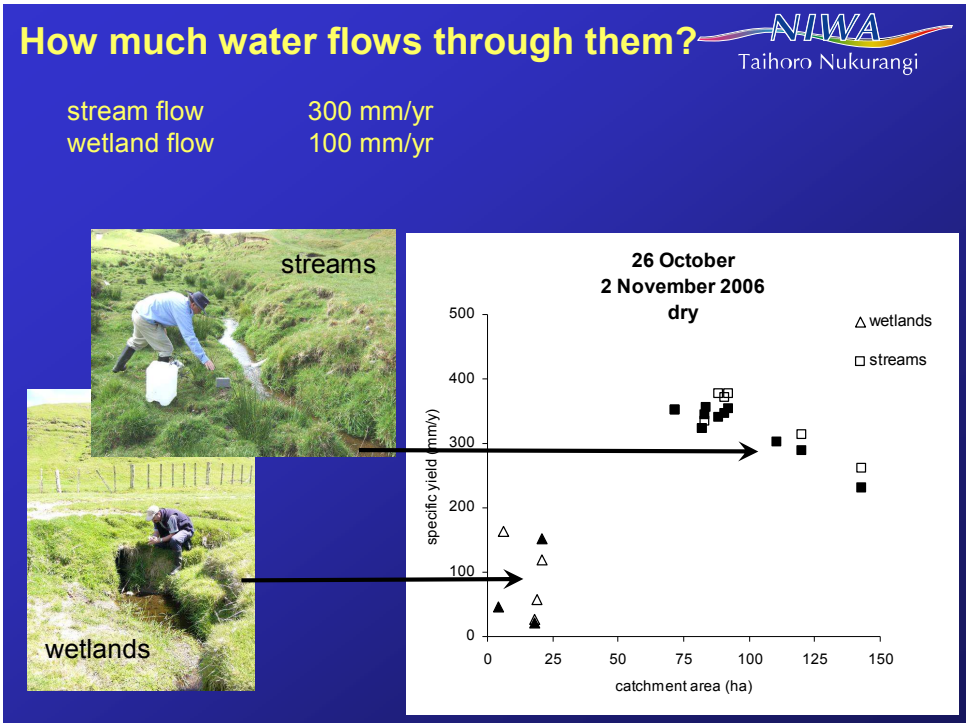

Figure 9

What is more important than their area is how much water flows through them. *(Figure 9)* Does the fact that wetlands occupy 5% of surface area mean that 5% of streamflow originates in them? We looked at the specific yield in millimetres per year. About 100 mm was going through the wetlands we monitored, whereas in the streams the specific yield was about 300mm per year. This means that about one third of the water in the headwater streams had been through a wetland, where conditions favour nitrogen removal. The average for the entire catchment may not be as high as one third. 300mm of run-off is low, and the specific yield of the stream at the lake will be more like 600mm. Therefore, another 300mm of groundwater may well be sneaking past the “boggy bits” and wetlands. Nevertheless, there is an opportunity to optimise the nitrogen retention in pasture wetlands and thereby reduce nitrogen runoff from pasture.

The final mitigation measure I want to talk about relates to internal loads from the bed of the lake. Slide 16 was used by David Hamilton yesterday and is based on David Burger’s work. There are 1.2 tonnes of phosphorus coming in from the stream and only 0.6 tonnes going out of the lake. Lakes always have a net retention of phosphorus which ends up buried deep in the lake bed. But on its way it gets recycled a number of times and during that process it fuels the algal blooms which cause water quality problems. The ability to trap phosphorus in the lake bed is being investigated by a number of people including NIWA, Waikato University and SCION. Putting a cap on the lake bed will interfere with the recycling process and thereby accelerate lake recovery. However, there is no point in capping and continuing to pour phosphorus into the lake, because the cap will just disappear. Capping has to be done in conjunction with reducing the external load.

Calculations have been done on reducing the load to Lake Rotorua without doing anything about internal cycling[7]. Eventually internal loads will adjust to the new external load, but this will take tens, if not fifties, if not hundreds of years. The orange layer, or cap, might make it happen a quicker.

NIWA's contribution to this study has been to take cores from Lake Rotorua back to the laboratory. Four agents are available as potential capping agents in New Zealand – Alum, modified zeolite, Phoslock and allophane. Max Gibbs and David Bremner have put them through oxic/anoxic cycles, and Chris Hickey has looked to see whether toxins are released as a result of this process. What did they find? Alum has been crossed off the list largely because it gets easily re-suspended. It removes nutrient from the water but it does not cap the sediment successfully. Each of the other three are potential candidates. They are granular, can be deposited where they are wanted, and are more likely to stay there. The surprise was allophane because its theoretical phosphorus-binding capacity is low. It turned out the calculations were misleading and in trials it was shown to be candidate. There was no significant toxic effects detected in the laboratory at pH7, which is the pH level of the lake. These were the results.

Agent	P-binding capacity (theoretical)	P-binding capacity (measured pH 7)	Required amount (to treat top 4 cm)**
	(g P / kg)	(g P / kg)	(g / m2)
Alum***	100	(not measured)	60*
Zeolite	50	23	190
PhoslockTM	20	12	280
Allophane	5	16	220

* literature estimate ** TAP = 3.16 g/m2 *** easily resuspended

One thing Max Gibbs picked up is that the cap might interfere with the nitrification/denitrification process in the lake. Slide 19 shows on the left a normal lake, and on the right a lake with a cap on it. Under normal circumstances ammonium is generated in the deep lake sediments, which diffuses upwards. Oxygen diffuses downwards into the sediments and there is a region near the surface where ammonium gets oxidised to nitrate. If that nitrate continued to diffuse up into the lake, there would be no effect on internal nitrogen load. However, at the bottom of the oxic layer is an anoxic layer where denitrifiers convert some of the nitrate into nitrogen gas which is inert. Putting a cap over the bed that cuts off the oxygen supply. This interferes with the nitrification/denitrification process and the net result is you could get more ammonium being released from the system. This has been identified as a potential issue and we have to do more analysis about the trade offs.

Wrapping up, as a number of speakers said yesterday, we are doing pretty well on point sources – we know that sewage is a bad thing. However, run-off from agriculture still provides challenges.

We have a toolbox of mitigation measures and the measures discussed above typically remove 30-60% of the nutrient from the flow they treat. However, we can never treat 100% of runoff. We cannot put contour filter strips or wetlands everywhere and groundwater is hard to treat. Wetlands and filter strips are not "set and forget" things but require ongoing maintenance. Nevertheless there are things we can do to reduce nutrient

[7] Rutherford et al. (1996) Predictions of phosphorus in Lake Rotorua following load reductions. *New Zealand Journal of Marine & Freshwater Research 30(3):* 383-396

runoff from agricultural land. However, these mitigation measures are not a magic bullet and my assessment is they are struggling to keep pace with land use intensification. The snake oil merchants may say otherwise but as Stewart Ledgard keeps reminding us the fact that there are five mitigation measures that can each remove 20% of the load does not mean you can bolt them together and get 100% removal!

What can and should we do? First, we agree what are Nutrient Sensitive Zones and what are not. Second, we quantify nutrient load targets, identify losses from land use and quantify the effects and limitations of mitigation measures. Of course there are uncertainties but we can do it well enough to make sensible management decisions. I have had thirty years of doing this second step. What frustrates me is that we can identify zones where the load minus the mitigation is always going to be greater than our target. So why not identify those places and cross them off the list? Why not send strong signals to stakeholders that say “sorry, you can’t do that in that area because no combination of mitigation is going to let us achieve an acceptable water quality target”? Let’s not pretend we can have our cake and eat it.

I like Guy Salmon’s description of “slippery wording” in regional plans and elsewhere. The engineer in me likes to see acknowledgement of where problems lie. In existing situations where water quality targets are not being met, we may have to claw our way back and if that requires public money then so be it. The thing that really drives me up the wall is greenfield situations when we all know “it ain’t gonna work”. So why don’t we just cross those off the list and get on with investigating other scenarios.

RECREATIONAL PERSPECTIVE

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Rob has been working on the Rotorua Lakes fisheries for the last twelve years, and previously worked in the Lake Taupo fishery management team after graduating from the University of Waikato with a fresh water fisheries-based degree. He has a wide knowledge of recreational fresh water fishery management in New Zealand and had a great deal of involvement in water quality restoration programmes in the Rotorua Lakes. His ties to the University have also allowed him to remain very much up-to-date with the research programmes looking at ways to restore water quality in the lakes.

ABSTRACT

A recreational perspective on the need for solutions

Fish & Game, New Zealand, represents the interests of freshwater anglers throughout New Zealand. This quantifiable group of recreational water users has been affected by deteriorating water quality locally and nationally. This presentation describes some local information gained on what the impacts of declining water quality mean for anglers and lake users in general. Other examples are also given to show that this is a national issue that has real effects on recreational users of waterways. The effectiveness of current mechanisms to preserve the quality of lakes and waterways for recreational users are discussed, along with some important considerations that need to be taken into account when applying the concept of Nutrient Sensitive Zones to New Zealand waterways.

TRANSCRIPT

Thank you John and tena koutou everybody. I have been invited today to give a recreational perspective and we will start from the point of view that we are not the only recreators out there.

Fish & Game has been asked to give the recreational perspective, probably because we are a quantifiable group of users. Fish & Game is an organisation set up under the Conservation Act and we represent anglers and hunters. Fresh water anglers and game bird hunters are funded by the Fish & Game licence fee and only licence fees - we receive no money from the tax payers. Because we have a licencing system, we are then able to quantify the number of people we have out there, and are able to contact them through a number of avenues and determine where they have been and what they have been doing.

A brief quantification of fresh water angling in New Zealand;

- 2001-2002 National Angling Survey (NIWA survey of NZ Freshwater fishing)
  - Rotorua-Rotoiti - 106,000 angler visits/year
  - Bay of Plenty - 245,000 angler visits/year
  - North Island including Taupo - 676,000 angler visits/year
  - New Zealand – 1,455,000 angler visits/year

We do a national angling survey every seven years and there is one under way at the moment. These figures show that there are just under one and a half million angler visits across the country in fresh waters. Angling is a pretty popular activity, but we are also fully aware that we are not the only ones recreating in fresh water. As part of the Action

Plan work in the Rotorua catchment, Nimmo-Bell did an investigation on other lake users and what are the tangible or less tangible values of the lakes.

Nimmo-Bell (2004) - 1000 Household study of use of the Rotorua lakes

- 40% of Rotorua households and 33% of Bay of Plenty households said they had fished on Lake Rotorua or Lake Rotoiti over the last 12 months
- Other Active Recreation also popular
  - swimming, 65% of households
  - boating 40%,
  - kayak 30%.
- Passive Recreational use of the lakes was even more popular than active use,
  - picnicking, 80% of households,
  - walking 65%,
  - driving 60%.

Passive recreation, which is often something that we do not really think about, involves people who just enjoy the lakes for the fact that they are there. This includes activities like walking, driving or enjoying the scenery with a picnic. This type of recreation was even higher still than active users. So anglers are a large group using fresh water, but certainly not the only group.

Now what happens when things go wrong? If we look at the affects of water quality on recreational use - what happens when water quality declines? How does it actually affect recreational users? We can get a handle on answers to these questions by looking at anglers, the group that we survey ourselves. Fish & Game go out every summer and survey anglers on the lakes and quantify what is happening and how anglers view the fishery and what influences their satisfaction.

When the algal blooms affected Lake Rotoiti in the 2003 summer, the trout in the lake did not really suffer. So when we looked at what was happening to the trout as a result of the blooms, the finding was that they actually grew reasonably well that season. We know on other lakes like Rotoehu, declining water quality has certainly decreased fish growth. It appears that trout are not affected by blooms on some lakes, but other lakes they certainly can not handle declining water quality.

When you study a fishery though there is another side to it - you not only consider the fish. A fishery requires anglers too. As part of our surveys we were able to determine the effect declining water quality had on the anglers. In 2003;

- Locally monitored effects on angling as a result of the 2003 algal blooms
  - Short term licence sales declined - $100K
  - Angler use dropped 65% on Rotoiti over typical summer peak in use
  - Blooms cited as significant detraction to 45% of anglers

The first thing we discovered is that angling success declines dramatically during these peak algal bloom periods. Catch rates drop significantly, and as any angler will tell you, a good catch rate, or the number of fish they catch per hour, is pretty important to the quality of their experience. If they are not catching fish they are not very happy.

The next thing that happens is that you get a marked decline in use. A combination of poor catch rates, unpleasant lake conditions, bad press, etc. keeps anglers off the water. Over the 2003 summer short term licence sales fell dramatically in this region compared to other years and other regions across the country. Fish & Game lost about $100,000 in licence sales in the Eastern Region over that 2003 summer. Angling use dropped 65% on Lake Rotoiti over the peak part of summer, and this flowed on through to a 30% reduction

on the next opening day. All the press comments – *'Don't come to Rotoiti, you are not going to have a very good time'* - had a flow-on affect into the following 2004 season. Of the anglers that we interviewed on the lake over the 2003 summer, 45% of them said that, "yes, the poor condition of the lake was a significant detraction to their angling experience".

Now what about all these other recreational users out there? Nimmo Bell did a survey of households in the Rotorua and Bay of Plenty region of the effects on other lake users and asked two questions -

- Does the presence of blooms affect your use of the lakes?
    - 70% of Rotorua households said yes, blooms do affect our use.
    - 62% of the rest of the Bay of Plenty agreed
- How has your household use changed as a result of the blooms?

Activity	Average days use with blooms	Average days use without blooms
Picnicking	13	23
Walking/Photography	12	22
Swimming	19	33
General boating	23	35
All Activities as %	63%	100%

By the time you bundle all the active and passive recreational activities together, in the bloom years there was only about 60% of use on the lakes compared to non-bloom years. The key point to take away from this information is that effects have been quantified, and the diminished recreational quality and quantity has a flow-on affect. We recognise this affects us as an individual, as organisations, and certainly extends to huge affects on local economies and right through up to regional and national economies.

Moving from a local to a national context we can use the National Anglers' Survey to look at angling across the country. *Figure 1* shows the amount and type of angling use nationally and the popularity of the lake fishing in Taupo and Rotorua, and the low-land river fisheries often associated with salmon in the lower South Island. If we look at the classic New Zealand Tourism boards "*clean-green, come and fish New Zealand*" image - what a lot of people consider to be New Zealand fishing - this type of fishing in reality only accounts for about 10% of the fresh water angling in New Zealand.

The lakes and reservoirs in New Zealand provide for about 40% of the fresh water fishing use in New Zealand, and low-land and mainstream rivers add up to another 50%. So 90% of fresh water angling is in lakes and reservoirs or in lowz-land and mainstream rivers.

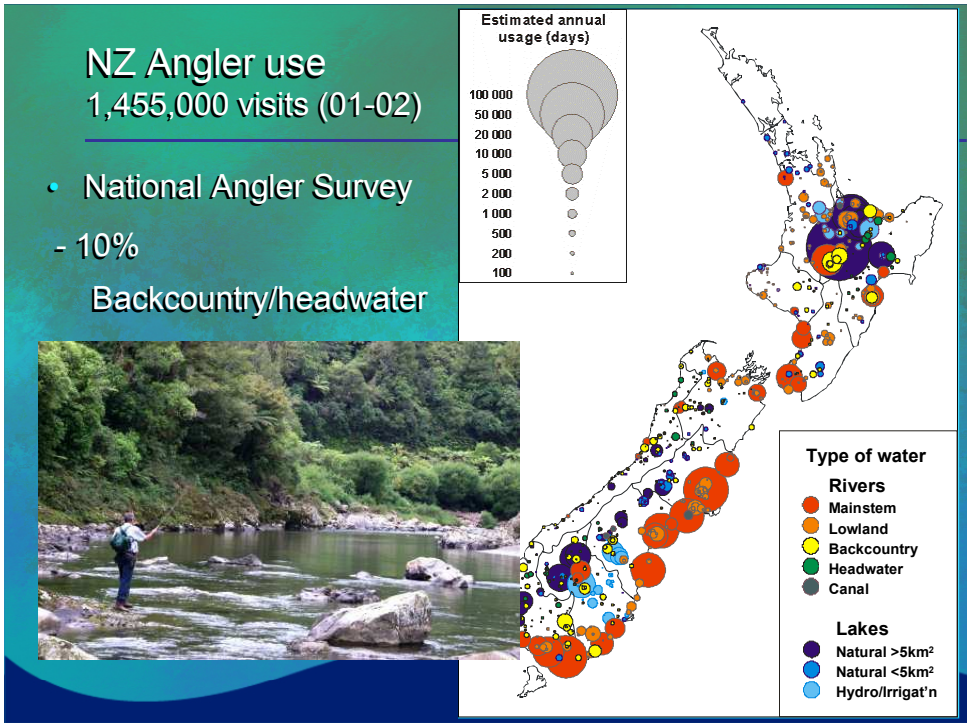

Figure 1 – National Angler Survey

These popular waterways for angling are the areas that have a high potential to be affected by declining water quality. In terms of where angling recreation is occurring, it's happening in areas that are lower downstream and in lakes, and these areas are all highly threatened by declining water quality.

If we now consider lowland rivers, how do you actually determine what is happening with the recreational value of these waters? It is pretty difficult over the long term because a lot of the rivers have no measured long term water quality data. In 2003 NIWA did a search around the country for anglers that had fished on lowland rivers over an extensive period of time. NIWA were able, through quite an extensive search of angler licence data bases and a lot of survey questionnaires, to come up with a group of anglers that had an average of thirty five years experience fishing on 321 low-land rivers across the country. These anglers were asked to fill out questionnaires on how they considered their angling experience on rivers had changed over a long time frame. The following table shows the results;

How has angling quality changed over time?	% of Rivers nationally
Markedly worse	34%
Generally worse	34%
No Change	25%
Generally better	6%
Markedly better	1%

When these anglers were surveyed to look at what the cause of that decline in angling quality was related too, the most commonly sited reason was declining water quality. Declining water quantity was a fairly big issue as well, and as we saw yesterday with the Canterbury rivers - if there is no water, there is not much of a fishery. There were significant reasons cited for these water quality declines especially in the central South Island - increased silt and sediment loads which is a catchment related effect, and increasing angler use. Water quality problems are clearly a national issue in terms of how they are affecting anglers as a recreational group.

I was going to spend a bit of time talking about the *2007 State of the Environment Report*, but I think we have all got a fairly clear picture from this Symposium of what that showed. In terms of fresh water trends, the SOE Report tells us that there have been improvements in terms of point source discharges, and these are the discharges that are generally associated with urban catchments, or catchments that have had a significant city-type affect. We are making progress in this area. But it was noted in the 2007 Report that we have not got on to the diffused point sources yet. If you look at the rural catchments, they are getting worse. This declining trend was clearly identified ten years ago and still the worst quartile of poor water quality rivers in New Zealand continue to deteriorate. This is a key point to take away from the *State of the Environment Report*.

The real question from this Symposium is, "Are the tools we have available as water managers not doing the job, or is it how we are using them"? We have a number of statutory tools available to us now. The National Policy Statement, which is in draft form, will hopefully provide regional councils with a higher level of guidance. We have the Resource Management Act and the planning processes that are used within it. We have things like Water Conservation Orders, which are relatively specific in what they are set up to protect. We also have a number of non-statutory tools or mechanisms as well; the land care/catchment type groups; Fonterra's Clean Streams Accord; industry standards that set targets to achieve; and various other industry codes of practice such as best management practices for forestry and farming. Some of these things seem to be working, others certainly are not.

If we look at some tools that perhaps are working, we can go to Rule 35 of the EBOP Regional Plan and look at the Action Plans that are happening around the Rotorua lakes. Nine of the lakes in this region are in the fix-it mode after they have hit a declining water quality trigger. When this trigger is hit Rule 35 of the Plan effectively then says "right - lets get on to it". Lakes like Tarawera and Rotoma are now being worked on and from a recreational users perspective you would think they were pretty good - they are quite clean and they look alright. Recreational users would not have detected a decline in water quality, but things are now underway in those lakes to get them fixed up. Lake Okaro, which you would certainly recognise as having major water quality issues, has an Action Plan that is well under way and actions are happening to fix the lake.

Some of the things that perhaps are not working need to be looked at, and Water Conservation Orders is one tool with some graphic examples. WCO's are very specific in the way that they function, and the Mohaka River is currently "protected" by a WCO. The Mohaka has been recognised as "a river of national importance" and has outstanding amenity or intrinsic values. The map (*Figure 2)* shows the Mohaka originates in the Kaimanawa Mountains near Lake Taupo and runs through into the Hawkes Bay. In the upper catchment the Taharua River flows into it, and this is a river catchment with fairly extensive agricultural activity. This agricultural area also drains north into the upper Rangitaiki. What I want to show you is an underwater video clip taken by Fish & Game divers in the upper Mohaka, just above and below the Taharua River confluence.

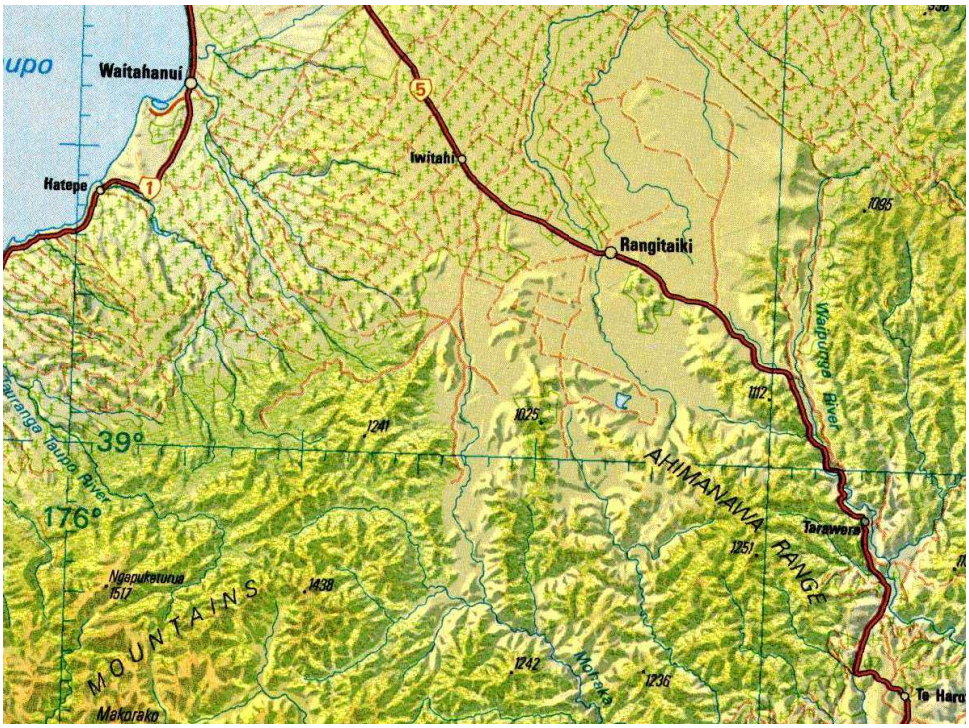

Figure 2- Origins of the Mohaka River

[*Video clip projected of underwater footage of upper Mohaka River and commentary follows. The video can be found on the CD at the back of the Proceedings*]

As you can see the upper Mohaka River deserves its national outstanding rating. (Hopefully no one gets motion sick with this video). Here are some of those "good fish" (trout) that we were talking about earlier in the Symposium. As you drift down the upper river - water quality is clear, there is a light periphyton algae growth on the rocks, the river here has a very good MCI score, lots of macro-invertebrates. You can clearly see from this footage - it is a river that does deserve its reputation.

Now we swim a little bit further on, in fact this is another 100 metres from the end of the last clip, and we are now in the Mohaka just below the Taharua River confluence. You can see what the river looks like now. Visually we easily see a huge decline in water quality. Visibility has dropped dramatically and you can't see very far through the water, major filamentous algal growth is apparent on the rocks and substrate - and remember these two dive sites are only 100 metres apart! One dive upstream of the Taharua and one downstream of the Taharua. And this is supposed to be a nationally outstanding water body.

Are nutrient sensitive zones then going to be the answer? The National Policy Statement talks about outstanding fresh water resources. In Environment Bay of Plenty we have Rule 11, and we have heard about Variation 5 with Environment Waikato. There are already a number of tools out there and nutrient sensitive zones, however you might like to fit them into an overarching plan, may be another tool. We as recreational users must stress that water managers have to consider things nationally, right through to almost internationally.

New Zealand is full of outstanding fresh water resources relative to the rest of the world. We accept we do not have the opportunity or resources to totally fix every freshwater resource. There is going to need to be some fairly serious, pragmatic application and prioritising. But whatever happens, one of the key things, and I think this came from Erik yesterday, was that regulation and enforcement of rules are critical. You need to be able to monitor what is going on with water quality. You need to take action when necessary, and you need to be able to correct problems.

In summary, recreational users are strongly affected by declining water quality and there are a lot of recreational users out there. We would say to the policy makers "you have to improve your performance". Whether you change the tools, or add tools, or you change the way we use tools - something has to happen.

If you look at a National Policy Statement guiding yourselves to the tools, to the toolbox, or the tray in the tool box or something like that. You can have the Resource Management Act that provides the crescent to do a variety of things; you can have Water Conservation Orders which are very specific, so a bit more like a ring spanner; you have got your polygrips of non-statutory rules; and nutrient sensitive zones may be another tool that could be used. Whatever happens though, for the sake of water quality in New Zealand you have got to use what ever tools you choose properly, because if you do not - the nuts are going to fall off.

Session Six – Economics, Markets and Change

SESSION CHAIR: Dr Jan Wright, Parliamentary Commissioner for the Environment

The Chair for this Session is Dr Jan Wright, the Parliamentary Commissioner for the Environment. Trained as a scientist, her interest and further education has lead her into the field of policy applications of science. At a time of increasing public and political interest in environmental issues, she has a strong focus in the inter-relationship between economics and the environment.

NUTRIENT SENSITIVE ZONES – ECONOMICS AND OPPORTUNITIES

Dr Dan Marsh
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Dan studied Agriculture and Agricultural Economics at Oxford and Reading Universities in the United Kingdom. After graduating he spent fifteen years working on agriculture and water resource projects around the world. He has been at the Department of Economics at the University of Waikato since 1995 where he maintains a great love and strong interest in water resource issues.

ABSTRACT

There is a large and rapidly growing body of research on economic approaches to water pollution. The economics of pollution control is mainly concerned with two questions;

- What is the appropriate level of pollution (if any)?
- How should the desired level of pollution be achieved?

This presentation will introduce the economic approach to water quality issues and show how it can be applied to the Rotorua Lakes and the concept of nutrient sensitive zones.

TRANSCRIPT

I would like to thank the LakesWater Quality Society for the opportunity to attend this symposium and share some of our work with you. The Department of Economics has been working on different aspects of water quality in New Zealand for many years. Today I will concentrate on some of the findings coming out of the development of a simulation model of the upper Waikato catchment, looking at environmental and economic aspects with data going down to the farm level.

More recently, we have been doing a survey in the Upper Waikato catchment trying to understand how much people value improvements in the quality of water. If you live in the area around Karapiro and Arapuni, it is possible that one of my survey assistants has knocked on your door and asked you to fill in my survey. Thank you very much if you took part.

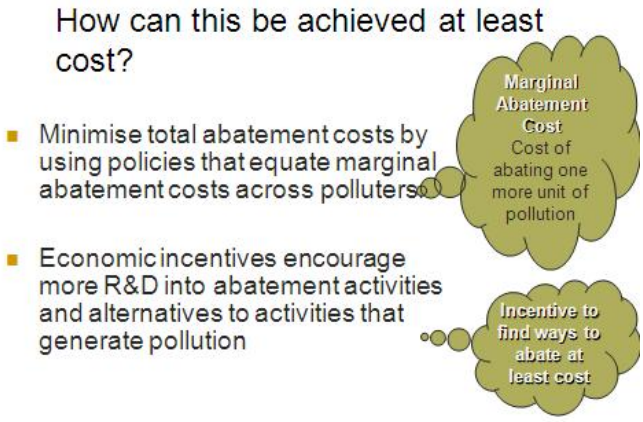
We are also researching the economic consequences of environmental regulations. One piece of work is looking at the national economy and what would be some national economic affects if environmental regulations led to reduced profitability in dairying.

I want to start by saying a few things about how environmental economists think about water quality issues. In the end this whole body of work addresses two main questions:

- What is the 'efficient' level of pollution?
- How should we get there?

The first question may seem somewhat controversial in this forum. Many people believe that the efficient level of pollution is zero; but this is often not the case. For example the Waikato River could be returned to the water quality that existed before the arrival of Europeans. We could remove all the hydro dams, move all the people and put the whole catchment into native trees. Hopefully within one hundred years or so water quality would be near perfect. But most of us would not be willing to pay that price. I will not be addressing the efficient level of pollution today since the people of Rotorua and New Zealand have already decided to a good degree what water quality they want in the Rotorua lakes.

The second question that environmental economists spend time on is "How should we get there" and in particular "How can we get to our goal at least cost?



We might also look at the question of "Who should pay?", but I spoke about that at the LWQS Symposium in 2006. Today we will start by looking at the economics of pollution control and how to achieve better water quality at the lowest possible cost.

The way to get the total abatement cost (the total cost of reducing pollution), to the minimum is to equate the marginal abatement cost across all polluters. This sounds like jargon but in fact is common sense. What it means is that if we want to reduce pollution at least cost we must start by taking the cheapest measures where the cost of reducing pollution per unit is cheapest. We go on taking those measures until costs rise, and only then should we take the next more expensive step. It may seem unfair that we put the entire burden on people who can reduce pollution cheaply. An alternative is to require everyone to reduce pollution, but to allow people who find this expensive to pay for pollution reduction by those who can do it more cheaply. In this way the burden is shared, but we still get pollution reduction at least cost.

Least Cost Reduction in Pollution

A simple example (*this is not real data!*)

Source	Annual Emission (Units)	Unit Cost of Emission Reduction
40 Intensive Farms	150	$10
30 Low Intensity Farms	30	$30
100 Lakeside Houses	20	$50
Total	200	

I would like to give you a simple numerical example to underline the importance of reducing pollution at least cost. This might look like real

data but I would like to stress that this is simply an example designed show the importance of economic approaches which enable us to clean up at the least cost.

Suppose we wanted to halve the amount of pollution in a catchment and that the catchment had 40 intensive farms, 30 less intensive farms and 100 lakeside baches. Also suppose the total amount of emissions and unit cost of emission reduction is as indicated above. Probably many of you have looked at the table and you already know the answer. The reason we go through this exercise is that often we come up with policies which do not reduce the pollution at least cost.

Quite often we end up with a regulatory approach where we say that everyone has to reduce pollution at the same rate. We might say that everyone has to halve their pollution. In this case we have 40 intensive farms; they would have to reduce by 75 units at a $10/unit cost of reduction which is $750. The 30 low intensity farms have to reduce by 15, so that is $450 and so on … giving a total cost of $1700.

A Regulatory Approach

Source	Annual Emission (Units)	Unit Cost	All Reduce by 50%
40 Intensive Farms	150	$10	$750
30 Low Intensity Farms	30	$30	$450
100 Lakeside Houses	20	$50	$500
Total	200		$1700

We know that the least cost approach is for the people who can reduce pollution most cheaply to do so. If we want to get 100 units out of that catchment we could have got 100 units from the intensive farms at $10 each that would be $1000. We could have achieved the same level of pollution reduction for almost half the cost.

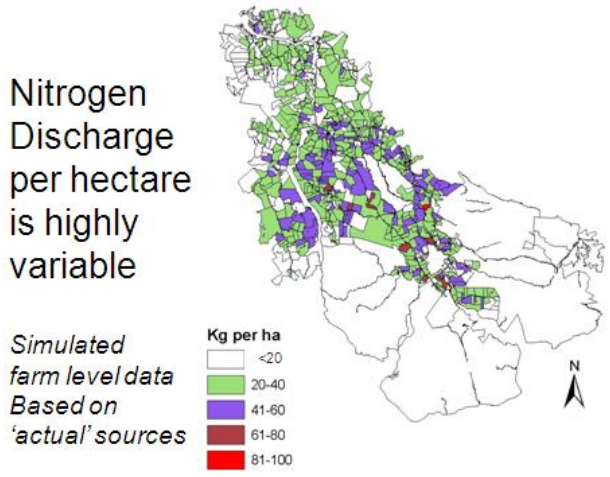
That was an artificial example, and yet I could point you to any number of studies from around the world where we find these differences between the actual cost of pollution reduction and what the cost could have been with the most cost effective policies. I could cite well-documented cases where the policy adopted cost twice as much, ten times as much or even twenty times as much as the most efficient policy. From a practical point of view, this is very important. We must aim to achieve improve water quality at least cost. This is not just because we do not want to waste money, but for reasons of practicality. If we impose expensive solutions on people they are much more likely to try and resist these policies and get around them, so these policies are much less likely to be successful.

Least Cost Approach

Source	Annual Emission (Units)	Unit Cost	Least Cost
40 Intensive Farms	150	$10	$1000
30 Low Intensity Farms	30	$30	$0
100 Lakeside Houses	20	$50	$0
Total	100		$1000

Dr Dan Marsh, Department of Economics, University of Waikato

Figure 1



How can we design the most cost effective policies? We do so by taking account of differences in abatement

costs, the cost that different people face in reducing pollution. I will now share with you some recent research findings from work by Thiagarajah Ramilan, Frank Scrimgeour and I, on the Upper Waikato catchment. We cannot be sure of how applicable these findings are to the Rotorua catchment, but conditions are fairly similar. The catchment that we studied is defined as all rivers and streams that flow into Lakes Karapiro and Arapuni and so does not cover the upper Waikato below Lake Taupo. The work involved creation of a micro-simulation model for the whole catchment using data from a range of sources. What is different about our work is that it includes environmental and economic data right down to the farm level. I should stress that this is simulated not real data but when we compare the results from our model with real data; it matches very well. Our model includes the range of different kinds of farms that we might expect, from less intensive to more intensive, from more profitable to least profitable and so on.

When we look at the results (*Figure 1*) suppose one of those red dots is your farm, I have not got real data for your farm but we can say that we expect that kind of range. The results of the model show a lot of variability. It is no good thinking about average farms and average discharges.

The green farms discharge in the range of 20-40 kilos per hectare of nitrogen and we have some much higher levels of discharge. The green and blue areas are primarily dairy farms and the white areas are primarily forestry. Our work mainly concentrates on dairy farming areas. We are looking for efficient policies to reduce pollution that take account of the differences between farms.

Figure 2 shows the technical efficiency of the dairy farms in the catchment. By technical efficiency we mean the ratio of inputs to outputs. What do you put in? What do you get out? Output is milk solids. Input is labour, fertiliser, brought in feed, and so on. The results are quite similar to what other people have found. The level of variation is fairly small; most farms are similar in terms of technical efficiency. Perhaps you would expect that because dairy farming is a highly developed system in New Zealand, most people follow the same system and do a pretty good job. The Figure for 'economic efficiency' shows cost per unit of output. You can see that there is more variation in economic efficiency as compared to technical efficiency. Whereas most farms were no more than 30% below the best farms for technical efficiency, we have a much bigger spread for economic efficiency.

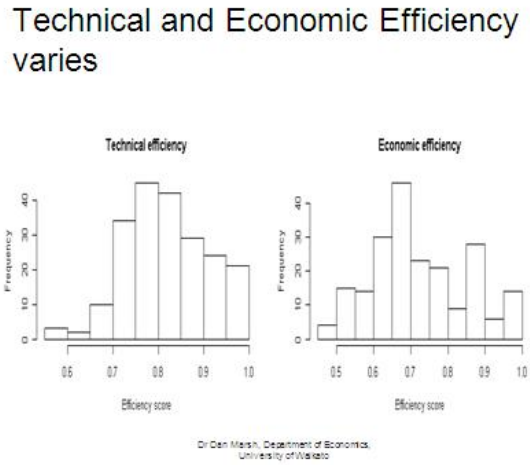


Figure 2

In *Figure 3* we measure environmental efficiency by looking at nitrogen discharge per unit of output. From this graph we see that environmentally efficient farms produces lots of milk and do not discharge much nitrogen

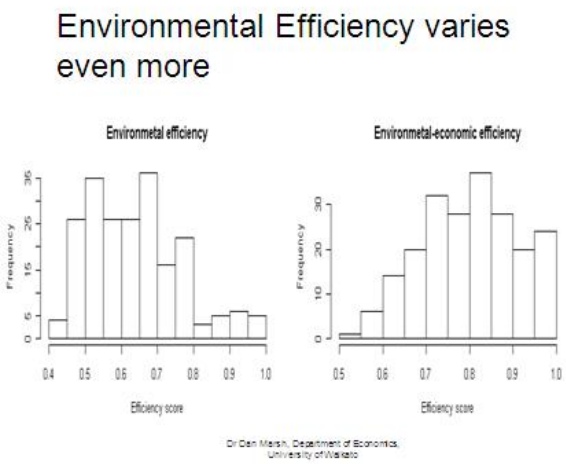


Figure 3

while less environmentally efficient farms discharge more nitrogen per unit of output.

We find an even bigger range for our environmental efficiency variable. Whereas with technical efficiency most farms were in the range 0.7 to 1.0, with environmental efficiency we find many farms that are 40 or 50% less efficient than the best farms. This suggests that we need policies that target the different kinds of farms.

In *Figure 4* we compare our different efficiency measures across 200 farms. The green line shows that about half the farms are less than 60% as environmentally efficient as the best farms.

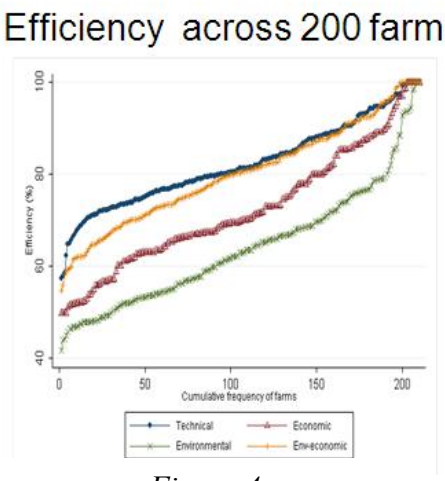


Figure 4

If all farms could be as efficient as the most efficient farm then this could lead to a reduction in nitrogen discharge of up to one third. (*Figure 5)* I should add an important caveat that our measure of environmental efficiency does not yet distinguish the reasons why some farms have lower nitrogen discharges per unit of output. Low discharges may be because of factors outside the farmers control such as soil type, slope and location, or may be because of less careful nutrient budgeting or stock management. At this stage we are not able to separate these two factors. Obviously we need to do this if we are to estimate the actual level of improvement that can be achieved by better management alone.

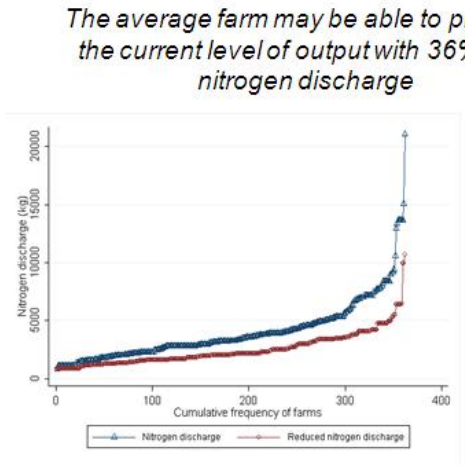


Figure 5

We have also worked on abatement costs *(Figure 6)*, i.e. what would it cost different kinds of farms in order to reduce nitrogen discharges? On the vertical axis we have abatement costs per hectare. These figures are a little bit out of date, using 2003-2004 data, and they are at 2004 prices. We would expect quite significant change since then, particularly as the higher milk solid price will tend to increase abatement costs. You will miss out on more income in 2008 - if you produce less in order to reduce your nitrogen discharge.

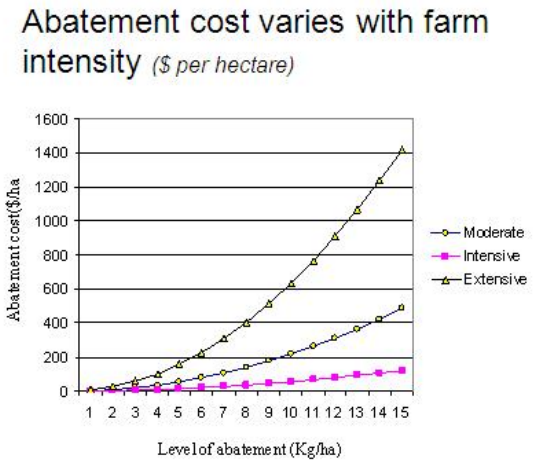


Figure 6

In *Figure 7* we have separated farms into three groups depending on whether they are intensive, extensive or in between. This reveals a very clear picture. If you are an intensive farm, your abatement costs are relatively low On the other hand with an extensive farm abatement is much more expensive. This figure averages out the abatement cost per kilogram over the first ten kilograms of abatement. Remember that costs will tend to rise as we increase the level of abatement. This figure highlights the very large differences in the cost of reducing pollution depending on farm type.

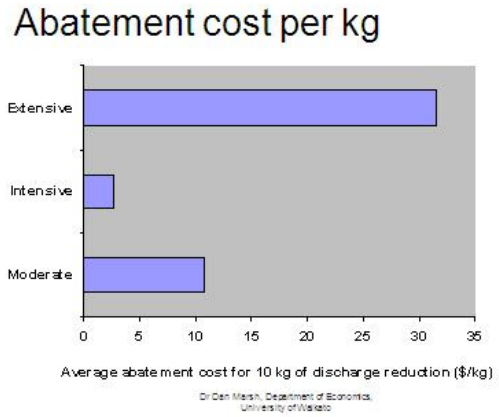


Figure 7

We have developed economic models for each of these farm types *(Figure 8)* so that we can look at impact on farm profits and reach some important conclusions. For example, data for extensive farms shows a large impact on farm profits (the blue line) while little is achieved in abatement (the red line). What we see in this slide is that if you are an extensive farm and you are faced with strong policies demanding reduction in pollution you immediately start losing a lot of money because it is so hard to clean up. Whereas an intensive farm suffers less impact on profits and is likely to be more successful in reducing pollution.

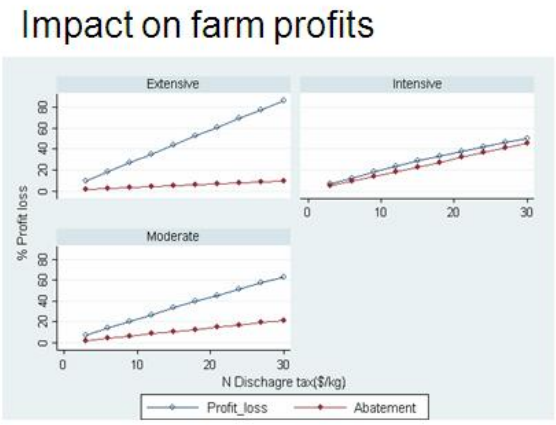


Figure 8

An interesting exercise would be to find out the abatement cost for farms already at 'best practise'; I would expect to get a similar kind of answer - if you are at best practice then you will find it more expensive to reduce your pollution further.

The policy implication is that if we require low intensity farms to reduce pollution then this will reduce their profits a lot without having a great deal of impact on nitrogen discharge. In that situation it would be quite natural if farmers try to resist and find ways around the regulations. They would be facing high costs and would know that there is not a lot they can do to reduce their discharge.

We should also note that low intensity farms would likely be the first ones to respond to any incentive to change land use. Supposing there was some scope for farms to change from farming to lifestyle, the first ones who are likely to volunteer to do this are going to be the low intensity farms. This will not be very effective in reducing nitrogen discharge, because they are not the ones who are producing the most in the first place.

Policy should target more intensive farms where abatement costs are likely to be much lower, especially those not following 'best practice'. This would have the advantage of being cost effective, and farmers would have less incentive to resist the policy. It would also allow the regulator to concentrate their efforts on a smaller number of farms – so reducing costs and increasing the efficiency of monitoring and enforcement.

MARKET-BASED MECHANISMS FOR ECO-SYSTEMS

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Suzie joined the Crown Research Institute, Landcare Research, as a senior economist in 2007. She came from the World Resources Institute, an environmental policy think-tank in Washington. There she worked on performance-based mechanisms such as nutrient trading for improving water quality; developed accounting and reporting guidelines for greenhouse gas reduction projects; and looked at United States agricultural policy related to water quality, biofuels and climate change. At Landcare Research she is working on ecosystem service markets, environmental policy, and the GHG accounting from products.

ABSTRACT

Around the world water quality issues are on the rise. Last count there were over 415 eutrophic coastal zones globally and countless more in our freshwater systems. Traditional approaches have relied on command-and-control approaches such as regulatory limits, taxes, and subsidies; and while an important first step, many believe they are no longer sufficient to deal with the problem.

In the last decade market-based instruments have increasingly been considered, explored and implemented to deal with environmental issues including water quality. In the United States, Australia and Canada, water quality trading programmes involving both point and non-point sources are operating. Reverse auctions or tenders have also been trialled in Australia and the United States.

This session discusses in further detail how market-based instruments work, how they are being applied in other places, and some of the common barriers to their successful implementation.

TRANSCRIPT

Good morning everyone, I am going to give you a quick introduction into market-based instruments for eco-system services. Essentially they are instruments or regulations that encourage behaviour change through market signals, rather than explicit directives. They

- alter market prices
- set caps to alter the quantity of particular good
- improve the way a market works
- create a market where no market currently exists.

They can work in a number of different ways but what sets them apart from other types of policies is they are performance based. That means we look at the environmental outcome, rather than the implementation of a practice or technology. That is a recurring theme with a market-based instrument; they are essentially focussed on performance.

Why do we want to use market-based instruments?

- Market based instruments allow different entities to make different sets of decisions based on their circumstances and their preferences: -
  - Are they in a nutrient sensitive zone or not?
  - What kind of management practices do they currently have in place?
  - Are they in the low lands or in the hills?

There are all sorts of things that mean that farmers face different sets of circumstances.
- They can also lower costs. They provide an incentive to identify the lowest cost action to achieve a specified goal.

Commonly Used Instruments for Water Quality

- *Reverse auctions/tenders* – Conestoga, Watershed (US), Wetlands Reserve Programme (US), EcoTender (Australia), Lake Taupo Protection Trust (New Zealand)
  Reverse auction is a terminology from the United States, whereas tenders are Australian and New Zealand terminology. These systems are starting to be used in different areas around the world and the Lake Taupo Protection Trust is considering using a tender process to allocate some of their funding to reduce the nitrogen flowing into the lake.
- *Water quality trading programmes* - there are many programmes in the United States, with a few in Australia and Canada. In NZ, there is the Lake Taupo nitrogen trading market, which I assume will continue and grow.
- *Payments for ecosystem services* – These typically focus on developing countries, but some exist in developed countries such as the New York City Watershed Agreement, which paid farmers upstream to reduce their nutrient losses in lieu of building a $4-6 billion drinking water treatment plant.
- *Offsets*—Wetland Banking (US)

Reverse options or tenders are instruments that are just starting to come into the water quality realm. They are:

- Competitive bidding system with single buyer and multiple sellers
- Allocates funding based on cost-effectiveness
- Shown to be more cost-effective than subsidies, e.g., Conestoga Reverse Auction

Funding can be allocated using a number of different criteria: it could be an outcome, i.e., the level of environmental improvement achieved, or a price. However, most focus on cost -effectiveness. Cost-effectiveness is the greatest improvement in environmental quality per dollar spent. Essentially auctions want to purchase, for example, the largest reduction in nitrogen losses for X dollars and fund the most cost-effective reduction options. People put in bids and they are ranked from 'most cost effective' to 'least cost effective'. The funds are allocated to the point where the budget is exhausted or where there is a discrete change in price between two consecutive bids. In many instances, this has been shown to a more cost-effective to allocate funding than traditional ways of doing things.

In an example (*Figure 1*) of work I did in the United States on water quality services in Pennsylvania, we compared the use of a reverse auction with the traditional way the United States Department of Agriculture allocated agricultural conservation funding in the Environmental Quality Incentive Programme (EQIP) in the Conestoga catchment. Using EQIP funding allocations it cost about $58 per kilogram to reduce phosphorus losses, but under the reverse auction it was about $8 per kilogram. Immediately you can see that there is a large cost saving by moving towards market-based instruments. When we look at the total amount of phosphorus reduced there is a significant improvement in the actual environmental outcome with an auction from approximately the same amount of money spent. It is these kinds of pilot programmes and examples that are coming through that are making people stand up and say, "Hey this could be a really interesting market-based approach for dealing with a situation where you have a pot of money that you want to give out in the most cost effective fashion". In other words, how do we to get the 'biggest bang for our buck'.

Figure 1. Summary of the comparison between the traditional way of allocating funding (EQIP) and a reverse auction in the Conestoga catchment in Pennsylvania, USA.

Programme	No. of Funded Projects	Total Cost (US$)	Total P Reduced (kg)	Cost-Effectiveness ($/kg P reduced)
EQIP	13	275,552	4,782	$57.62
Reverse Auction	7	292,635	36,721	$7.97

Now turning to water quality trading, there are

- Two basic steps
    1. Set a goal for the total amount of nutrients that enter surface waters
    2. Allow sources with low-cost mitigation options to reduce beyond the required amount and sell excess reductions

- What trading is not
    - A substitute for regulation
    - A way of letting market forces determine the environmental outcome
    - A way of letting polluters off the hook
    - Exclusive of other policy approaches

Water quality trading programmes are growing rapidly throughout the world. There are –

24 Active Programmes:
- 20 in United States
- 3 in Australia
- 1 in Canada

20 Emerging Programmes
- 18 in United States
- 1 in New Zealand
- 1 in Australia

11 Inactive Programmes:
- all in the United States

13 US State/Regional Trading Rules
- 7 are active
- 5 are in development
- 2 are inactive

What is interesting here is that in the 13 sets of US State/Region trading rules, the policy makers have suddenly looked at how expensive it is to develop these. Yesterday, Robert Brodnax told us how tedious, long and costly the process has been for the Lake Taupo Variation. If you did the same for every single catchment in New Zealand, just imagine how time consuming and expensive it would be. So what decision makers in the United States have done is sit down and say "OK, we are going to set down what the basic set of rules will be. The finer details can still be worked out in the catchment level, but we are going to go through a lot of these tedious decision making processes, these challenges, these disagreements once, and once only. That will give a base set of rules and then we will go from there".

Recently, we took a closer look at water quality trading programmes. The concept has been around a while, so why are there not more of them? We interviewed a number of water quality trading programmes around the world, and looked at the hurdles or barriers that they had experienced while developing and implementing their programme. We wanted to speak to all the different stakeholders, not just administrators of the programmes. We spoke to NGOs (non-government organizations) that might be involved, the point sources if there are any, and any non point sources, and the administrative bodies. Different stakeholders have different perceptions of why something may or may

not have been successful and Taupo was certainly one of the programmes that we looked at.

Some of the common hurdles to trading including:-

(1) *Inadequate market drivers to drive demand.* In other words the regulation was not stringent enough. One example that was quite interesting is the Lake Dillon programme in the United States, which has been around for twenty years. It has only experienced trades recently, why? Their goal was quite generous. As urban development has continued in that particular catchment, it is only now starting to bump up against those regulatory requirements and creating the demand for trading water quality credits.

(2) *Time wasted reinventing the wheel.* By this, I mean you have the go ahead for trading in your catchment and then you go "Oh, I have got to develop a set of rules for the programme, I've got to develop an infrastructure to run it, I've got to have a registry, and I've got to have all the communications materials". A lot of these programmes are also thinking "Oh, my catchment is so different from anyone else's that I have got to start from scratch". In many respects that is not necessarily true and there is certainly work being done in the United States to actually try and get some basic sets of materials together so it is easier for trading programmes to evolve over time.

(3) *Inadequate stakeholder outreach and education.* In other words often the trading programmes were being developed in a box with little stakeholder interaction. This has meant there was not particularly good stakeholder buy-in. The Taupo nitrogen market, however, took a lot of time to interact and engage with the stakeholders, much more than a number of other trading programmes we assessed.

(4) *Lack of transparency in policy/rule developments*. This is a big problem. In many instances stakeholders do not understand the rationale why a particular decision had been made, which makes it very difficult for them to want to participate in a trading programme.

(5) *Lack of buy-in from regulatory agency staff*. This is another big one. The upper management may think it is the most fabulous idea and really push for it, but the people at the implementation level are saying "Well, I am not particularly interested", so they drag their feet and it does not go far, very quickly. Conversely it can be the other way around; the people at the implementation level say "Ye ha, this is fabulous", but not get significant buy-in from upper management. That happened in a number of the programmes in the United States.

(6) *Lack of a trading programme goal and metric for measuring success.* Was the trading programme successful? Did it experience any trades? To decide whether a trading programme was successful is often measured by the number of trades the programme experiences but in reality this is not the main goal of most trading programmes—it is an improvement in water quality. However, programmes frequently do not clearly state that their main goal is actually an improvement in water quality.

(7) *Disagreement over load allocations*. This is something that Taupo certainly experienced and there is the Rotorua Trading Dialogue Group here which has spent quite a bit of time discussing that issue as well.

Interestingly the first six you can actually do significant amounts about and get the wheels rolling to streamline things. The last one is always going to cause problems. Regardless of how you do the load allocation, there are always winners and losers and somebody is going to be unhappy.

These are some of the hurdles that trading programmes around the world have experienced, and what you should be aware of if you are moving down a market based instrument route, in terms of water quality trading.

Broadening our thinking

Now I am going to spend the rest of the talk on how you might broaden your thinking. This is something that a lot us realise in the back of our mind, but we do not do much about. We have a tendency to focus on the ecosystem service that is obviously being degraded. This Symposium is about water quality. That is fine, and we have got to do something about it. But when we only focus on one particular ecosystem service, or one problem, we tend to develop policies that only deal with that issue. This means we do not necessarily think more broadly about what is going to be the effect on other ecosystem services. Inadvertently it might lead to a policy development that remediate the degraded ecosystem service BUT inadvertently damages other services.

I am going to quickly run through an example of some policy analysis that we did in the United States and apologise that I do not have anything similar for New Zealand. Essentially it was a comparison between different agricultural policy options that could be used to help mitigate the hypoxic zone in the Gulf of Mexico. The hypoxic zone is caused by excess nitrogen coming down the Mississippi River and forms at the very bottom of the Mississippi River basin—about 42% of continental United States contributes to the problem. It is an area that dies every year and there has been about ten years now of lots of discussion and not much action in the US. But anyway what we did was a comparison between a number of different policies that could be implemented to address the problem. We looked at the traditional command-and-control policies like taxes and extending the Conservation Reserve programme, which is a set aside programme. We looked at subsidies in terms of conservation tillage subsidies and then two sets of market based instruments. One was greenhouse gas trading and one was the nutrient trading, either nitrogen or phosphorus. What came out were some really interesting results that make you think you have got to start thinking more holistically.

If I was a policy maker and wanted some analysis done, then the most interesting part of the analysis is the impact of the various polices on the amount of nitrogen that's delivered to the Gulf of Mexico". If you look at the nitrogen delivered to the Gulf (*Figure 2*), it is the nutrient trading programs that provide the greatest reductions. Some policy makers would say "OK, we have got our solutions, let's think about trading". However, policy makers should think more broadly about the impact of the policies on farm income and other environmental goods and services.

Looking at the impact on aggregate farm income (*Figure 3*) across the entire catchment, not individual farm income you start to realise that some of the policies do not do so well for farm income and others do much better. The fertiliser tax and conservation tillage subsidy results in decreases in farm income, while water quality trading does quite well. In terms of taxes, you can understand why there might be a decrease in farm income, but not with subsidies. When we started showing this around people would say, "Well, why is that?" When you start thinking about it, it does make sense. What this particular policy did was give an incentive to bring more land into agriculture, which increased production, which lowered the price of the commodity. So in reality what you were doing is getting lower prices for your commodities so farm returns actually go down.

We also want to think about other environmental goods and services. We looked at greenhouse gases (*Figure 4*) and found that in most cases greenhouse gases decreased which is good. But in one instance, the conservation tillage subsidy, it increased greenhouse gas emissions. This is primarily linked to more agricultural land being in production and then there are more greenhouse gas being emitted as a side effect of

increased production. So, this sends a signal that not everything is going in the right direction.

Then we looked at the amount of phosphorus that was lost in waterways (*Figure 5*). Looking at the Mississippi River basin, a lot of the nitrogen came from the very top of the United States near the Canadian border, but the impact of these nitrogen losses was actually in the Gulf, thousands of miles south. It was hard to get farmers in the north to think that they had any impact on what happens in the south. We had to think about other ways to spin our story to farmers in the north, because if is important that we have a story that resonates with all the different stakeholders. This was really useful because in the northern part of the country there are lots of phosphorus issues in the lakes and the rivers. We were able to say that if you do embark on a water quality trading programme, you will get positive impacts on your own local water quality. So by taking a slightly broader look we were able to find another way that we could get people to be more involved in finding a solution.

The last thing we looked at was soil erosion (*Figure 6*). All policies do quite well, but the conservation tillage subsidy does incredibly well. This was the policy that was implemented in the United States in the 1980's and 1990's to try and reduce soil erosion. It was phenomenally successful in terms of reducing soil erosion, but they did not think about the side affects or impacts on other ecosystem services. Perhaps if they had done this kind of analysis, looking more broadly, they might have realised that it was not necessarily a win-win for all the different environmental goods or services we might be interested in or for overall farm income.

Lastly, we looked at cost effectiveness (*Figure 7*). Because I am an economist and we always do these sorts of things. What are the most cost effective policies? It is those with the greatest distance between the red bar and the blue squares with the white crosses. Looking at this graph, the market-based mechanisms in terms of nutrient trading certainly did better than the command and control approaches.

What is my reasoning for outlining this analysis at a conference that is focused on water quality? It is important to take a step back and think a little bit more broadly about what we can do in terms of putting policies in place that have a significant impact on water quality but might also have significant impacts on some of the other environmental goods and services that we are interested in. Yesterday, Morgan Williams brought up what we need to think about in terms of ecosystem services. By taking this approach we are not just dealing with what we have got, or the problems that we have got, but starting to anticipate what our next slew of problems will be.

So, just some final comments. Market-based mechanisms or instruments have shown to be both theoretically and also practically cost-effective. I showed you an example of the reverse options work in the Conestoga catchment, but if you look to other environmental issues such as sulphur dioxide in the United States, trading was also shown to be incredibly cost-effective in this instance. They also work alongside nutrient sensitive zones and this is what this entire Symposium is about. There are many ways that you can design markets or market instruments that allow you to take into consideration the differences within a catchment, or the differences in how areas might be zoned.

Policy and legislation is just the first step. A lot of the work that I have done is on that first step, but in recent years I have started to move towards the implementation side. I think a lot of people overlook the fact that the policy development and legislation is most likely the tiniest step. The biggest and most difficult step is probably implementation. If anybody asked Jan Hania or the rest of the Taupo Implementation team I think they would give you a lot of insight into some of the hurdles and struggles that they are finding as they move into the implementation phase.

Lastly we need to think holistically about ecosystem services, not just the ones that have been degraded.

Figure 2. Nitrogen delivered to the Gulf

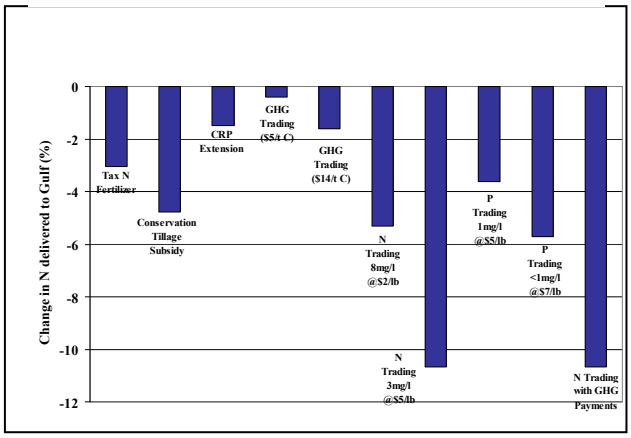


Figure 3. Farm Income

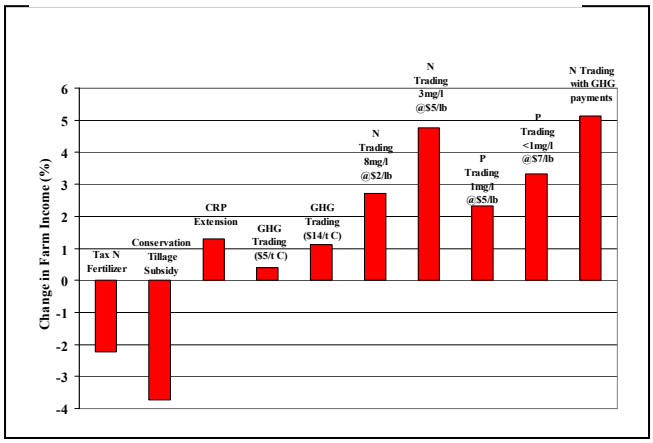


Figure 4. Greenhouse Gases

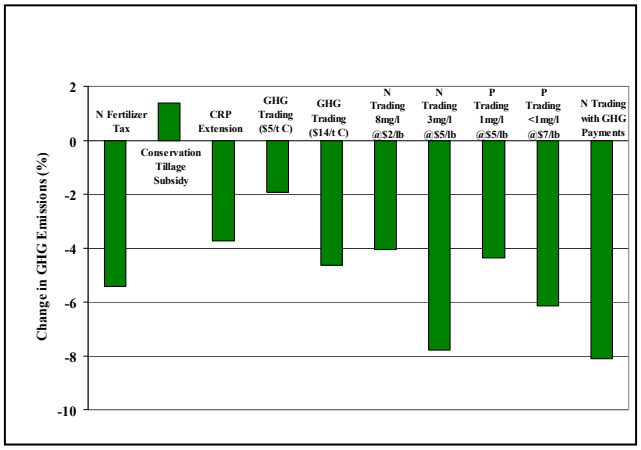


Figure 5. Phosphorus lost to waterways

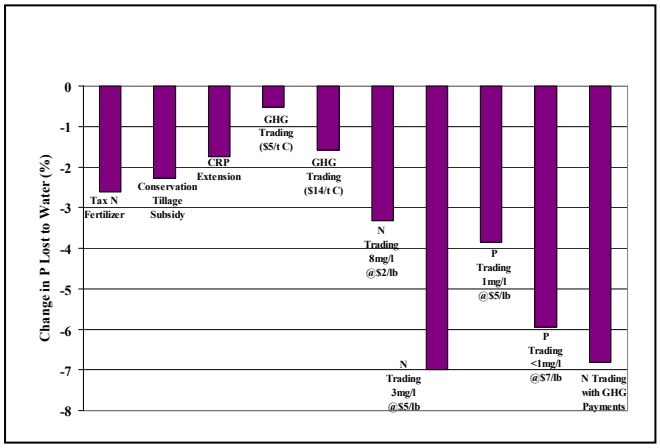


Figure 6. Soil erosion

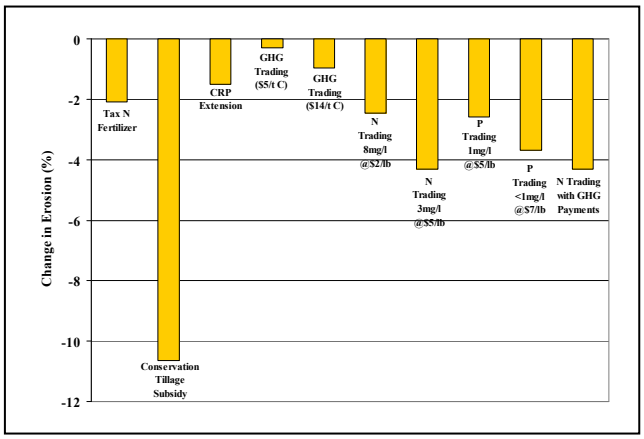
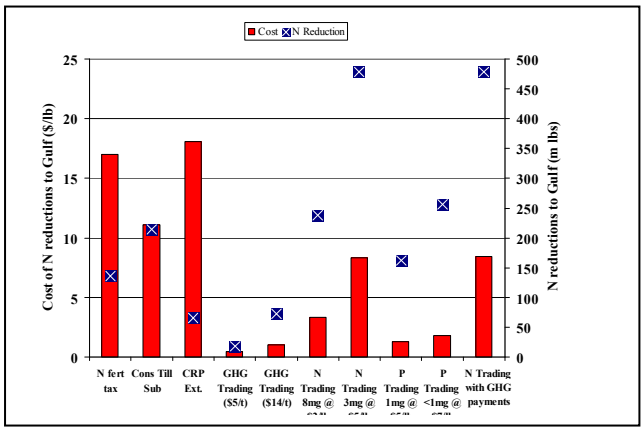


Figure 7. Cost-effectiveness of policies



LAND USE CHANGE FOR A BRIGHTER FUTURE : A PERSONAL OPINION

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Rick is currently the Group CEO of Ngati Whakaue Tribal Lands Inc. of Rotorua, an organisation with significant investments in farming, property development and tourism. He has had twenty-five years in farming, farming industry representation, meat industry directorships, and general management consulting and property development projects. His focus is on the development of people, socio-economics, property rights and the liberalisation of the New Zealand economy.

ABSTRACT

Strategic economic, political, cultural issues context –

The land still provides the bulk of our wealth in New Zealand – having delivered us once to the top of world living standards, and paid for the development of the modern welfare state

We need to keep in mind the importance to all New Zealanders of ongoing successful and sustainable land use when planning the future

Most of the land in the region and district is privately owned and while we stay with a property-owning democracy, they are the actual owners of most of the Bay of Plenty

The importance of ownership in a free democracy: Property ownership and a respect for ownership law is fundamental to a free democracy and a successful modern economy

The Importance of Landownership to Maori: Maori families, trusts and incorporations own 60 – 75% of the land around the lakes district; they have the same interest in economic success and expect the same level of respect as any other land owner

The culture of the political governors and administrators of New Zealand has changed in recent decades with the urbanization of the population, changing political systems and changing economy. Tensions arise from this cultural change

Key Values & Principles for solving the environmental challenges we face

Focuses for Land Use Change and new wealth creation

- Changes to soils and soil management
- Changes to animal systems and animal management
- Nutrient export mitigation over land and in streams
- Changes to land use and optimisation of land allocation
- Innovative high end uses and environmentally enhancing development

TRANSCRIPT

Kia ora katoa. My talk is on land use change for a brighter future. It is going to be about that in the end, but starts off trying to set up a perspective about the people we are talking about, because we sometimes overlook the things that are most important.

The importance of choosing the right paradigm.
It will be advantageous for the ongoing well-being of Rotorua, the Bay of Plenty, and the New Zealand community, if we address our environmental challenges with the right paradigm. Any paradigm which destroys the wealth of the community and/or the environment will fail in the long term, and there are some great examples around the world. For example, the book by Jarrad Diamond, *Collapse* - documents what happened on Easter Island, and to the Maya Indians *et al*. - is just a quick read, but it really spells out how communities have got it wrong before. Any paradigm which prevents increasing the wealth of our community will fail on our social goals of health, happiness, safety and general well-being. The current median income of our region is way too low, so anything which lowers it any further, is not going to be successful. The only sustainable paradigm, from our community well-being point of view, is one of embracing wealth creation, alongside the achievement of environmental sustainability. This whole water quality issue is as much a socio-economic challenge, as it is an environmental one. We cannot successfully address one without the other.

Strategic economic, political, and cultural issues
These issues frame the context in which this whole discussion takes place. The land still provides the bulk of our wealth in New Zealand, having once already delivered us to the top of world living standards and paid for the development of our modern welfare state. Productive land is privately owned by people or their commercial organisations. The culture and spirit of rural New Zealand was significant in building New Zealand through to the present, and will remain so into the future. You have only to go to small rural towns, particularly to a dawn parade, to get a sense of that spirit and culture.

Land use change polices will be more successful if they acknowledge this culture and collaborate with it, rather than ignore it. We need to understand changes to the culture of political governance in New Zealand, and the tensions arising from this cultural change as it bumps up against rural New Zealand – I believe the way through it requires a great deal of empathy, listening, and collaboration.

Changes to the culture of the political governors and administrators of New Zealand
This is really significant in this whole discussion. The culture of governorship of this country has changed dramatically over the last four years. It used to be more closely aligned to the land, large land-owning users, and the primary sector wealth creators. It was also made up entirely of them, whole governments and government departments were very close to rural New Zealand. This certainly led to policies which have ended up creating some of our problems today, a very production driven economy, and that has landed us in the cart today. But it also created the good things in this country. So selective bagging of the past is very unhelpful when seeking to improve the future.

We now have a situation where the governance of many of our agencies and departments is made up almost entirely of people whose background is non-landowner, non-user, and non-primary sector wealth creators. This has led to the difficulty of rural policy development increasingly being made by people who only have academic knowledge, rather than personal experience of the sector or the industry for which they are trying to develop policy. This major change occurred with the urbanisation of our population over the last 50 years since the war. There are tensions - and it is not hard to see them in the newspaper - which arise from this cultural change.

Tensions arising from this cultural change
The rural population is now very small, and relatively socially and politically isolated. For instance how many Maori or Pakeha practising landowners or farmers are in this room right now? Perhaps 10% max. This naturally makes it more difficult for accurate understanding and empathy for the efforts, the natural and commercial risks, and adversities faced by owners and managers of land based protein and fibre (including forestry) production or export systems, despite their importance to our economy and the well-being of us all. Conversely, the environmental problems faced by these people and their traditional systems are well exposed and high on the public agenda.

This cultural, political and economic dichotomy needs empathic attention if we are going to successfully develop solutions which are also supportive of ongoing wealth creation from the owners of land based industries. A high level of engagement and the development of innovative solutions which deliver on the landowners aspirations, just as much as they deliver on all of our aspirations for the environment, are a key requirement for success.

The importance of ongoing successful and sustainable land use for New Zealand
We often lose sight of these sorts of things in our discussions – we can get so focussed on one problem that we forget the bigger picture. The reality now - and will remain so – is that we would be in the biggest economic slump since the 1930's if it was not for the dairy industry; and meat and wool also looks to be coming up this year. We need to remember these things - it is not about killing the patient, while we sort out the therapy.

There is a danger of silos growing up around different government functions or focuses, and an increased danger of not understanding the unintended consequences or negative impacts of planning preferences and policies. We do need to maintain the helicopter view and learn how to carry out this whole strategy in a sustainable way - with appropriate changes to biological systems, technologies, land uses and land use changes – diving into specific issues, but all the while maintaining the helicopter view.

The land is owned by people but the vote has shifted to the cities
This is very important, and I know you know this, even though it seems often to be forgotten; there can be a tendency to treat people like 'things' in our modern world. The vote shifted to the cities, but most of the land in this region is privately owned. Whilst we stay with a property owning democracy these people are the actual owners of most of the Bay Of Plenty, and pay their share of rates for collective services. With the urbanisation of the population and change in the voting system, there is a decreased interest in the position of the owners and operators of land and their political weight has dramatically declined. This is not surprising, because as the urban population grows there is inevitable disconnection. However, the ongoing success of the owners in using their land resource in a large part determines the ongoing well-being of the whole community. We must not lose sight of that fact in the public discussion over control of land use.

Sustainability is in the interest of both groups - the landowners and users, and the wider community – because for obvious reasons, both depend on it. It is quite clear that we need to sort the job out, but we also need to hear each other in the process. There will be no satisfactory solutions to environmental problems if those solutions are arbitrarily and unnecessarily abusive of the owners of the resource. Cutting off a leg to save dying from bone cancer has a pay back - you live - but just chopping your leg off for no reason at all, is just mutilation, and at the very least makes you lopsided. There are, and will ever be, developing solutions to the advantage of all if we look for them and continue to seek new knowledge and innovation, whilst utilising current knowledge. In other words, it is a moving game. We should not freeze ourselves out of the future.

The importance of property in a free democracy
I just wanted to get a little philosophical here too. There are principal fundamentals to a free property owning democracy which should not be sacrificed while seeking solutions to our environmental problems. In this regard we need to acknowledge the importance of ownership and property rights to Maori and Pakeha landowners in the lakes district, and seek solutions which respect such ownership. I do not mean "don't change", but I am saying "do so with respect". Anyone who thinks these things do not matter should read F.A. Hayek's *The Road to Serfdom*, and Huxley's *Brave New World*, or simply study the history of the 20th Century - we had a fair go last century at ignoring some of these principles and the result was not good.

As the urban population grows at the expense of rural populations, as pressures on the environment grow, as international resource and political pressures grow - the tension will also grow between private landowner, interest and public good as determined by urban dominated decision making processes. Managing this tension through appropriate solutions without destroying the very nature of a free property owning society will become increasingly difficult. A free society has no excuse for destroying the environment, but protecting the environment is no excuse for unnecessarily or casually removing economic or social freedoms. As we develop solutions for our environment we need to remember what we have learned from history and what we hold dear about New Zealand.

Particular issues for Maori landowners
Maori families, trusts and corporations own about 60-75% of the land in our lakes district – this figure is difficult to define accurately, but it is certainly a large chunk of the land around here. Maori value their land culturally and economically just as much as any other landowner. They have some difficulties managing their landownership systems, but that does not alter how much they care about their land. The fact that it may have only recently been returned – sometimes in a pretty sorry state - or is under-developed, does not diminish their owner interest in using it economically, just the same as any other owner.

Plans that try to restrict land to cultural use only - and you read these words in some plans - are increasingly out of touch with the socio-economic aspirations of the owners. The tendency for the community to see Maori land somehow as public land in certain areas, also raises misunderstandings over land use aspirations and the rights of the owners. Maori landowners will not agree to be the sacrificial lambs for unnecessarily restrictive land use control, and require the same wealth generating land use opportunities as anyone else, to the degree that we can successfully do that in this environment. We need to understand this as we develop solutions.

Key issues, principles and values
There are a number of key issues, principles and values which we need to respect while searching for solutions to the environmental challenges we face. The land still provides the bulk of our wealth in New Zealand, and we need it to continue to do so, at least in the foreseeable future. The landowning population of New Zealand may be relatively small in number, but they must be accorded respect and understanding. Property and property rights are important to the continuance of free democracy, and the owners around our lakes do care about these rights.

There is acknowledgement of increasing tensions with urbanisation, and we must manage that carefully. Urbanisation of Western populations is a very new thing; only about 50 years old. I visited the United States in 1985 - there were 23-24 million farmers there in 1950, down to 3 million in 1985, and currently heading for perhaps 1.5 million. In New Zealand we have chopped our numbers of rural people by half. It throws up a few issues when you think about that.

Land use change for a brighter future
This is about acknowledging the culture, spirit, aspirations and values of rural New Zealanders as we develop better, more sustainable ways of doing things. It should be about wealth creation at the same time as increased sustainability. It should be about embracing environmental sustainability, responsibility and owning the problem - some good points were made about this by an earlier speaker – and focus on solutions.

We should avoid rigidity and frozen paradigms, and accept that there will always be change. Much care is required if we are to avoid being locked into one way of thinking – subsidies are an example of a dangerous paradigm. The world changes, all underground coal and oil was once up in the atmosphere as CO_2. We need to develop flexible systems which recognise which issues should be addressed, respond to change, and not kill the patient on the operating table.

Pastoral farming – focus for the future
Pastoral farming is only one sector of rural land use – but consider it now as an appropriate focus for that sector. I believe the industry itself should take most of the responsibility for this, but obviously also research agencies. We need to focus on the soils – developing soil management systems which deepen top soils, inhibit the leaching of nitrogen and phosphate, prevent soil loss, and reduce dependence on expensive industrial fertilizers. Through soil conditioning, soil management, new plants with deep roots which complement and utilise the new soil environment, develop new animal biologies to complement these and build sustainability. All of these mechanisms must be embraced to produce a low-cost sustainable future for the pastoral industry that will survive reductions in petro-chemical inputs, AND have a zero N and P export to water footprint – we cannot afford environmentally or financially, for it to be otherwise. We have a $20 billion milk industry and about a $10 billion meat industry, sustainability should be a top industry priority, with a bit of government help of course. We should zero right in on this problem and not leave the room until it is fixed. The sector should not abrogate its responsibilites and in New Zealand we have had a tendency to think of such issues as someone else's problem - as Gandhi said "Freedom is the luxury of self discipline".

Mitigation of existing problems
We now know we have a legacy problem to deal with which alone will continue to damage streams and lakes for maybe another 80-100 years. Current research carried out in Rotorua indicates that there are viable natural means of mitigating this problem to low levels. Someone asked the question on the first day of this Symposium - 'Have the landowners done anything?". Well, landowners right here in Rotorua spent well over $1million - a big chunk of it their own money and time - getting stuck in to the problem of mitigation. The watercress trial on Ngati Whakaue's Waingaehe stream showed a 60% removal of N, and up to 100% reduction in P transmitted across the ground. There are a whole range of things we can get stuck into, and we are - we are not running away from the problem. Simple mitigation systems should be a prime focus of industry and agencies in our lakes district.

Optimisation of land use
We will not achieve the necessary step up in wealth if we do not optimise our land use in this district and in the Bay of Plenty. Taking a safe environmental footprint as a given, we need to think laterally about land use, and there are a whole range of potential uses which would, on the one hand reduce the nutrient problem, and on the other hand, lift wealth. This is particularly important for a large area of underperforming Maori land, or Maori land which for a whole lot of reasons was not previously developed; owners now want to do something with it which is economic, but are severely restricted because of the nutrient problem. This does not necessarily mean turning all that land into pasture, or trees, or anything else – it means taking a look at everything and choosing the best mix from all points of view. Ngati Whakaue have spent time and money working with Tech NZ to develop a land use optimisation tool called Octopus **-** I believe that tool should now be taken to the next level. It was very valuable in helping that organisation and could be developed into a very useful tool for others.

Leadership of land use change
I believe it is all about leadership and people. Whilst we need a very firm and clear regulated environment which provides the framework, in the end you will get the best out of people through leadership. The Rotorua Lakes Strategy Group (RLSG) - EBOP, RDC and the Te Arawa Lakes Trust – has had the wisdom to form the Land Use Futures Board (LUF) promoted by the Rotorua Lakes and Land Trust (RLLT), which itself was formed under the auspices of Federated Farmers and Te Arawa. We approached EBOP and the RLSG and suggested that the way to really get on top of the leadership side of the equation was to involve the owners - and I am very pleased to say that the suggestion was taken up. The LUF Board is made up of Maori and Pakeha landowners, industry representatives (forestry, dairy, meat and wool), and RLSG members; it has the Te Arawa Lakes Trust, EBOP and RDC on it as well. Its job is to provide leadership and advice to those agencies and landowners, but also to help landowners address the problems and make the changes we need to achieve the twin goals of wealth creation and environmental safety. The LUF Board is developing advice to put into the district and regional plans.

If we are going to get land use change we need to change the way we plan - toward enabling flexible, multi-use options, and away from the prescriptive, negative, narrow, frozen paradigms of yesteryear. We have got to get the RMA back to its original purpose – the sound objectives of what it set out to do - and away from the vexatious envies of hidden agendas and hand brakes on the future. I want to give you a couple of examples of that.

Ngati Whakaue took up the challenge to have a crack at two of its properties for a start. It produced an environmentally sensitive plan to effectively take out one farm altogether and turn it into an eco-park, create wealth for the owners, and remove about 3 tonnes of nitrogen from the lake next door. Note the zero costs for the community, values as agreed in terms of wealth creation, zero visibility and resource - a pretty good solution. An alternative for Lake Tarawera was a $16 million sewage scheme to reduce 2 tonnes, versus our no cost option for 3 tonnes. The community so far has opposed this vehemently. Interesting. We are also addressing another major property owned by Ngati Whakaue and believe we can take another 30 tonnes of nutrients out of the Lake Rotorua through similar land use change. These both happen to be properties which lend themselves to that sort of thing, but if the community prevents you, or the plans prevent you, we are a bit stuck and may be obliged to stay with dairying.

We need an innovative, flexible approach to this whole game. We need to understand the aspirations of owners and also understand the values inherent in this whole discussion of land use change. The Trust Board will be promoting that sort of innovation to go into the district plans, and we will continue to foster appropriate research which targets the

requirements of specific situations - it will be ‘horses for courses’. There are a whole lot of remedies, and some bits of the plan will be suited to one thing and other bits to another - there is no one silver bullet that fixes everything. There was a slide in a previous presentation addressing the ‘single solution for everyone approach’ – this will just result in a Soviet style economy, and we will all lose. I reiterate, it is about innovation, flexibility, and leadership – all aimed on the one hand at solving the environmental problem, and on the other hand, at increasing wealth.

The formation of the Land Use Futures Board (LUF) is an enlightened move towards collaboration and common sense - enabling landowners to own the problem and the solutions, and to work with the various agencies to achieve them. I believe it will work, I believe we will surprise ourselves just how well we go.

Thank you.

Session Seven – Nutrient Sensitive Zones

SESSION CHAIR: John Kneebone

John has been a farmer all his working life and therefore has a strong understanding of the conflicts between intensive farming and the environment. He is a past-president of Federated Farmers, an ex-member of the Waitangi Tribunal and is currently on the Waikato Regional Council.

ENVIRONMENT BAY OF PLENTY PERSPECTIVE

Bill Bayfield
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Bill is Chief Executive of Environment Bay of Plenty. Previously he managed the Ministry for the Environment's Sustainable Industry and Climate Change Office and was director of resource management at Taranaki Regional Council. He was also involved in coastal environmental management and emergency management.

ABSTRACT

Regional councils carry out a wide range of activities for controlling nutrients and pollutants entering waterways. Environment Bay of Plenty has some significant challenges in front of it with the Rotorua Lakes and with lowland rivers and streams. These challenges are being addressed through a toolbox approach. This presentation will look at the challenges and the tools, both old and new, within the toolbox.

TRANSCRIPT

First of all I would like to thank Marc Schallenberg yesterday for his definition of Nutrient Sensitive Zones. It really suits me, so I will use it because I do not like those full on European models. What it means for me is that most of the Bay of Plenty is a nutrient sensitive zone, as intense or inappropriate land use really starts to impact on our rivers, streams, lakes, estuaries and harvest. I would also Quality Society for inviting me to speak.

Figure 1 – Tauranga Harbour

This conference has explored in considerable depth the toolbox for managing nutrient sensitive zones and it is really important and timely for Environment Bay of Plenty because we know we are at that point, which they have all described, where the world is starting to kick up the way the Europeans did twenty years ago. You would like to think that we have the imagination and intelligence to work out the solutions to avoid going where they went. So it is important that we have an exploration of our toolbox and make sure that our toolbox is as wide as possible to tackle the complex issues before us.

Figure 2 – Ohiwa Harbour

Nutrient Sensitive Zones for us include this jewel, Tauranga Harbour. *(Figure 1)* You do not mind falling off your windsurfer into this but you might hesitate if you are on a windsurfer off Beijing at the moment. But the combination of intensification of urban catchments around this harbour and the intensification inland is causing challenges; and that is a nutrient sensitive zone, and you have to think that broadly. This is another one, Ohiwa Harbour (*Figure 2*) and it is also a jewel in the crown. It has been recommended for Ramsar status at the moment, for its wildlife values, landscape and its cultural significance. However, when you look at it and start strategising what to do with it, you end up with a conversation about what is going on in the streams and rivers that drain into it and the catchments above it. It gets down to land use very, very quickly.

Figure 3 – Nukuhou River

I asked my staff for a picture of a stream that drains into the Ohiwa catchment (*Figure 3)* – the Nukuhou River. I asked for it to demonstrate riparian planting and management and this is what they provided me. I thought it was an aberration but I am staggered to find out it is probably the norm. Apparently if you stare really hard at it you can see a one-wire electric fence somewhere – I have not found it yet! I used that in my speech two months ago to the AGM of Federated Farmers in Edgecombe and I told them quite simply, "those days are gone, it is over, that is not acceptable anymore". We have now signed the *Clean Streams Accord* and I would like to see Kit Rutherford's Rolls Royce planting in every one of those catchments within the next five to ten years.

I have already said to you that we have nutrient sensitive zones all over this region, and we have. There is another one between Tauranga and Ohiwa, the Maketu Estuary. This Estuary is the natural river mouth of the Kaituna River which drains both Lake Rotoiti and Rotorua. In other words this is a whole of catchment process; it can not be anything else. When we start to discuss these twelve Rotorua lakes, we recognise that they are all connected and that is why I come back to - there is not much we do that is not dealing with a nutrient sensitive zone. Nevertheless we recognise that we have twelve special lakes and we are managing them as one of our core activities.

Not all these lakes are equal. I think that is an important point to start with. David Hamilton has given you the latest buzz on water quality. They are not all equal in the way they stand at the moment; they are not all equal in terms of water quality, risks, nor the solutions or toolbox that we might apply to them and very much not in public expectations. In other words it is very hard just to talk about the Rotorua Lakes. We used to talk about a formation of 4: 4: 4 - it made us sound like a Beijing hockey coach - and what it was referring to was four eutrophic, four mesotrophic and four oligotrophic. But that does not fit now because we have entered into a new arrangement with Central Government and we have picked four priority lakes. Therefore I am a very complicated Beijing hockey coach because now I have this new model – 1: 4: 3: 4. If you are confused, do not worry, the opposition will be even more confused, and therefore we should triumph.

I want to go into each of them. First there is Lake Okaro, our practice pond, and we are incredibly lucky to have that. It was already supertrophic and therefore anything you did to it had to be on the winning side. But we also had a marvellous opportunity to trial the techniques here that we believe we can take to other lakes, bringing them not only out of a laboratory, but trialling them in Okaro and think about using them in Rotorua, Rotoiti or Rotoehu.

Figure 4 – Zeolite Trial at Lake Okaro

Figure 4 is the trial that EBOP did with Z2 Zeolite capping the sediments. Touch wood, right now the results look really good and we hope they keep trending that way. One of the key questions for us, before scaling it up for a bigger lake, is how long will that cap last? Does it really represent a useful investment and have we addressed the off land discharges because simply capping those sediments is not enough.

Figure 5

Figure 5 is Okaro with its constructed wetland in its relatively early stages. We learnt a lot about building it, how they work and a lot about how long it takes to start up before they function. In particular, I want you to look at the house in the background, because working on Lake Okaro, our practice pond, also taught us how to work with farmers. We found out that this very small catchment Okaro only has six farmers. Here was a hero, this champion called Shane Birchall who lives in that house. He has already gone a step further, constructing the first operating herd home, making it available for all to see.

I have a question for you. You have only six farmers in a catchment. You are already dealing with Shane Birchall and he is a champion. Another farm is owned by Landcorp and there are four others in between, whom you have already talked to when you constructed this wetland. Why do you need a rule? Why not just sit down and talk to six farmers? Why not think about an MOU, a contract or a consent?

Figure 6 – Lake Okataina

The four that are really good to great lakes are Okataina, Tikitapu, Tarawera and Rotoma. The challenge for us is to protect them in their current condition, not to allow them to get worse, and to even enhance them where that is practical and within our priorities. One of these is more of a challenge than the others.

Okataina is brilliant; our challenge is to keep it that way and ensure that the planning regime maintains that water quality. Tikitapu saw an explosion of outrage about three or four months ago amongst the local Rotorua media when it was thought to be threatened by logging. It was brilliant to watch. There was a lot of misinformation, misunderstanding and misuse of terms but it did not matter. What you saw was the community saying, "don't do that to one of our top lakes, don't even put it at risk". We got the right outcome but it was pleasing to see the public engage on it.

Tarawera is the one that worries me. If we had better information, if we had an action plan actually done, then who knows it might have been the fifth priority lake. As it is, we are going to monitor it, watch it very closely and take action as and when priorities allow us to.

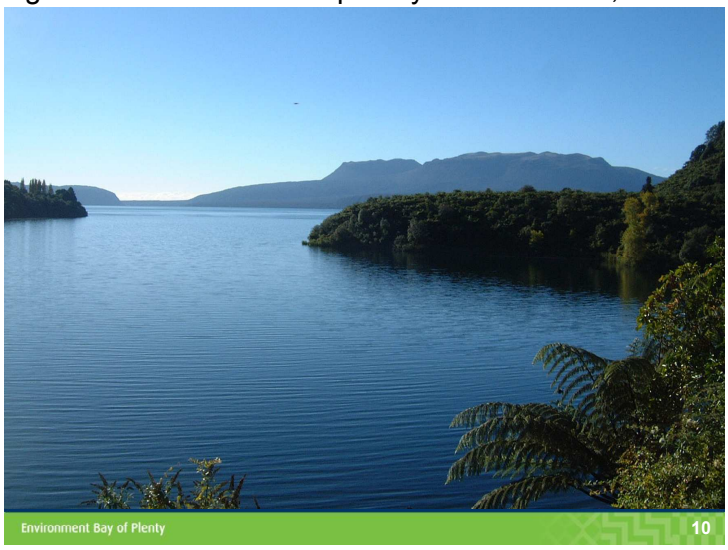

Figure 7 – Lake Tarawera

The next three, Rotokakahi, Rotomahana and Rerewhakaitu, are mesotrophic lakes. With the Government agreement to focus on four priority lakes, the actions with respect to these three will be limited to general advice, investigation, monitoring and actions where priority and funding allows. The threats are not considered great and right now they are not of immediate priority, with one exception, Rerewhakaitu. That community is just incredible, positive and ready to address an action plan and all the challenges that arise from it. You might have seen in the poster presentations outside[1] the phenomenal response from an AgResearch research-led project where they went to talk to the farmers in that catchment about doing Overseer and twenty-seven of them volunteered. It has

[1] Longhurst, B., Hawke, M., Parker, B., Balvert, S., (2008). *Lake Rerewhakaaitu Catchment – nutrient management Project.* Agresearch, Bay of Plenty Farm & Pastoral Research, Fruition Horticulture

complied with our dairy shed effluent compliance requirements five years in a row, 100 percent. These are guys that seem to have a moral link to Lake Rerewhakaitu, and keen to do something about it. What I hope is that we can borrow from Kit Rutherford's toolbox and really make it work with them.

Then there were four, Rotorua, Rotoehu, Rotoiti and Okareka. These are the lakes that the Rotorua Lakes Strategy Group, comprising Environment Bay of Plenty and our partners Rotorua District Council and Te Arawa Lakes Trust, have determined as the priority lakes for action. We worked in close conjunction with Central Government, particularly the Ministry for the Environment and drew up an agreement for 50/50 Government funding to tackle some of the actions required in those lakes. We signed that Deed of Agreement yesterday, and for me, it was another great day in the saga of the lakes.

Figure 8 – Ohau Wall, Lake Rotoiti

But even within those four lakes there are big differences in the nature and the scope of the challenges that go with them. For three of them, Okareka, Rotoiti and Rotoehu, the challenges have been imminently doable. Over Rotoiti in the last summer we saw the impact of the Ohau Wall (*Figure 8*) and the clean-up with the Okawa Bay sewerage scheme. They have been real reasons to celebrate because in both cases they have actually delivered a solution faster than any of us anticipated.

With Okaro doing okay, the Okawa Bay sewerage scheme working, there are some positive solutions around the place. Not so with the monster. The monster is Rotorua.

Why is Rotorua different?

- Rotorua has a vibrant, urban, growing community, not a relatively small collection of villages and baches.
- Rotorua has more than 2,000 land owners. Okareka has 6, Rotoehu 3, Rotoiti 100.
- Rotorua has intensive land use, dairying and cropping; Okareka has none, Rotoehu has one dairy farm, Rotoiti a couple.
- Rotorua's large catchment means lengthy lag times between nutrient loss from the land and its arrival in the lake. That means an average of sixty years of ground water residence with elevated nutrients heading towards that lake.

But it is an iconic lake and we have promised to fix it up. We have promised to take it back to at least what some of us remember in the 1960's. We have, after some really good science and careful analysis, found that it is all about pasture. I would like to pause and say that our sponsorship of David Hamilton's position at the University of Waikato, as Chair in Lakes Management and Restoration, pays us dividends far greater than the monetary input we put in, and I really appreciate it. After good science and careful analysis we estimate that we need to remove nearly 250 tonnes of nitrogen and 10 tonnes of phosphorus from the current nutrient load going into the lake. The bad news is that we estimate that 170 tonnes of nitrogen and 6 tonnes of phosphorus has to come from the

land users in that catchment. That is a big ask. That is where Kit Rutherford is at the point of "wow, what do you do, what do you say?"

Where are we on Rotorua?

With the agreement of the stakeholders, which is no small thing, the community has in place a regional rule, Rule 11 which is a marvellously powerful instrument that applies to the four priority lakes and to Okaro. That powerful instrument provides an immediate back stop to ongoing discussions about how we might tackle the task ahead and to work out where the hell we are going on this monster. The Rule has meant no conversion of dairying since it has been in place. With dairying it means no intensification of nitrogen use, although we would be blind and naïve not to admit that some intensification has occurred.

So we have that greenfield zone as Kit Rutherford said. The Rule has bought us time to work out what course is best to take and how to achieve a cleaner lake in the most efficient and equitable way. The tonnage reduction of nitrogen required in this lake catchment is such that it is going to impact on all in that catchment and in particular on high nitrogen users, and perhaps even more particularly, on high nitrogen losers.

Right now the action plan for the Rotorua lake is on hold and we are gathering information

Figure 9 – The Monster, Lake Rotorua

on what might be the best course of action of four pathways.

- *Option 1* is the use of voluntary mechanisms to facilitate change, a softer option with little guarantee of success.

- *Option 2* is to look at some form of private/public partnership to achieve the same.

Our money was different from Central Government. We did not get the money to go into land use like Taupo; ours is for in-lake capital action. For both of these options the size of the task in Lake Rotorua is daunting, but they look exciting for other lakes. For Rotorua, it is just too big, they do not stack up.

- *Option 3* is to take Rule 11 and build it into the standard regulatory path we all know well, rules requiring consents and conditions requiring demonstration of reductions. A path that we have all questioned whether it is truly applicable or whether it will work. Let us keep questioning that but it is the back stop we know.

- *Option 4* is to take Rule 11 and build a market mechanism under it, consents that allow and require trading, i.e. a nutrient trading regime. An approach that should encourage the reductions to occur in the most efficient way, recognising the need to balance the social and economic impacts of the changes that will occur.

There is real possibility here. We are very naïve when it comes to nutrient trading mechanisms. It is an exciting proposal and we have been doing considerable work with Motu Consultants on it in the Rotorua catchment, but it is new ground. I would note that probably the best example of a trading regime we have in New Zealand is our fisheries.

Nothing on Rotorua will happen fast. I am sure that gives some of you a real sense of frustration but choosing the right pathway is vital.

Currently the action plan for the Rotorua Lake is on hold pending further investigation to look at where we get the best bang for our buck, to look at what is needed for a point at which to move forward. This conference and the tools that are emerging from it are a vital part of continuing to reassess how we deal with this monster. The important driver here is to ensure that the solution for Rotorua is successful and least cost to the community, both socially and economically.

We, Rotorua District Council and Central Government have committed yesterday over $144 million dollars worth of expenditure for the four priority lakes over the next ten years. Rotorua District Council needs to raise $39 million from their community and ourselves $32 million, a large chunk of which will come from the same community. In addition to that, Environment Bay of Plenty has indicated in its Draft Ten Year Plan expenditure of between $30-$40 million on the other lakes and planning, science and monitoring actions on all the lakes. It is a big sum and a big ask.

Funding the Rotorua Lakes and Restoration Programme is a significant burden on the Rotorua community and I suggest to you that affordability will play a significant part in the prioritisation of solutions. To add to this, Rotorua has the sixth worst air quality in New Zealand. There is a National Environmental Standard that says that during the same ten year period that I am talking about we have to sort that issue out as well. These programmes will cost between $15 -20 million. There are times when I am really glad I am a Chief Executive and not a Councillor because these are tough trade-offs and big decisions to be made on funding sources and impacts.

It has taken me two years to wrap my head around the challenge of leading Environment Bay of Plenty in the lakes issues. But it is a challenge which I, my staff and my Council will be judged on, and I welcome that. This is what we joined up for. I stand here convinced that in the next decade we can, and will, tackle the challenges of 11 out of 12 of the Rotorua lakes. By that, I mean that we will see trends going in the right way, or lakes achieving their TLI goals, at the end of the next decade.

Not so for the monster. We need ideas, imagination, innovation and particularly leadership from you all to join us in tackling the lakes in Rotorua, but especially Lake Rotorua itself.

I really like Morgan's words, "this is the first 5 kms of a marathon". I do not think we are in the first 5km of the marathon, I am not even sure if the starting bell has rung. I think we have to rationalise and recognise for Rotorua it is going to take us 50 to 60, perhaps 80 to

100 years to see that lake come back to what we have currently identified as our target for it. There will need to be big impositions and changes in the Rotorua catchment to achieve that. Let us hope they are done with flair and imagination and as effectively as possible for these water bodies.

Thank you.

NATIONAL PARTY PERSPECTIVE

Hon. Dr Nick Smith
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Hon. Dr Nick Smith first stood for public office at the age of 18 for the Rangiora District Council. He joined the National Party as a teenager and has held governing positions through all levels of the organisation. He entered Parliament in 1990 as the youngest MP ever and was a minister in the last National Government. He is currently the National Party Spokesman for Environment/RMA, energy and building and construction, in addition to being the Caucus representative on the National Party Board.

ABSTRACT

Ensuring good water quality is one of the big challenges ahead for New Zealand and a high priority for National. Nick Smith will address the Symposium on National's ideas on this important issue.

TRANSCRIPT

Kia ora, can I acknowledge both John Green as the Chair of the Society, and also John Kneebone as the Chair of this particular session, and thanks to the LakesWater Quality Society for the invitation to join in this Symposium. Can I also acknowledge the Parliamentary Commissioner for the Environment, Dr Jan Wright, and also Simon Upton, former Environment Minister, and Todd McClay who is National's candidate here in Rotorua.

This afternoon I want to give you a flavour of National's thinking over these important issues of water quality and the challenge we have in the Rotorua lakes, a bit of a critique on where the Government has done well, and where we need to lift our act and also some idea of where National would want to lead on these key questions.

In my eighteen years of political debate, water and its quality is a greater issue than at any time previously. Recently I attended a meeting of nearly six hundred people in Christchurch associated with water quality issues, and in the days of television and politics through the tube, that is an enormous number of people. Last week I attended a school conference of my daughter Hazel and again water quality was the feature in theme of an urban school's view of where things are at. So water quality has become a major issue.

My interest in these issues was as a PhD student. I did some work with Bob Spiegel from the University of Canterbury on some of the issues of trying to understand the seasonal stratification in Lake Rotoiti and how that impacted on the fixing of nutrients in the Lake. Five years ago I came here with the Sunday programme to give the issue a bit of a rev-up in terms of the lack of importance which was being given to the issues around the Rotorua lakes. I want to acknowledge that over the five years since then we have started to see some progress and the Society in many ways can take some credit for the way in which those issues have been brought to the fore.

In many ways the lakes around Rotorua are a forerunner and warning sign for many other parts of New Zealand, a reminder that if we poorly manage water resources it is where we may end up and the challenge that goes with that. In the bigger picture, National view the issues of water as the second most important priority after the challenge of climate change in our policy formation. We have put quite a lot of work into where we will head.

Eighteen months ago we published the thirty page *Bluegreen Vision* document which set out sixteen different issues we wanted to engage with New Zealanders about the approach on those, and where we would head. Key areas have been on both water quality and issues of water allocation. We have received over 200 submissions on that *Bluegreen Vision* document and are in the final stages of teasing out the programme which we will put forward to New Zealand as we go into this General Election.

There are five underlying principles that National applies in its overall environmental approach.

- The overriding principle of sustainability, of ensuring that we are managing New Zealand's precious resources in ways that do not compromise future generations
- We are a party that wants to marry together good economic policy with good environmental policy. New Zealand does not get the choice between the two and that is why we favour (not religiously) an economic instrument approach to these sorts of challenges.
- Our approach to these issues needs to be based on good sound science. It is so easy with environmental issues to get carried away without that really good science underpinning our decision-making.
- We are very much in favour of communities being engaged around the way in which we approach these issues
- We need to recognise New Zealand's quite unique heritage around recreational access to precious resources like our lakes

There were three substantive ideas in that *Bluegreen Vision* document which I want to expand on a little bit further in terms of how we deal with lake water quality issues. The first of those is that National is very enthusiastic about the work which has been done by Ecologic, and funded by The Foundation for Research Science & Technology, around the models which have been applied in Scandinavia to collaborative environmental decision making. The way we approach these issues in New Zealand within the RMA framework is one of an adversarial approach and one that is very divisive.

If we take the issue of water quality, we have organisations like Fish & Game which is very confrontational to the dairy campaign and we have Federated Farmers referring to environmental organisations as being economic vandals. These sorts of highly polarised political arguments are not taking us forward; we need to have a far better process of collaborative decision-making and as part of that we need to develop a process as we outlined in that *Bluegreen Vision* document of getting a broad consensus across New Zealand around some long term environmental goals which are struck around things like water quality, air quality, bio diversity and the like; and that would be part of our programme.

The second view National holds is that we do a poor job of measuring environmental performance. We subscribe to the view that you manage what you measure. We spend over a billion dollars a year with accountants and auditors looking at how we manage our financial resources. If you add up all of the budget which has been spent by Central and Local Governments, it is less than 1% of that, $10 million on measuring the quality of our environment. I do not think there is a New Zealander who would rate those 100:1.

We wish to bring in a new Environment Reporting Act which will require thorough independent reporting the state of the environment on a five yearly basis, as is required in many other jurisdictions. We had a big debate at the beginning of this year about the loss of the Chapter in the State of the Environment Report. It is National's view that whether it be regional councils or government agencies like the Ministry for the Environment, there will always be a suspicion that they do not quite want to say it the way it is because it

might be embarrassing. That is why National's view is that we want to extend the role of the Parliamentary Commissioner for the Environment to do that up-front reporting.

The analogy I would make is this; in the area of public finances, when New Zealand had an awful history record, the Fiscal Responsibility Act which required open reporting of New Zealand's public accounts has resulted in a huge improvement in New Zealand's public finances; and open, accurate reporting about the state of our natural environment is the key to it. What we would like to see is every one of our major lakes having standardised reporting across the country so we know which is the best, which is the worst, which is improving, which is deteriorating; and equally so with our river systems. So that is the second approach which we are proposing.

The third is that National has a big question around the effectiveness of our Government institutions which have environmental responsibility. If we look for instance at our Ministry for the Environment and the polling about what New Zealander's think is important, you would think that the Ministry for the Environment would have a large number of highly skilled staff around an issue like water quality. We note they have three out of a staff of 272. Is that the focus we would want to see from the lead agency? With their Water Programme of Action which has now been five years in the running, described ironically by the new CEO of the Ministry for the Environment as "the Programme of Inaction", all we have delivered is a wishy-washy National Policy Statement which is unlikely to be taken up anyway, and all the other key benchmarks from that programme of action are not being delivered.

We have lost both the Minister and the CEO of that Ministry. National believes there is a very important role to play in rebuilding the Ministry for the Environment as one of the key public think organisations with the same sort of level of respect and leadership which we have come to expect from agencies like the Treasury and our Foreign Affairs Service. But further to that, National believes New Zealand should consider the establishment of an Environmental Protection Authority. There is one in every state of Australia. When I talk with both environmental organisations as well as industry, there is a deep concern that environmental regulation in New Zealand has been excessively devolved to local authorities where there is not the leadership from Central Government.

So National is exploring the creation of an Environmental Protection Authority (EPA), leaving the Ministry for a more focussed policy role. The EPA will take responsibility for delivery of the National Policy Statement, National Environmental Standards as well as the agency which will take responsibility for processing major consents under the Resource Management Act. If you doubt the need for an EPA, look no further than the Parliamentary Commissioner's most recent report on the fiasco in my corner of the world in Mapua where key failings resulted in sub-standard performance around both air and water quality. National is looking at those options and next Monday is hosting a water forum at Parliament Buildings with key stakeholders to refine down our final proposals around these issues. They will be announced at National's Bluegreen Forum to be held on Waiheke Island with leader John Key the first week in September, before we take it to the wider community.

We see it as critical that whether it be water users, commercial, farming, power generators, environmental groups, iwi, regulators and researchers, they must be able to grapple with two key areas where we think public policy is failing. The first of those is acknowledging that the Resource Management Act has done a good job of dealing with point source pollution however it is failing to address the non point incremental pollution and that new tools are going to be needed in our legislation to deal with that.

The second key area of failing in water management is the 'first in, first served' approach to water allocation is not the best mechanism which can be used, and again, we need to look to new tools.

In conclusion, National views water reform as a key priority looking forward and that New Zealand is well behind best practice internationally. We wish to see legislative reform, institutional reform, as well as engagement with organisations like those which have run this forum. We see that many of the initiatives which have been taken in the Rotorua lakes do provide some idea of the way forward and we would want to support those local initiatives.

Can I conclude on this note: last December I attended a forum of the International Parliamentary Union where over 130 countries were discussing environmental concerns. The idea that New Zealand has got a choice between economic and environmental success was brought home to me when the Europeans were too easily able to pick the issue of water quality in New Zealand as a key area of failing and I say to those who depend on water for their industry, the very survival of these industries depends on us lifting our game. We cannot market ourselves as 100% pure in our tourism branding when we have lakes in the state which you have in this district. My point is this; economically, environmentally, culturally and socially New Zealand has to lift its game about water management. We are blessed with plentiful rainfall and stunning lakes and rivers, but with this blessing goes a huge responsibility to lift our game. National is committed to doing that.

Thank you.

WHAT COULD A NUTRIENT SENSITIVE ZONE LOOK LIKE FOR TAUPO AND ROTORUA: LEARNING LESSONS FROM THE UNITED KINGDOM

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Dr Mark Shepherd has recently joined AgResearch Ltd, Hamilton, in Land & Environmental Management. Before that he was the head of ADAS Catchment Management, which undertakes National and International research-based consultancy relating to all aspects of the interaction of land management and diffuse/point source pollution. His specialist research area is nutrient management in agricultural systems with an emphasis on decreased environmental impact. He has a grounding in the issues and legislation relating to agri-environmental interactions, particularly the Water Framework Directive and the Nitrates Directive of the European Union.

ABSTRACT

A roadmap for addressing water quality issues

1. Understanding the issues
   - Source apportionment between sectors
   - Understanding pathways and processes
   - Providing the evidence base
2. Developing solutions
   - Strong research base required
   - Integrating into agricultural systems – avoiding unintended consequences
   - Links with cost-effectiveness
   - Will potential improvements be sufficient to meet targets?
3. Implementing solutions
   - The policy mix: voluntary vs regulatory vs support
4. Reviewing effectiveness
   - Monitoring 'activity'
   - Monitoring water quality

Case study: 'Nitrate Vulnerable Zones' in the UK

- Large area of NVZs - 55% of England (4.7 million ha)
- Mandatory rules (compliance visits by Environment Agency)
- Must follow Code of Good Practice. In addition, specific rules focus on N inputs:
  - Closed periods for manure and fertiliser applications
  - Limits on stocking rates
  - Limits on application rates of manure and fertiliser
  - Controls on how N is applied
  - Controls on where N is applied
- Keeping detailed farm records for five years is compulsory
- Monitoring effectiveness:
  - Coarse-scale monitoring of surface- and ground-waters
  - Collection of farm activity data (e.g. surveys of fertiliser and manure management)
  - Catchment/regional/national scale modelling of potential impacts of changed practices
  - Minimal specific on-farm monitoring/modelling
- How effective?

- Recent analysis suggests that the overall effect is likely to be a *c*. 10% reduction in N leaching, with the largest effects in areas of intensive livestock
- Will these reductions be sufficient? This is still being debated.

Lessons for Taupo/Rotorua Nutrient Sensitive Zones?

- The emphasis of NVZs is in good practice – similar to Taupo/Rotorua
- The emphasis of NVZs is also in controlling inputs – easier to regulate, given the large areas involved in the UK?
- Reliance on modelling to gauge effectiveness
- But using an output-based approach, as advocated for Taupo, has potential advantages:
  - Much greater flexibility for the farm in how it achieves targets
  - Targets set at the farm level may mean better 'ownership' of the issues
- Flexibility: farmers have a wide range of mitigation options available for integrating into their production systems. It is not just about limiting fertiliser inputs, manure (FDE) inputs or stocking rates, as in the UK, to achieve targets.
- For example, none of the following practices (that have potential to reduce leaching) would be encouraged by an input-based system:
  - Use of low-protein feed supplements instead of N fertiliser to meet feed shortages
  - Increase the percentage of male cattle/decrease percentage of female cattle
  - Use of nitrification inhibitors
  - Restrict grazing in the winter
- This flexibility bodes well for the operation of Nutrient Sensitive Zones around Taupo/Rotorua.
- But some of the issues are the same as in the UK:
  - Evidence of effect?
  - Is the required size of reduction achievable? And at what cost?

TRANSCRIPT

Good afternoon. Thank you for the invitation to speak and thank you to John and Ann for organising it and making me so welcome over the last couple of days.

I would like to get it straight from the start: I landed in this country seven months ago, so there is no way I am going to come here and tell you exactly what a nutrient sensitive zone should look like! I took this talk on when I had only been in the country for three weeks and in the nicest possible way it was probably a hospital pass that I was given. But like a good English centre, I kept my eye on the ball, swerved, and by just adding experiences from the United Kingdom I will be able to provide you with something that I hope is interesting and relevant. I will relate my experiences in the UK to what I have learnt since being here, and over the last two days, and how it can all relate to the Taupo and Rotorua approaches.

I worked for ADAS Catchment Management, a commercial research organisation, originally researching at the plot level and then developing mitigation methods, as pollution and water protection policy has evolved. More recently, I worked with policy makers on how we might implement change at the catchment level. Of course, much of that is a team effort and I would like to acknowledge colleagues, in particular Eunice Lord and Steve Anthony from Wolverhampton in the Midlands, and also colleagues from the Institute of Grassland from Environmental Research (IGER), Phil Haygarth, Dave Chadwick and Steve Cuttle. If I use the term DEFRA it is the Department for Food and Rural Affairs, the MAF equivalent. The Environment Agency (EA) is another organisation, organised nationally but with regional activities as well.

Professor Jeppesen yesterday mentioned the Water Framework Directive. To me that has been a really exciting development in water policy because, over the last five years, it has driven a lot of the developments in water protection. As a framework directive it is very general, but the devil is in the detail and every European country has challenges ahead. It is trying to do what you are endeavouring here around these lakes. It looks at the ecological and chemical quality of water. Interestingly, it also considers water quantity, and involves all water bodies. Cost-effectiveness is a major consideration and actions will not be put in place if they are disproportionately expensive. The key point for me is that activity has to be multi-disciplinary. If we are going to clean up water, it involves a wide range of skills and it also relies on a strong science base. The Water Framework Directive has been asking the scientists to make decisions and to use our best judgement now. Without previous investment in science, we would not be able to do it.

For a long time we have talked about the potential of how we manage agricultural land to deliver food and water, but with the introduction of a Water Framework Directive the emphasis is now on bringing about change at a land management level to protect that water quality. There is nothing like the strength of a multi-million dollar fine from the European Commission to galvanise politicians and policy makers into action!

The Water Framework Directive has policy makers, politicians, lawyers and regulators doing their best to interpret its meaning. However, it can be simplified down to four steps, which are exactly the issues that we have talked about here over the last two days;

- identifying problems;
- identifying solutions;
- putting those solutions into place and
- monitoring their effects.

So far, we have been good at the first two; the challenge, which we can tell from the debate here over the last two days, is how we implement those solutions and get action and changes within catchments. That challenge is not just focussing everybody's minds here; it is the same across Europe as well.

I would like to use two case studies (*Figure 1*) which are useful in terms of the contrast. First, Nitrate Vulnerable Zones, where the first zones were designated in 1996 with a focus on nitrates from agriculture. The other is Catchment Sensitive Farming (CFS) Priority Catchments, which is a much newer initiative with a focus mainly on sediment and phosphorus from agriculture. There are some useful and interesting contrasts between them.

Nitrate Vulnerable Zones (NVZs) cover about 55% (4.7 m ha) of England. There is a review on at the moment that may extend the area to 70%. The emphasis is on diffuse nitrate pollution from agricultural land into surface and ground waters. Because of the size of the NVZs, there is a regulatory approach to managing nitrate loss. There are codes of practice and additional specific rules, which are backed up by compliance visits. Detailed farm records are compulsory for five years. I will say more about the specific rules in a moment because I think they are directly relevant to what we might consider within a nutrient sensitive zone here.

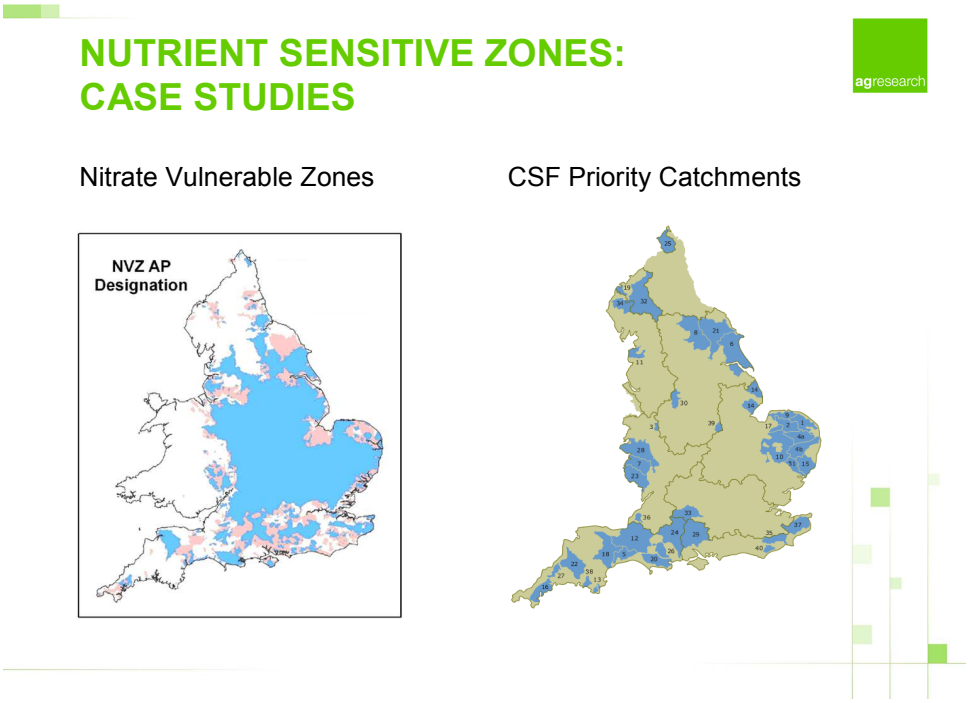

Figure 1

Nitrate Vulnerable Zones (NVZs) cover about 55% (4.7 m ha) of England. There is a review on at the moment that may extend the area to 70%. The emphasis is on diffuse nitrate pollution from agricultural land into surface and ground waters. Because of the size of the NVZs, there is a regulatory approach to managing nitrate loss. There are codes of practice and additional specific rules, which are backed up by compliance visits. Detailed farm records are compulsory for five years. I will say more about the specific rules in a moment because I think they are directly relevant to what we might consider within a nutrient sensitive zone here.

CSF priority catchments are a little different and have been set up in specific response to the Water Framework Directive. Selected priority catchments have been identified as surface waters that are at risk from agricultural diffuse pollution. Whereas NVZs are about nitrate, CSFs focus primarily on phosphorus and sediment. The CSF catchments could be considered a big experiment, a pilot area, where we learn how to bring about changes in agriculture to benefit water quality. There is a catchment officer in each catchment whose job is to facilitate and generate action, co-operation and get partnerships working. The emphasis is on stakeholder engagement and involvement. In terms of how change is effected, the policy is still being developed but a lot of it is a "light touch" approach rather than more regulation and it is linked to other environmental policies and tools that are already there. CSF provides a good contrast with NVZs.

If we now work through each step of the catchment management process:

Identifying problems
Below are a couple of examples of the situation in England. As has been done in the lakes here, the first thing was to identify where the sources of pollution came from (work done by the Environment Agency).

Groundwater:

Pressures	Groundwater
Point discharges	3.9
Diffuse pollution	75.3
Abstraction	26.1
Physical changes	Not applicable
Alien species	Not applicable
Overall % of water bodies at risk	75.3

Surface waters:

Pressures	Rivers	Lakes	Estuaries	Coastal Waters
Point discharges	23.1	20.1	48.5	18.2
Diffuse pollution	82.4	53	25	24.2
Abstraction	10.7	2.1	14	Not applicable
Physical changes	48.2	59.3	89.7	77.8
Alien species	21.1	9.3	36.8	45.5
Overall % of water bodies at risk	92.7	84	98.5	84.8

The first point to note is that the surface waters show that we still have point discharge problems, some of that is sewerage treatment works needing secondary and tertiary treatment installing. But in most cases, particularly inland waters, diffuse pollution is the biggest challenge we have. Professor Jeppesen commented yesterday how many rivers have been straightened, and we have exactly the same problem - hydromorphological issues. What is blatantly clear, if we did not know before, is that we have to look at how we manage our land and how it will impact on water quality.

I have worked with farmers for many years now and, as an example of a catchment project I was working on before I left the UK, in the south-west, we looked at land management change and managing nitrate losses. (*Figure 2*) These figures reiterate what I hear every time, that farmers want evidence that –

- there is a problem
- they have caused a problem
- work they are asked to do will make a difference to the problem

That is a challenge that scientists have to take on board all the time. It is the same for anything; if you want to look at making change you must have the evidence to support the need for change. Surveys show that we still have a way to go in convincing some land managers, although the majority of farmers in the UK appreciate the need for action. Inevitably, however, we see significant proportions of farmers that still have problems recognising that there is an issue. More than 40% think that tackling diffuse pollution will be prohibitively expensive. What is most disappointing to me is that, even now, more than 40% disagree that agriculture is responsible for a lot of the nitrate leaching and water quality issues. That is a reflection of how we have provided the evidence base. It is a challenge for scientists and regulators to get the evidence and demonstrate the need for action.

Identifying solutions

I have a lot of sympathy for farmers trying to manage the nitrogen cycle. It is a difficult nutrient to manage. And they are not just trying to tackle nitrate, they need to consider

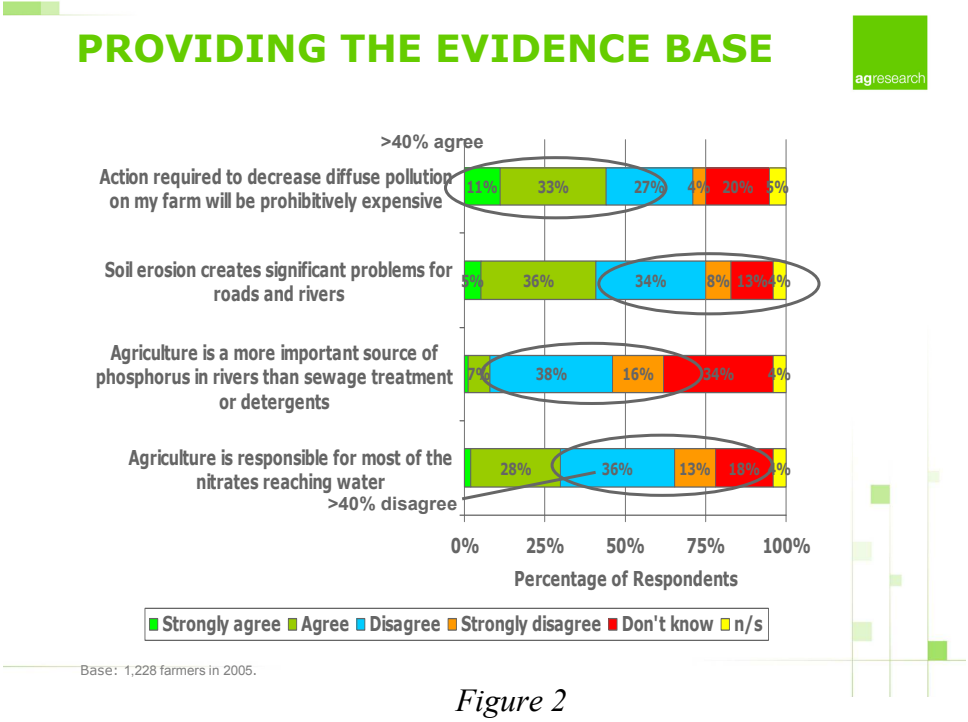

Figure 2

nitrous oxide emissions – and all in the context of a profitable business. But the good news is that there are tools available to assist their management decisions.

Using UK's Nitrate Vulnerable Zones as an example of some of the management options, these tend to focus on source control (see below). These rules are mandatory; because of the scale of the operation of that nutrient sensitive zone (5 million hectares), by necessity, there has to be a regulatory aspect to implementation.

- Closed periods for fertiliser and manure applications (autumn – early winter)
- Limits on rates of N fertiliser and manure (including direct excreta)
- (Indirect) limits on stocking rates
- Controls on how and when N fertiliser and manure are applied
- 4-yearly review of 'Action Programme'

A lot of these rules are based on source control, on closed periods for fertiliser and manure and by that I mean excreta that are collected during the housing period for animals. We have a wide window where farmers cannot apply manure, so they need large storage requirements. We are not nearly as stringent as the Danish. The Nitrate Directive is countered by wheeling political gamesmanship and the UK approach is not to "gold plate"; whether that means that it is not as effective, we will see in a little while.

(*Figure 3*) explains that effect of indirect limits on stocking rates which can have big implications for farms. At present there is a consultation to extend these rules to a much wider area of the country which will impact on farms that were not in the NVZs until recently. The figures show the implications of working with average N loading across a farm if the regulation says a farm can only have manure directly excreted from animals at 250kg per hectare of air. The recommendation coming from the European Community is that we work at 170kg per hectare of air, reducing stocking rates that we have to operate in livestock farming in the future. The British were resisting that and it is being worked through.

(INDIRECT) CONTROL ON STOCKING RATES

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Standard total nitrogen production as livestock excreta and maximum NVZ stocking rates ANNEX 4

Livestock Unit	Age Range or Average	Body Weight kg	Occupancy per cent of year	Annual excreta production m³ or t	Annual N production kg	Animal number per ha to comply with maximum N loadings		
						170 kg/ha N	210 kg/ha N	250 kg/ha N
Cattle								
Dairy cow		650	100	23.2	116	1.5	1.8	2.2
Dairy cow		550	100	19.2	96	1.8	2.2	2.6
Dairy cow		450	100	15.3	76	2.2	2.8	3.3
Dairy heifer replacement	>2 years	500	100	11.7	58	2.9	3.6	4.3
Beef suckler cow[9]	>2 years	500	100	11.7	58	2.9	3.6	4.3
Bull beef	6-13.5 months	300	60	4.8	23	7.4	9.1	10.9
Sheep								
Adult ewes	>1 year	50-70	100	1.5	9	19	23	28
Lambs[6]	0-6 months	4-40	50	0.2	1.2	140	175	210
Lambs[6]	6-12 months	30-50	50	0.5	3.2	53	66	78

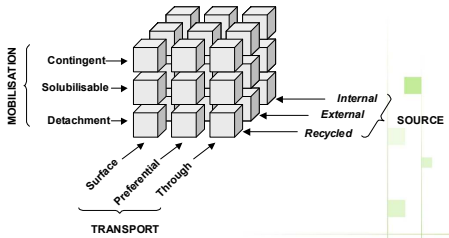
Figure 3

BUT THERE ARE MORE SOLUTIONS!

agresearch

- **Based on a large body of previous research**
- **44 mitigation measures**
- **Cost-effectiveness on N, P, FIO losses**
- **Field effects**
- **Also expressed as an average across representative farms**

Fertiliser
Soil
Crop
Animal
Manure
Farm structure



Chadwick et al. (2006)

Cuttle et al. (2006)

Figure 4

This gives some idea of the environment that the UK are working within in the NVZs. Rules that are input based but there are a lot more solutions out there, and we have heard about some of them at this Symposium. My colleagues and I from ADAS put together a compendium of forty-four mitigation measures, trying to estimate their effectiveness; we found what that measure actually meant, estimated its effectiveness to farm scale and then put a cost on it. The list is going to have to be increasing all the time as new mitigations become available (for example, we did not include nitrification inhibitors).

Figure 4 shows the mitigation measures for fertiliser management, soil management, crop/animal management, farm structure, wetlands, constructed wetlands, etc., very much think along the same lines as New Zealand. The study tried to identify where those mitigation measures and the main point of action was. Was it in terms of whether it was

pollution detached from the soil, whether it was solubilised, coming from the internal soil core, from manure, or from fertiliser? Having that layer of understanding of mitigation methods helps when we look at different ways of using mitigations on farms and then developing policy.

It is a requirement by the UK Government to either bring environment economists or treasury people onto the projects to give the financial dimension. Kit Rutherford mentioned that if you achieve five mitigations that are 20% effective then you have solved the problem. Of course you have not if they are all acting on the same source of nitrogen. We use a multi-faceted model to calculate effectiveness. If you look at the cost-curve calculations in *Figure 5* you see that some mitigations can be highly effective at low cost and those are the ones that tend to be used first.

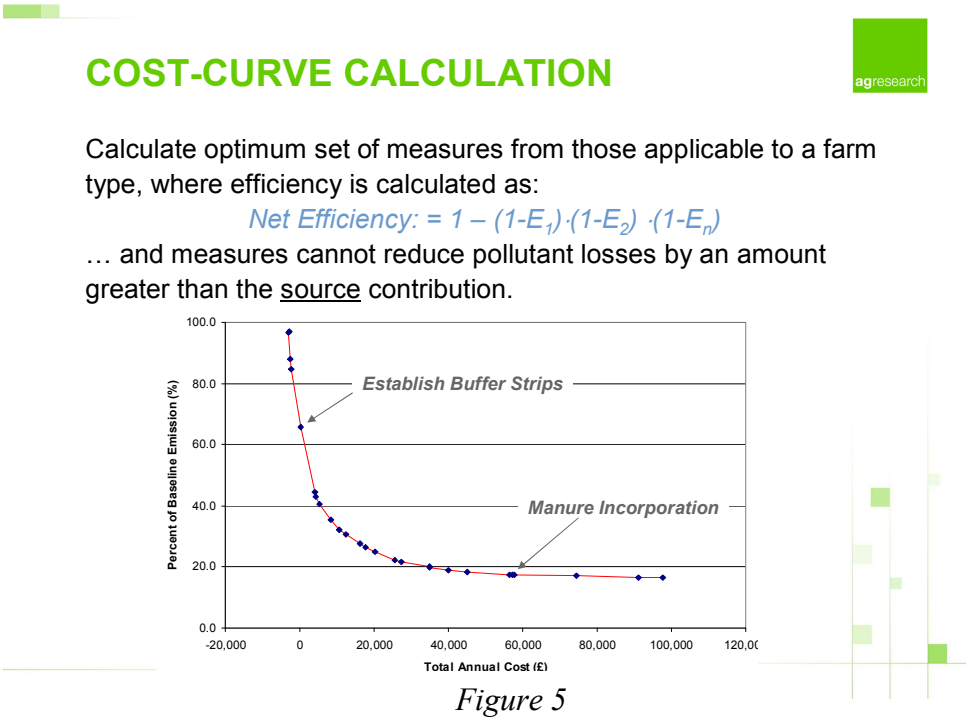


Figure 5

In a farm model with the information I have presented, (*Figure 6*) you have a collection of mitigations together, for example, driven by a nutrient management plan; it brings in 12 of the list of 44 mitigations, the added effect on a model dairy farm might reduce nitrate by about 17% but it would cost about €7,000 (about $20,000). This is a way of looking at individual farms and a collection of mitigations put together, but we can also take that approach and scale it up to look at catchments on a national scale.

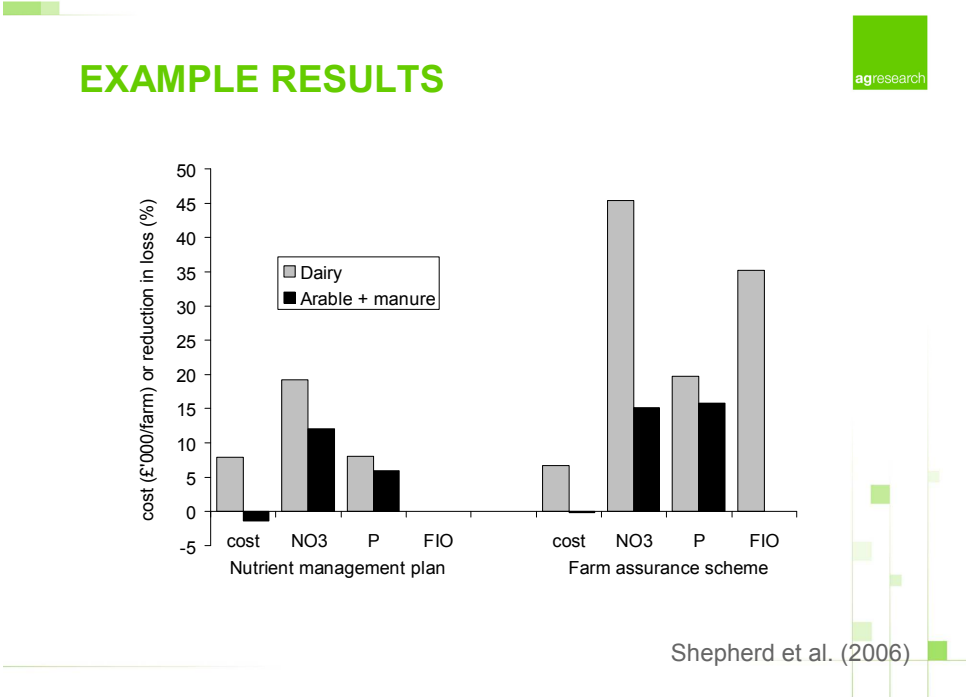


Figure 6

Implementing Solutions

This is the challenge we have now. We have the tools to reduce losses; it is getting them up and working in a fair and equitable way. There are a number of approaches we can use, i.e. a mix of policies.

The Policy Mix

- Voluntary (uncompensated) without external pressures
  - e.g. advice to adopt good practices
- Voluntary (uncompensated) with external pressures
  - e.g. taxation, compliance with Product Assurance Schemes
- Voluntary (compensated) schemes
  - e.g. Sensitive Area Schemes
- Mandatory (uncompensated) schemes
  - e.g. regulations such as agro-chemicals approval, nutrient planning, farm licensing
- Mandatory (compensated) schemes
  - e.g. environmental plans

Interestingly, I have not included nutrient trading on the list, though it is something being considered here in NZ. It has been considered in our policy work in the UK but was set aside as an option (though it was targeting P rather than N). The big question is what sort of mix of policy tools do we need to achieve the required water quality targets? To answer this, it is important to understand in a catchment what drives the farmers. It is encouraging from our surveys that the main driver for change is concern for the environment. (*Figure 7*). But it is not the only one and there are a whole range of drivers, some more important than others.

What are the barriers to change? Two things that are probably not so surprising are cost and lack of time. In *Figure 8* we asked farmers and private consultants who work with farmers separately, and interestingly in every case the advisers seemed to put a more negative spin on it than the farmers themselves. 60% of the advisers saw cost as an issue, 40% did not.

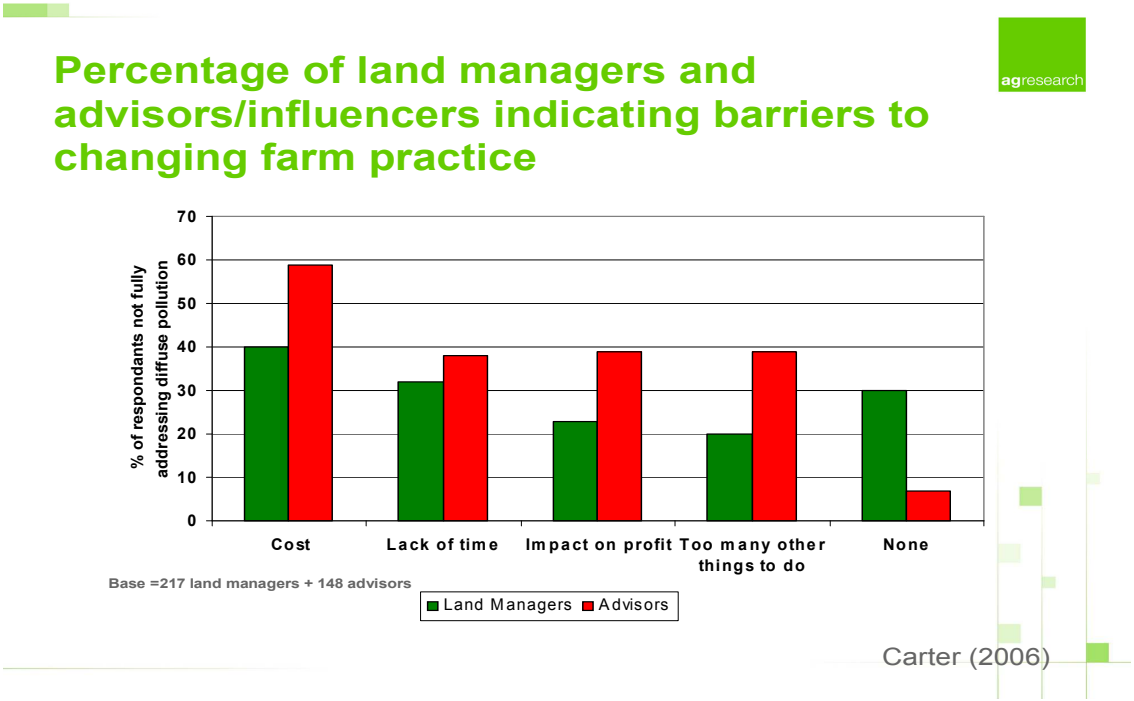


Figure 7

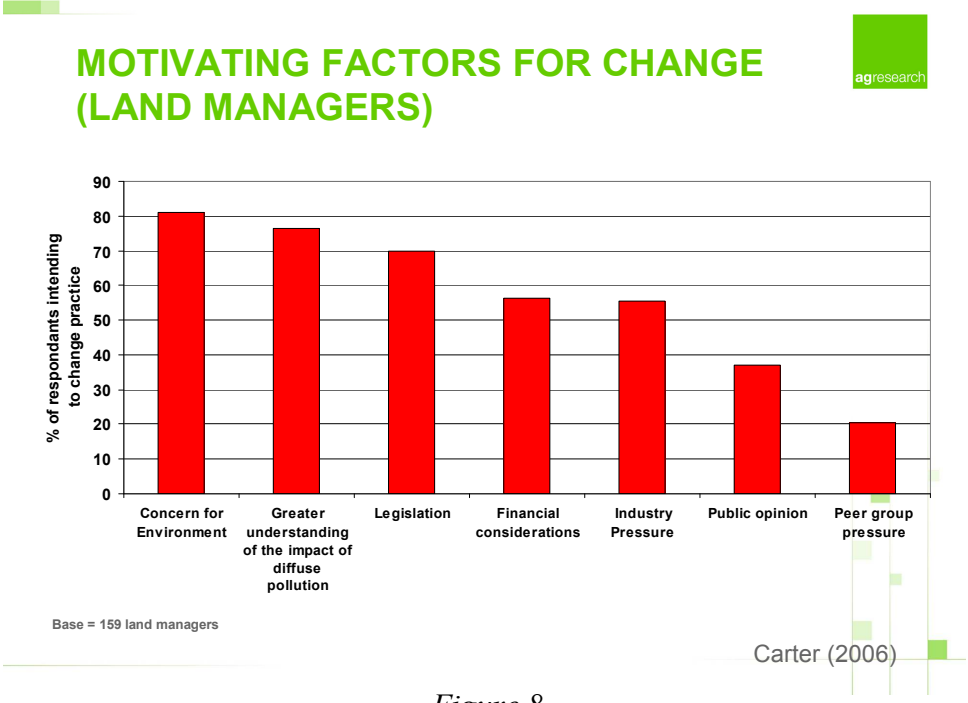


Figure 8

A policy analysis of the Catchment Sensitive Farming (CSF) initiative, described earlier, looked at policy measures for the best ways of bringing about change. We can take our mitigation measures and scale them up to a national level and look at the cost and effectiveness of different policy mixes. This is a scientific approach because the diffuse pollution models are driven by science, natural science if you like. However, to use these models to investigate the effects of policies, we need to apply expert judgement on how each policy would actually encourage uptake. We are having to use expert judgement, a whole range of experts, a whole range of surveys to say, if regulation is in place, which mitigations would it impact on and what would be the likely effect of the uptake. With

regulation, for example, we might expect uptake of a mitigation measure to be 95% but if it is voluntary action it may only be 20%, depending on the cost. It is crystal ball gazing but backed by good natural science as well.

Figure 9

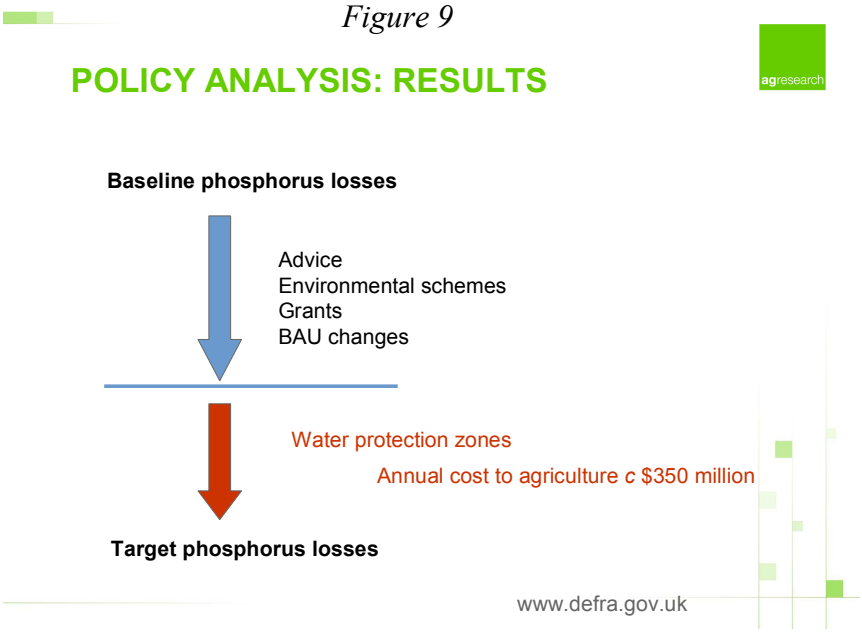
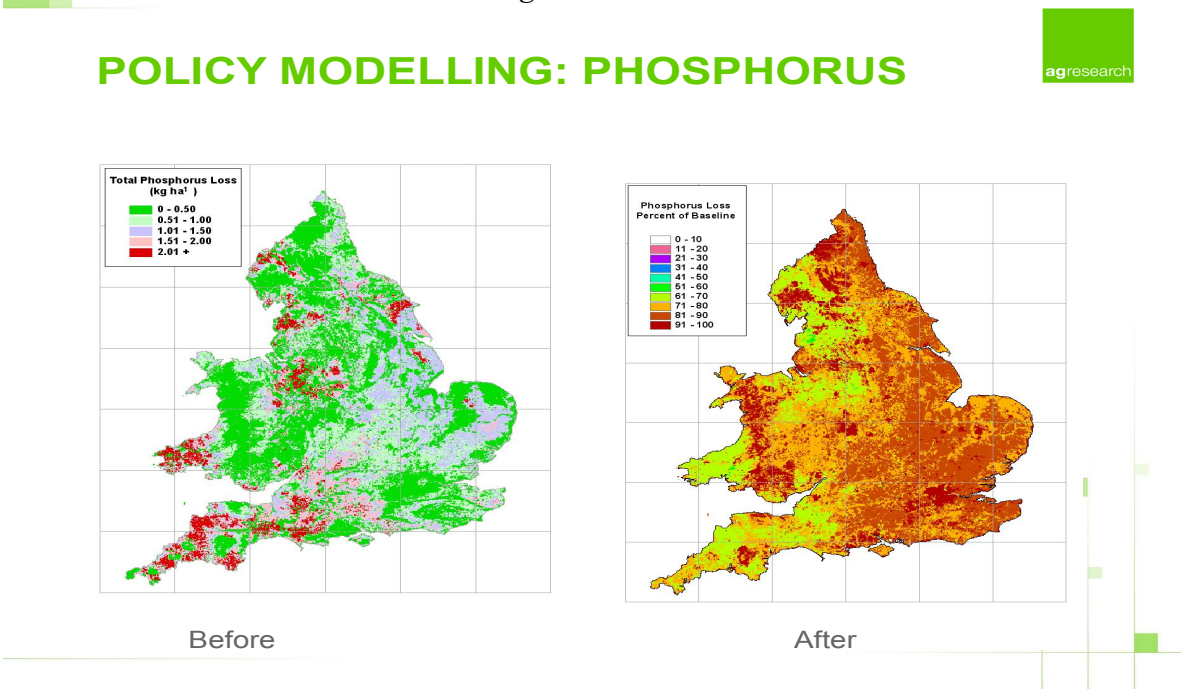


Figure 10



If you apply this approach at a national scale and on the individual catchments, you can come up with calculations like this example for phosphorus. (*Figure 9*) The red and orange represent an example of the losses as a percentage of the base line after we have applied a whole range of policy instruments. We are only expecting a reduction of 10-20% in phosphorus losses across the country; but in fact the target we were trying to get to was nearer 50%. (*Figure 10*)

Cutting to the chase, we concluded that if we have targets to meet, a gap between our base line in what is happening now and where we need to be to improve water quality, we can get some way toward it by using a mix of advice, environmental schemes, grants and

what is called “business as usual” changes. There are going to be changes in agriculture anyway due to world movements, European policy, changes in livestock numbers, etc. If we factor them all into where we need to be, we get a substantial way towards the target. But the conclusion was that we would also need some level of additional regulation, in this case Water Protection Zones, to get as far as we needed to be to meet the targets that have been set.

The message yesterday from Professor Jeppesen on the European case, was that we can get so far with voluntary schemes but it is that last bit than can hurt where regulation may need to be involved. A Water Protection Zone is a regulation that DEFRA is now looking at using.

- The objective of a Water Protection Zone is to **restrict or prohibit activities** that can cause water pollution within a particular area.
- They can be used **at any scale**, whether it be at a multiple catchment, catchment or sub-catchment level.
- WPZs also have the potential to target almost **any pollutant** and any polluting activity across any **business sector**.
- With regard to agriculture, a WPZ could be used to:
    - restrict manure applications at high risk times
    - prohibit tramlines during winter to reduce phosphorus loss

On the DEFRA website www.defra.gov.uk there is a lot more information about it.

Monitoring effectiveness
This is all about evidence. We want to demonstrate change, we want to demonstrate that the actions that are in place, often at large expense, are bringing about change. How do we actually monitor that effectiveness? Yesterday, Stewart Ledgard said that monitoring water quality looking for a possible trend is very difficult because of the natural variations between seasons and years. We have an example of a river in the UK in the north-east which is showing nitrate concentrations (*Figure 11)* seasonal patterns with high concentrations in the winter, low in the summer and as we go along it is very difficult to see any trends there because of the seasonal effects. If we convince ourselves we can see a trend we can probably see a reduction in nitrate levels in the two years 2002 - 03. That coincided with a foot and mouth epidemic in the UK, so that catchment was destocked. So, a rather extreme measure was required to bring about an observable change in the short-term.

There is a range of tools that we can use to judge effects, no one on its own will provide all of the required information, but we can use a combination of approaches. One is the use of farm statistics and farm practice surveys. In the UK, there are annual farm censuses and regular farm practice surveys. These generate much information that we can use. This approach helps understand agricultural practices and we can summarise those statistics and apply them in farm models. We can also use the information as

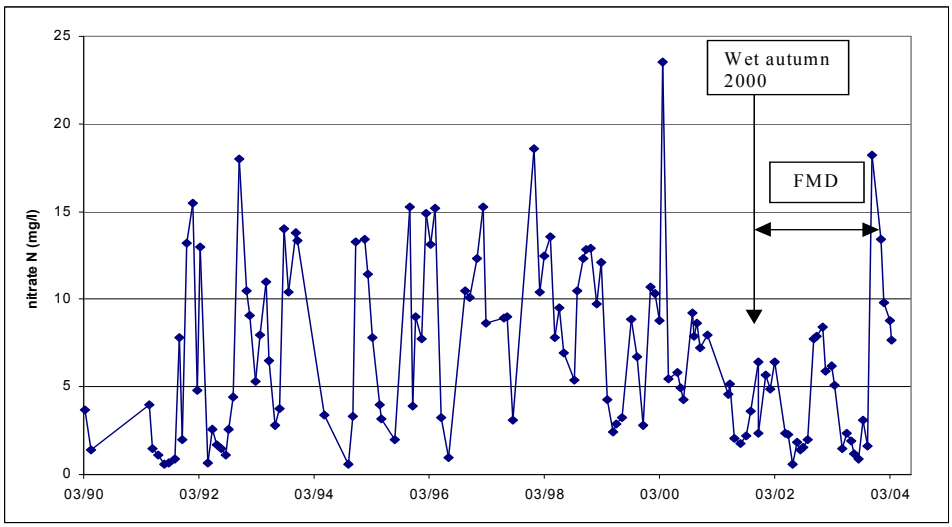
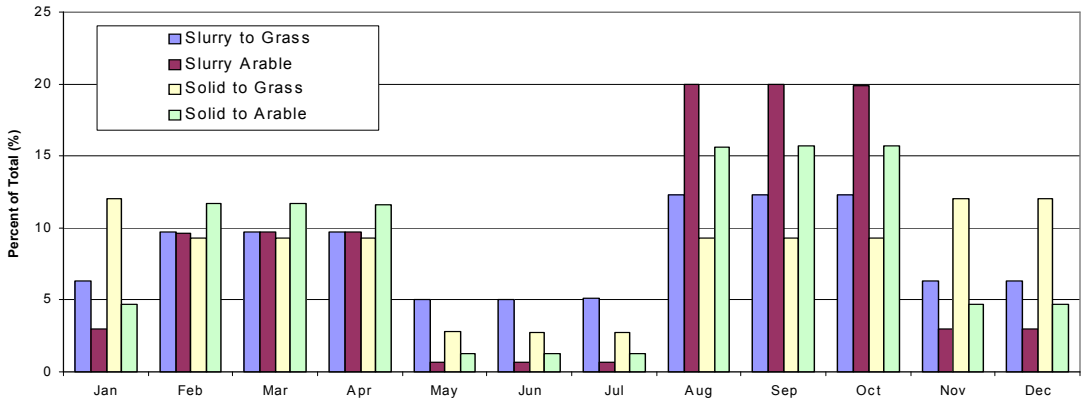


Figure 11 – Nitrate Concentrations in UK River

evidence of change. In *Figure 12*, a graph of nitrogen fertiliser use on grassland before the NVZs were introduced, and after, shows that nitrogen use on pasture decreased after the introduction of NVZs. We cannot say that the two are directly linked, but we can collect the evidence such as in this graph and say that the catchments are changing and we can factor that into our models and calculate the likely effects on water quality. (*Figure 13*)

Figure 12 – Statistical Farm Practice Data



We can also undertake farm monitoring (*Figure 14*), for example with a network of sites monitoring drains, ditches and streams. This is useful for two reasons. First, it provides evidence of the nutrient levels leaving agricultural fields. This is useful as part of the evidence base but the main benefit of a network of measurements is to support the development of nutrient loss models.

This is because the only way we can look forward at the effects of the practices that we are implementing now is to have good robust models linked to farm practice data, and combining these will give us an idea of what we can potentially achieve by implementing various sets of measures. This assessment needs to be made right at the start of the planning process by asking “what if?”. What if we do this and it has this impact on land management changes? How far can we get towards that target?

Figure 13

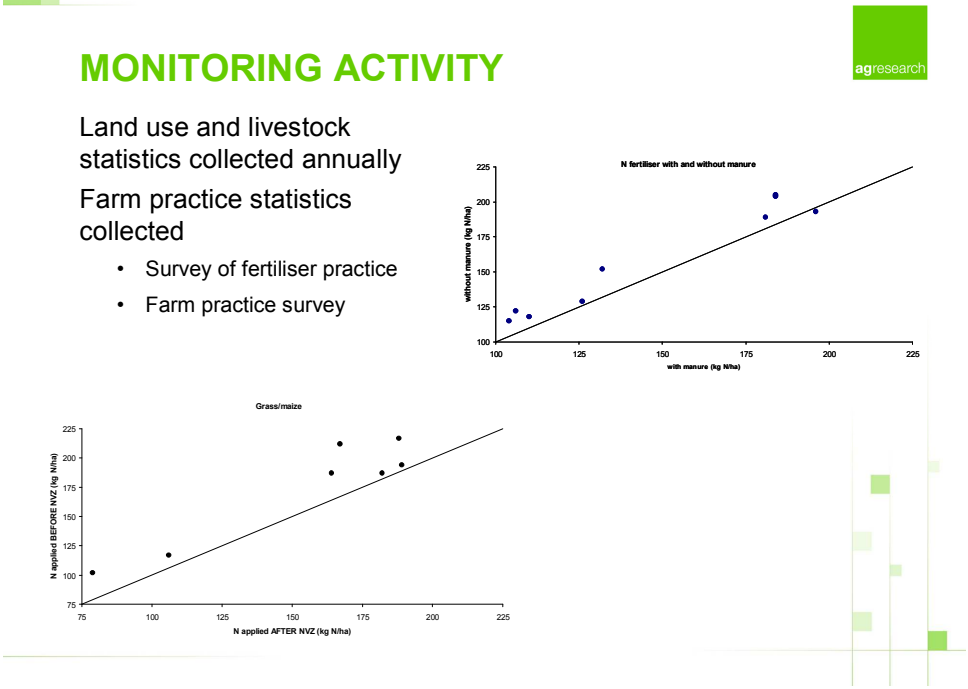
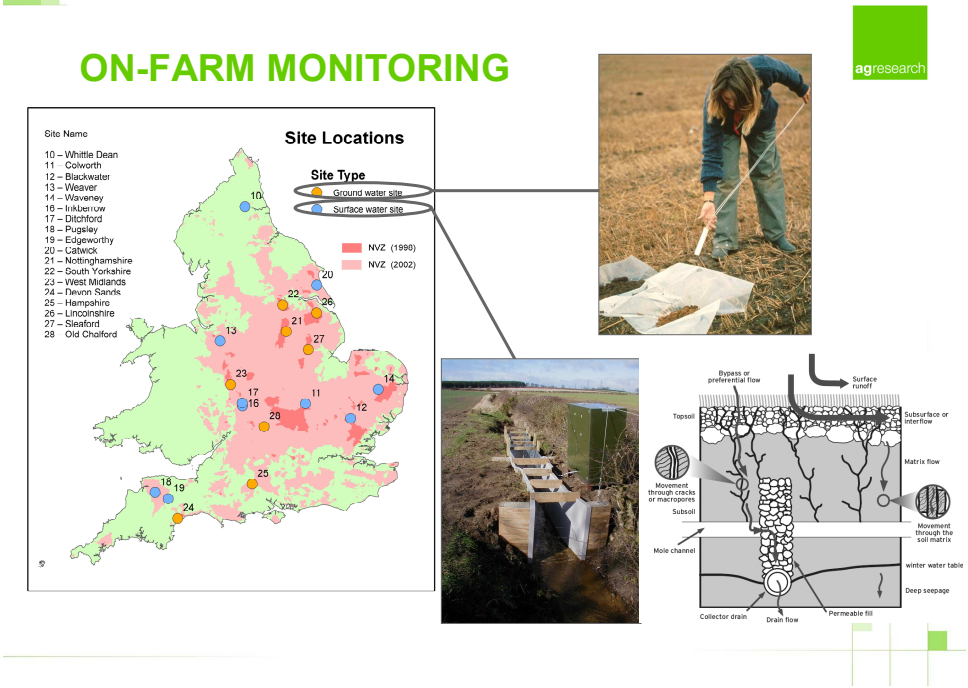


Figure 14



Implications for Taupo and Rotorua?

These are some of the issues that we have covered in the UK. How does that fit with the approaches that are being used and could be used for the nutrient sensitive zones in Taupo and Rotorua? My observation is that I have moved 13,000 miles across to the other side of the world and, actually, it is exactly the same issues as in Europe! What we have heard over the last two days are the same issues that we have been wrestling with in the UK. The starting point is source apportionment. We identify points of diffuse sources, we tackle point sources and recognise that diffuse sources are the next

challenge. We develop the evidence base to support that hypothesis and it is clear to me that the way forward is to work with stakeholders, and it has to be that way if we are to get changes at a catchment level.

There have been lots of discussions about what the policy tools are that we use; have we got them right; is it going to be enough to make the changes? That debate is on-going everywhere. It also seems to me that resources are an issue although the amount of money that have been spent in NZ is quite remarkable and obviously recognises the importance of the lakes here. When you bear in mind the catchments within the UK, the catchment where farming was an issue had a budget of about €50 million for two years, and that covered forty catchments. It strikes me that one of the issues is how to assess effectiveness; how to know that you are going to get to your target and how long it will take.

I have come here and see lots of positive things that I wish we had thought of when we were looking at diffuse pollution policy in the UK.

- Not a farm-level emphasis in the UK?
- UK approaches input based and less scope for innovation
- NZ looking at more innovative mitigations
- An output ('result oriented') approach potentially provides more flexibility

NVZs tend to focus on a regulatory approach, I suspect, because of the sheer size of the NVZ areas. Thus, the UK approaches tend to be about limiting inputs; although if we look at water protection zones they may be more imaginative in the mitigation measures that will be put in place.

I have borrowed a phrase from German colleagues on the WAgriCo project (Water Resources in Co-operation with Agriculture'). It is a 'result oriented approach' that you are using here, saying this is the amount of nitrate that is leaching, this is the amount allowed to leach and how do we make the reduction? If we rely on regulating inputs, we lose the flexibility to manage diffuse pollution. I also think the Overseer® nutrient budgets model is a valuable tool. The NCycle model in the UK developed by the Institute of Grassland and Environmental Research (IGER) is the nearest thing that we've got to Overseer, but it's not really being used in policy support. Overseer is a great planning tool and an education tool because if you can say my management practices are such and this is the result of that, then you can start to look at 'what if' scenarios. It has also been used for benchmarking, a slightly different approach, but again it is innovative and a really valuable approach. Obviously, Overseer is a good model but we should not sit back on our laurels here because there are still lots of challenges ahead; it is keeping the science up to date, making sure the model robust. If it is going to be used in a regulatory role you've also got to think about how to use it and how we train people to use it to the same standard. Its philosophy was always to be simple, using inputs the farmers could provide. But even then there is still a level of interpretation between checking farm records and putting it into the system.

There are still plenty of things that we need to do to get Overseer and similar models working for us in the best possible way. That involves the science because if we are developing new mitigation methods we have to put those into Overseer as well. Wetlands have been added this year and there is a programme going forward to bring in other mitigations as the science allows us. I am not known for my optimism but at least here in New Zealand different things are being trialled. Examples of these approaches: work jointly with Lincoln University on how to manage nitrification inhibitors and the effects of different soil types and different climates. Inhibitors were looked at 15 year ago in the UK but the regulators did not like them at all because of their concern that the approach might

not be foolproof. They need something that is not going to create more of a problem if it gets misused, and that may be the challenge here also.

Figure 15 from Stewart Ledgard shows the whole range of potential mitigations that we could use. If we just say regulations are going to control inputs, we lose many of these other approaches. So I commend the approaches that have been taken here in terms of giving more flexibility to the system, looking at a results oriented approach.

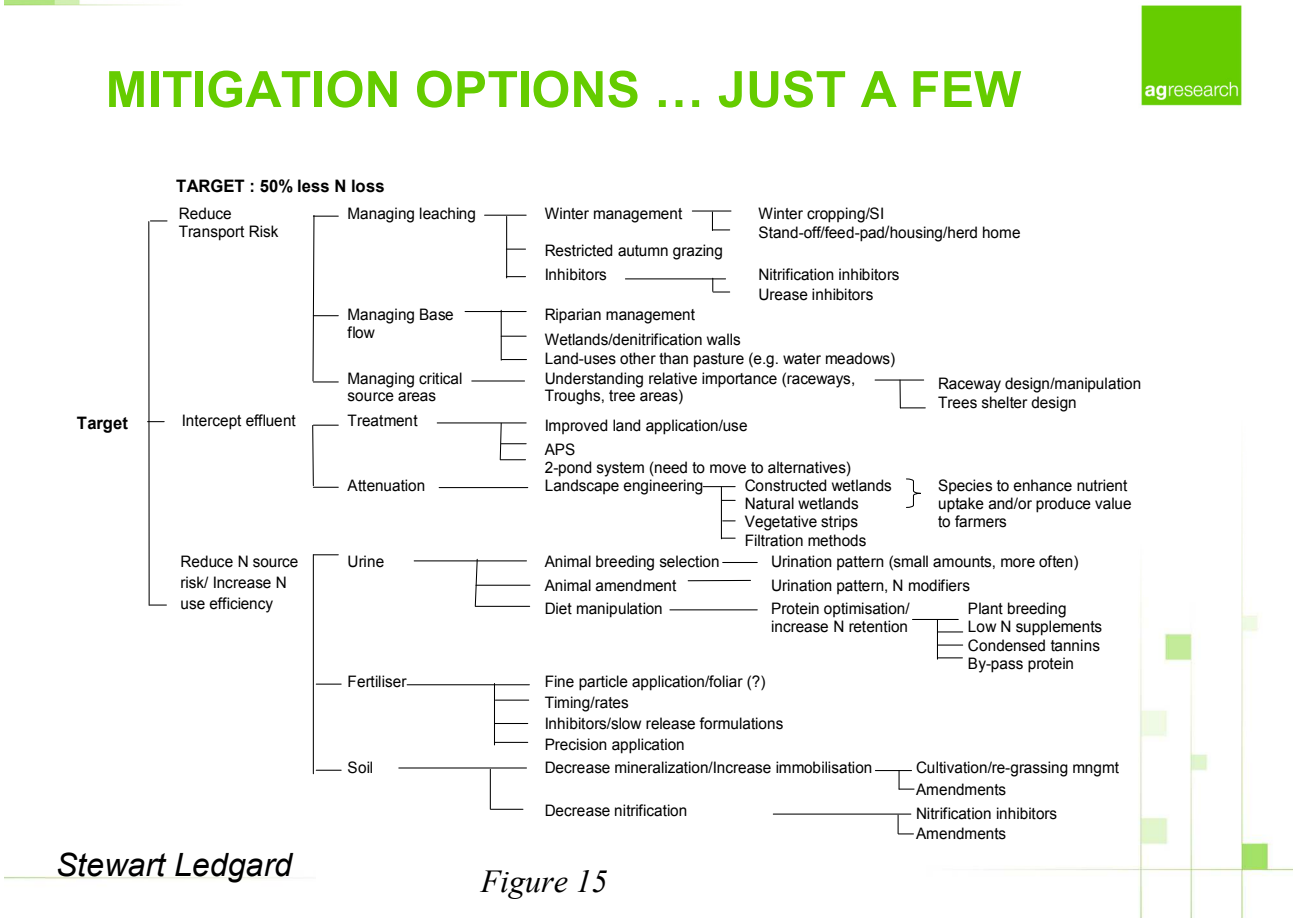
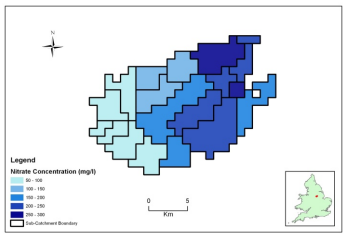


Figure 15

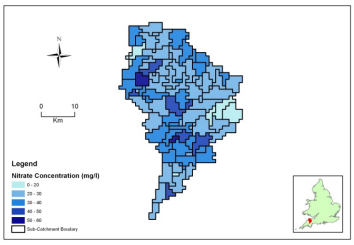
The biggest question that we all ask is 'can we get to where we need to be?'. Can we have intensive farming and can we meet water quality targets? I think the consensus in this modelling project we did (*Figure 16*) shows the outcome that if we just use the policy tools that we have now, the expectation in the UK is that between now and 2015 we will at best have a 5-10% reduction in nitrate beyond where we are now. That is because we have done a lot of good work already so the challenge is really how we make that 5-10% in some catchments bigger. (*Figure 17*) The same debate that is going on here.

Figure 16

WILL IT BE ENOUGH?



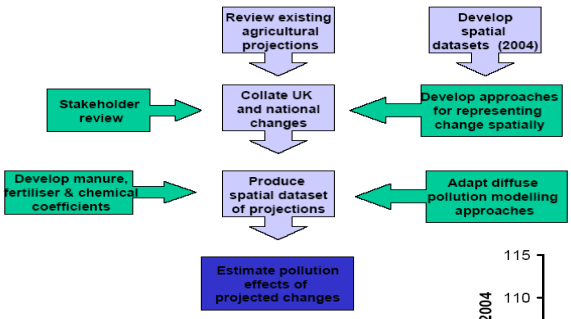
	N Leached (kg/ha)	Nitrate Concentration (mg/l)	Average Reduction (%)	(%)
Baseline	58.4	147	-	-
Do not exceed crop N requirement	54.6	138	6.5	1.7 – 20
Closed period PLUS do not exceed crop N requirement	49.6	125	15.0	1.9 – 23
10% Fertiliser Reduction	54.1	137	7.4	4.0 – 11.7
Remove all Manures	43.3	109	25.9	5.8 – 37.4

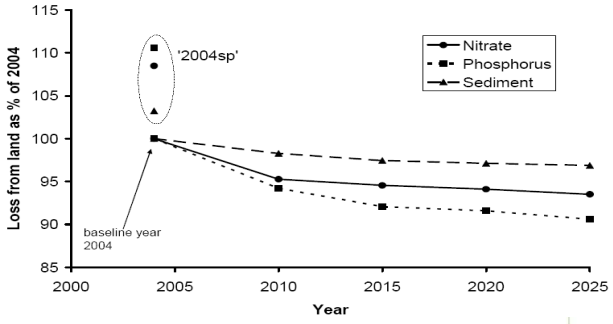


	N Leached (kg/ha)	Nitrate Concentration (mg/l)	Average Reduction (%)	(%)
Baseline	23.0	29.3	-	-
Do not exceed crop N requirement	22.7	28.8	1.5	0.1 – 5.0
10% Fertiliser Reduction	22.4	28.5	2.7	0.5 – 5.4
Remove all Manures	21.0	26.7	9.0	2.7 – 27.5

Figure 17

WILL IT BE ENOUGH?





In conclusion, I almost completely sidestepped what a nutrient sensitive zone will look like in Taupo and Rotorua! It is quite clear, however, that a lot of what we are doing is very similar between the UK and here.

- Tackle ALL major sources
- Diffuse pollution requires a multiple barrier approach
    - Source control – stopping nutrients leaving the fields
    - Transport control

    - Attenuation
- The right policy mix to achieve this

Will it be enough? Scenario analysis – and time – will tell.

The approach has to be a whole range of techniques, not a silver bullet but a silver shotgun cartridge with lots of pellets. These little pellets individually will get some way in some catchments; and in some catchments, the additive effect of all these pellets will be to get to the targets (but not necessarily in ALL catchments). The right policy mix will help to achieve this. It is also a multiple stakeholder engagement that is absolutely critical because it cannot all be done by regulation alone. I think that should be the last resort.

One last point. We looked at a whole range of catchment projects across the UK, Europe and USA and saw what lessons we could derive from those catchments. We studied 25 catchments and the key points coming out of it are that successful catchment projects have all of these attributes:

- Strong leadership
- Long-term commitment
- Objective setting
- Mix of methods and measures
- Public participation/mobilisation of volunteers
- Need for sound technical/scientific support
- Monitoring & reporting progress?

Strong leadership is essential, somebody or a community to drive the process, to have a vision, to set objectives and provide a long-term commitment. A whole range of approaches in terms of how you think about the change, so the mitigation methods that you use and also the policies and tools that you use; a diverse mix of approaches. Public participation, and the good news for me is the need for sound technical and scientific support. As I already said here right at the start, without that we would not be able to make the progress that we have made here already on these lakes. It is interesting that while those projects were absolutely fantastic in the first part, it always came down to the variable reporting and monitoring of progress, and for me that seems to be the big challenge – determining effectiveness.

Thank you.

Session Eight: A time to focus – Where to from here?

OPEN FORUM – DELEGATES DISCUSSION

INTRODUCTION

Ian McLean, LakesWater Quality Society: It is my pleasure to introduce my friend, the Right Honourable Simon Upton – Rhodes Scholar, distinguished parliamentarian, midwife to the Resource Management Act and Chair of the Round Table on Sustainable Development at OECD - a paramount New Zealand environmentalist. Simon, we are very glad you are here.

Session Chair, Right Honourable Simon Upton: Thank you Ian. Thank you for your welcome. As you have heard, I am Simon Upton and I am the person who Professor Memon yesterday told you took back resource management in New Zealand ten or twenty years. Let me tell you, I was completely unaware at the time of the extraordinary influence that I apparently had. Given the reluctance of regional councils to tackle many of the effects of land use that worry us, you might have thought that my influence was negligible – but there we have it.

I would like to make one comment before moving on and that is regarding Professor Ericksen's comments this morning which I thought were pretty accurate on the RMA. I think he was much closer to the mark that there was a very significant under-resourcing of the Act once it was passed. It had been years in gestation and I took it over halfway through from Geoffrey Palmer. We said yes, yes, yes, we will pass it into law, and we did pass it into law. I was part of a Government that was in a fiscal crisis but I think, much more honestly, did not have in it's DNA an interest in environmental policy.

It is never easy being an Environment Minister in a National Government, I can tell you. But having said that … sorry Nick! Having said that, and Nick [Smith] is one of them – there have been some very committed individuals, and Ian Shearer was another – but having said that, money and people are not a passport to success either. When I left that Ministry there were 100 people; there are 262 today and I am told three or five are water specialists. All that money, all that resource, all that time and I do not think we are any further ahead.

We should be wary of simple suggestions such as "who is responsible for what". It is very tricky territory and that is why we are having this question and answer session, because you have listened to a lot of expert people speak most interestingly. I asked if I could come and listen and Ian said, "only come if you take part", so I have drawn the straw of chairing this session. The aim is to give you, the audience, a chance to raise questions about what you have heard, to challenge some of the statements and get feedback. You can not spend more than thirty seconds asking a question – I will cut you off. Sort your thoughts out and get the question crisp. To the speakers at the front, please keep your answers to two minutes. I want specific questions to specific people.

This is the LakesWater Quality Society Symposium and they have done a fantastic job providing us with the opportunity. I think it is their right to steer the discussion in directions of interest to their hearts. I have three questions from them and will take the first one from John Green in a moment, but it is not stage-managed and the questions are designed to open things up.

John Green, Chair, LakesWater Quality Society: This question is for Guy Salmon. There has been quite a bit of criticism on the National Policy Statement (on Freshwater Management); what would be the changes in the Statement and the process to make it work?

Guy Salmon, Ecologic Foundation: First, on the process – I must say that my studies in Scandinavian countries have persuaded me that it is worth getting a process that involves directly negotiating between the primary sector and environment interests, and fortifying that with technical expertise from professional societies. The aim would be to get agreement on some words that could go in a National Policy Statement which would be dropped directly into every regional policy statement in the country, basically directing regional councils to set their own targets for the various water bodies in the area, but ones which met a national objective of waters being fishable, swimmable and ecologically healthy and with a date on that.

Secondly, setting up a process by which industries or farmers in a catchment who felt they could not meet that target to apply for a longer time period – a sort of protracted polluted status. That would be the proposal I would suggest but it would be one for negotiation, and we would find out very fast to what extent the primary sector in this country is willing to face up to the challenge of the way we market our produce, which is clean and green. I believe there are quite a few people in the primary sector who would rise to the challenge and I would like to have a crack at negotiating with them.

Simon Upton: Thank you. Guy, just to be clear, if you were the Minister tomorrow – the process has been launched now, it has been started – you would take back a bit of it and rewrite it, would you?

Guy Salmon: If I was the Minister I would put the thing on hold and ask to speak to groups, if they could spend twelve months working together.

Simon Upton: Does anybody want to comment on what we need to do to make this National Policy Statement really worthwhile? Does anybody want to disagree with Guy? Does anybody want to raise a view about whether this is a process that is going to add value? Is Gary Taylor still here, he had some views on this? No.

Sally Brock, LakesWater Quality Society: I have been involved in the Rotorua/Rotoiti Action Plan and involved in a collaborative approach with farmers and other stakeholders in that process; and I have to say that three years on we are no further ahead in terms of coming to some sort of agreement about environmental standards and the primary sector wanting to make changes voluntarily. I want to know how you intend to change people's human nature in terms of the protection of their own private interests?

Simon Upton: Does the National Policy Statement as it is proposed provide enough effect to give you confidence?

Sally Brock: No.

Simon Upton: Does anybody here think it does? Some of you must have read it. The counter argument from some of the environmentalists is that the process is completely wide open and it can all turn to good. Nick [Smith], you would like to be the Minister. Has it got enough in it? Could you turn it around in a way which was favourable, in your view, reasonably easily?

Honourable Nick Smith: There are two concerns with the National Policy Statement. One problem is that it is so woolly-worded and a problem there to do with the failure of the RMA is there is too much of it. I think if we pile up all the regional and district policy plans they now top about 8 feet, and are perhaps more woolly-worded. The second concern is the timeframe to deliver it. Even with a National Policy Statement and the flow on to the regional policy statements, by itself will not do enough. The level of criticism of the Draft NPS would send us down the track of wanting to start afresh, rather than to put it out as a

Government statement, as something that we do not honestly believe in. So if National is successful later this year, we would want to go back. We are having a Water Forum next Monday and that will be one of the issues we will talk about. One of the things I will put into it is that we need to start with a new draft rather than work with something that is so deficient.

Simon Upton: Anybody here from the regional government sector who would like to add anything here? We waited fifteen years for this; it is a pretty important moment in New Zealand's Resource Management history.

Bill Bayfield, Chief Executive, Environment Bay of Plenty: In reply to Sally, we have been looking for stronger direction ever since the Act came out. The absence of a National Policy Statement has cost us hugely and has definitely contributed to that pile of documentation. I think there are certain parties with whom it is best to negotiate nationally and that is why I like the model of collaboration. Certainly on a local basis when negotiating with farmers or individuals that Sally talked about, self-interest overrides very quickly and very easily. To me, the more direction we have in this country at the moment, given the problems we face, the easier it will be for me to then subsequently negotiate within the communities with flexibility around the individual communities and individual lakes. You can not set targets for all twelve lakes but you can say that there must be targets and they must address the following matters and that they are agreed by all parties before we start.

Simon Upton: Do you want to hazard a quick shopping list of the key parties that you would involve in that negotiation?

Bill Bayfield: Yes, because we are all thinking about the primary sector and that is fine. You have to look very closely at how wide the primary sector is and make sure you have all the key big players. It is not just producers from the land, it is the companies you are dealing with, the people that own the value of the food chain right the way through. I also think when you have a conversation like that you have to make sure the funders are involved, which means you have to think very carefully about what the funding sources are and ensure you have the people in the room who are eventually going to bear the cost.

Simon Upton: So the thread coming here is that there needs to be some sort of pre-negotiations to get something a bit more concrete at the front end. Does anybody disagree with that idea?

Sue Edmonds: One of the things that came out of the EDS Forum in July was the creation of a Land Use Sustainability Forum. That has yet to have its first meeting, but it would seem to me that that sort of organisation is where this sort of Policy Statement ought to go first, because a lot of people have already signed up for it so we do have the kind of national coverage we were seeking.

Rowland Burdon, Royal Society of New Zealand, Rotorua Branch: I would suggest to add to Bill's brief list members of the science community as well, and science institutions.

Don Atkinson, LakesWater Quality Society: Can I just add a comment too that the tourism industry is a major factor within this industry – they are the biggest drivers of our economy, and we miss them out so frequently.

Simon Upton: Yes that is a good point, particularly in this region here.

Professor Neil Ericksen, University of Waikato: I would like to ask Guy if he thinks that there is anything concrete about the Nordic countries in the way they have approached

this at a national level; in other words what works there and do you think it would work here in New Zealand? I like the idea that you are suggesting because I agree with a collaborative approach and I think you are probably going to come out with a stronger, goal-oriented national plan than you might if you simply rely on the way we do it now.

Guy Salmon: Well, we did do quite a detailed comparative study and we drew the conclusion that the Nordic countries are in most respects the most similar countries to New Zealand that we could latch on to. We tend to compare ourselves with Australia and Great Britain but really the small Nordic countries with their proportional representation systems and their strong local governments are much more similar to New Zealand than those other English-speaking countries. There is one difference, though, which is worth reflecting on and that is that in the Nordic countries the stakeholder organisations like Federated Farmers or Forest & Bird tend to be larger, stronger, better respected and much more accustomed to playing a mediating role in these kinds of discussions. I worry a little bit that in New Zealand those organisations have declined over time and are not as widely represented as they once were, but they do provide the key to making this collaborative approach work. It is the chicken and egg situation. People would rejoin those organisations if they knew that they are doing something really important.

A lady just a moment ago asked how we get the primary sector to take this seriously enough to make any compromises? What we found when we interviewed these people who had participated in collaborative processes in Sweden, Denmark and Finland, was they had about three strong motives to compromise. One was, and this was the most important one, they felt that if they offered a compromise to the other side of the table and the other side exchanged a compromise back with them, that the elected decision-makers would implement the deal that had been made around the table and that was a very powerful motivator. There were a couple of other factors, one of which was desire for durability. When you are talking about long-term policies like superannuation or environmental policies, you do not want to have it flip-flopping every time there is a change of government. That was another motivation for compromise. And the third thing which was important was a sort of feeling that whatever was negotiated was constrained strongly by public opinion. I found that while the organisations often had quite extreme views, their stance at the negotiating table was strongly tempered by what they felt would be more widely acceptable. On that basis I have some optimism that both sides would find centre ground if they were actually empowered and were not just placed in a situation of being adversarial challengers, as our present system does.

Professor Ali Memon, Lincoln University: I agree with what Guy has said but I would be concerned if the negotiation process was limited just to the environmental groups and the farming industry. I think any deliberations that take place at a national level, regional level or local level have to be representative of all sectors of New Zealand society.

Simon Upton: But how is that possible in a practical sense given that we know that there are some big issues that are focussed around particular sectors? Can we always try to be perfectly representative at every level or is it worth taking some of these things to one side and then feeding them back into the process?

Professor Memon: It should be a two-way process - a top down process and a bottom up process.

Simon Upton: From a farming point of view you have heard the criticism of the NPS. How do you feel about it?

Gifford McFadden, Federated Farmers: I feel that a whole lot of people are talking in theories and have not got any experience actually; that is what I feel. Three months ago we wrote to those we saw as interested parties in the Upper Waikato – Iwi, Fish & Game,

Forest & Bird, Ecological Society and EDS, forestry, energy companies and farm converters – and asked them to come to a meeting. We said what we would put on the table: make the river fishable, drinkable and swimmable. Now this is what everybody is talking about as impossible to do. The only stipulation was Federated Farmers were running it. We had not been very happy about how Taupo went, so the Regional Council was not allowed and there were no regulators there. They all came and a second time and wanted to work with us. It is not a big deal.

I think you are going to have to solve these issues at a local level. You can not set targets at a national level. There are differences and you are going to spend time arguing whether it is the same type of stream in Western Bays or Hinuera or somewhere else. There are more problems with this and you can make it very difficult or you can make it very easy. What would be very easy to me is if we accepted Environment Waikato's leaching standards for stock in Rotorua. We have not come out with absolute responses at this time but we are a long way towards it and we have the process to do it. But if you think you just tell farmers goodbye like they are talking about in Taupo or anywhere else, that is not going to happen. We tend to talk and fight. We have mechanisms for raising funds with the Dairy Board levy and Meat and Wool levy, so if someone wants to go to the Environment Court, we now have the funds to go there. Before we had to negotiate very hard so we did not end up in there, but we do not want to go to the Environment Court.

The CEO of Forest & Bird in Wellington said the same thing – what is the point of going to the Environment Court when we can spend our money talking together? It is a lot cheaper and more satisfactory. We had Fish & Game in our group, not because we saw them as a major player, but in the Upper Waikato it is hard to find public, non-primary industry groups that you can approach, so we approached Fish & Game, and like Rob Pitkethley said today, he has to represent all recreational people. The big difficulty is finding local groups that will work. The rule of our meeting was that we would not take individuals, only come as a group. We are not interested in listening to individuals because individuals have no responsibility to a group. That is the most important thing about these meetings, people who come have a responsibility, their fellow members have a responsibility to keep them under control and a responsibility for their behaviour. That makes it very relevant to meetings so they do not get extreme.

Simon Upton: We have only got two minutes, can you just tell us in one sentence, is your position that we do not need a National Policy Statement, that it really should be left entirely regional?

Gifford McFadden: When it comes to Federated Farmers, they are very small fish and I am not doing a national opinion.

Mike Barton, Chairman, Taupo Lake Care Inc: Our organisation represented farmers in the process of negotiating with Environment Waikato. We represent about 95% of the farmers in the Taupo catchment and we have been talked about a lot at this conference. I would say that I support wholeheartedly what Guy is saying and in our case farmers have given up a lot. We have accepted that there is a huge financial cost to this process, but at the same time we want to protect the lake. If you work with farmers in the right way they will give you the outcomes that you are looking for and I stand here, I believe, as tangible proof that it is possible. So all power to Guy's suggestion. Personally I do not like the way it is worded at the moment but I have not read it in its entirety. We need to sit down with the sector groups and come up with a document that has got grunt, common sense and that will work.

I would like to ask one question if I may. It is the same question I asked yesterday of Mr Mallard and relates to the use of Landcorp farms in this whole process. I pointed out to Mr Mallard that the Government's response was to sell Landcorp farms in the Taupo

catchment and I asked him if he would do the same in other sensitive catchments and he agreed that he would. I would like to ask Mr Smith under a National Government what you would do with Landcorp farms and whether or not you would consider using Landcorp farms as large-scale sustainable farming systems to trial the sorts of things we have talked about at this conference.

Nick Smith: The answer is yes, there does seem to be an anomaly where we look at some of the most intensive agricultural developments owned by the Government as a State-Owned Enterprise and equally so with the large loss of forestry that is putting a huge hole in New Zealand's Kyoto obligations. The key player has been the State's own Corporation. I think we need to mature on from the very puristic view that State-Owned Corporations are only there for a profit margin to there being a leadership role for the Government to play in trying to develop the new thinking that is going to be required around our major primary industry about how we can be successful and profitable but more environmentally sustainable. The simple answer is yes, I would be considering that.

Richard Budd, University of Canterbury: I would like to ask Guy Salmon and Erik Jeppesen what effect the EU Framework Directive had on influencing the collaborations in Scandinavia?

Erik Jeppesen, National Environmental Research Institute, Denmark: Generally the EU Directive will be good for Denmark because in the old days the tendency in the Government was that we should reduce monitoring and reduce effort to improve the water quality. I think the Water Framework Directive will help us in this case and save the monitoring programme so we can be sure that they will continue for a long period. I think it is fantastic what you are doing here in the Bay of Plenty and Lake Taupo but I am afraid that this is very much a local issue. In other places they may not be, which was the same in Denmark back in time. Some counties were very, very good because strong people were managing – they could be scientists or non-governmental organisations. There were many examples but also many bad examples and it depends on the local government and different political parties in the different counties. We had no national standards in Denmark, and you have exactly the same here. You get some very nice standards as you go around the world, as the politicians in Denmark did, and all the others you forget about. That is how we ended up with national standards as a minimum. But on top of that in the regions you could do a lot of good things and some are much better than others but at least we have a base line. I also concur with Guy that it is the way forward. You need a strong National Policy based on advice from people who know something about it on a national level and even on a country level. Some of the best examples of that were taken to the parliament. It is not enough to have this local activity. There will be very good examples but there will be very bad examples also. There are good guys and bad guys and they are everywhere.

Guy Salmon: I probably have not got much to add. The Water Framework Directive was only passed from the European Commission in 2000 and it has taken some years to set up national level implementation of it. So all of the processes I studied had taken place before the Water Framework Directive was influencing things and in fact what was interesting really was where countries have far-sighted water policies, they had sprung out of a national initiative which had been negotiated between farming and environmental interests and had then been taken up in most cases by a broad, cross-party coalition in the parliaments of the countries concerned. What was illuminating was if you could overcome the disagreement between the stakeholders, then there was no longer any real grounds for the parties to disagree with each other either and they tended to come together, and you would get a broad national consensus around what you were going to achieve.

Erik Jeppesen: The question about whether New Zealand is a different case? Sure you are different but we are very independent also, we were Vikings in the past. But we have managed to change this behaviour and you should do the same!

Simon Upton: Very good point! I would have to say there is nothing Viking about our proposed Policy Statement. For those of you who do not read the *Dominion* [*Newspaper*], I have described it as the most insipid and evasive policy document I have ever witnessed in my long time as an environmentalist.

I would like to move on to the second question now. I think it is a really useful discussion at the national level and we have had some good observations about the link to the local level as well. But Ian McLean has a question that is quite specific, notwithstanding what you might do nationally.

Ian McLean, LakesWater Quality Society: Do we need to have special rules for zones to protect special waters and if so, should they or should they not be developed and designed nationally? Perhaps Dr Shephard and some of the Waikato people - Simon Berry or Robert Brodnax might comment.

Justine Young, Environment Waikato: Not necessarily, because in terms of designing the nutrient sensitive zone, I go to Mark's definition yesterday. I think it is regional councils that have the information needed to design those zones. If you are saying, should we at a national level design the criteria for those zones, then yes, if you want to expand on that definition.

Mark Shepherd, AgResearch: The question was directed to me also. It is on the periphery of my knowledge and expertise, but my observation is that we have got the nitrate vulnerable zones, set at national level, and I think the examples of the priority catchments now that have been developed are really more of a local activity in that each catchment is identifying its own issues of phosphorus and nitrate. There is scope there to develop their own rules that might apply to a nutrient sensitive zone, so I think that approach is logical. Different catchments have different issues, and you would set your rules and targets according to those issues.

Professor Memon, *Lincoln University*: Can I comment on that too. There is some merit in having national provision that can be included in regional plans for water protection zones. One of the problems of the RMA has been that every region and district has had to reinvent the wheel for itself, and that has taken a lot of money, time and litigation. If there was a national body like a National Environmental Authority that had model provision, for example, for dealing with water issues (and there are a lot of other issues), the regional and district councils could adapt that model and fine tune it to suit their particular requirements.

Suzie Greenhalgh, Landcare Research: I will give you an idea of how the US operates and that was brought up in Guy's talk yesterday too; they have a set of national criteria where they ask all the states to go into their surface waters and categorise them as whether they are swimmable, fishable, etc. So it was left up to the states themselves to determine what those criteria were and they were merit criteria; then also to work out what was the list of critical streams, called 319D streams, and these were the ones that had to be done first; then also to work out what the sources of impairment for all these different streams were and what the actions were. That gives you a flavour of how a different country dealt with that.

Gifford McFadden: I actually agree with Justine that Federated Farmers is in a position to take part in discussion. But my personal opinion is there should be a list of national criteria and then you argue it out at a local level. Because what I hear being said of it is

that here is a good chance to hijack the process and then we will have a whole lot of other problems. If we have a list of national criteria, then at a regional and local level it will be a lot harder to hijack and the people who are actually involved in the issues to be resolved will be the people making the decisions.

Dave Donaldson, Rotorua District Councillor and appointed member for the Rotorua Lakes Community Board: I have a question of Justine Young. It is in relation to the RPV5 [Regional Plan Variation 5] and your slide on market design and nutrient management. One of the steps there was the estimating of emissions by each agricultural land owner and it was interesting to hear Bill Bayfield mention the real possibility of turning Rule 11 into a nutrient trading regime. Did those estimates include undeveloped land because a real issue in the Rotorua lakes community, and it comes up at Community Board forums, is noxious weeds on undeveloped land, some of it private, some of it public. There is a poster out there on nitrogen leaching from gorse which we have got tonnes of, 200kg per hectare. So was that measured?

Justine Young: The short answer is yes. Through the Court process and the experts who were involved, there was a revision of the loads that came from each particular type of land. Some of the details that are going to be coming out in the decision will relate to the contribution to total load in the lake from, for instance, gorse and broom, and that was definitely an issue that was argued at some length in caucus between the various experts. Initially when Environment Waikato released the variation we assumed that undeveloped land was essentially background, it could not be managed below a very low level. So yes, that is part of the issue and further to that all kinds of questions came up about whether or not there were other mechanisms, for instance technical management strategies, which would essentially get rid of the problem. There are questions about what kind of land and what kind of practice allows gorse and broom to occur; and we were talking about gorse and broom on farmland and on the edges of forested land.

Max Gibbs, NIWA: I have been working on the lakes around Rotorua and Taupo for at least thirty odd years. The issue that I see with the Act, and measures that have been brought forward, is timeliness. We have developed a whole range of toolboxes, we know what we can do; Mark Shepherd said that we can identify the problem, we know the solution; it is implementing them. It has taken eight years to get RPV5 [Regional Plan Variation 5] to a point where it has been accepted and going to take an awful long time before we do all the discussions through nutrient trading. Can we in the meantime implement stopgap measures from the toolbox to stop nitrogen loads entering the land from key land uses such as intensive dairying, while the discussion continues about the ownership, the distribution of wealth, etc. associated with nutrient trading? The specific issue there would be that with $81 million being given for land management in the Taupo catchment, could we not spend say a million on each of the four farms that have got dairying there, to put them into, say, Herdhomes for three months of the year to prevent that nitrogen getting into the ground water and then they can dispose of that nutrient? In the meantime that is stopping the nitrogen getting into the ground while we are discussing the rest of these projects.

Simon Upton: So a quick fix while the lawyers continue to argue – or at least a holding position.

Bill Bayfield: I would like to congratulate that speaker because it is something that the staff are putting to me right now, which is that nutrient trading is a real challenge. We think it has real potential for most efficiently giving us the reduction and then allowing the minimising of the social and economic impacts, therefore we are interested. I do not think it would be a good idea if there are a whole lot of different trading regimes around New Zealand. It would be a marvellous thing if there was some national guidance, probably based out of the work that Environment Waikato has already done on it, so we do not

reinvent the wheel. Nevertheless we are looking for a quick win and something that sends signals. Certainly within the Rotorua catchment we have got to look at what might be the kind of thing every decade that is easy win, even though we know in the long term that it may take eighty to one hundred years to get there.

Justine Young: The phrase that caught my attention in your question was "stopgap measures" and I guess the thing that I would be careful about is putting money into anything when you were not actually capping what people could do as of right. Because remember under the Waikato Regional Plan … you are shaking your head so I have obviously got the wrong end of your question.

Max Gibbs: We already know that nitrogen from dairy farms is impacting on the ground so we can stop that with measures that we already know by using a very small proportion of the money that is being given to do that in the catchment. Why do we not do that while we are continuing on with the discussion about what to do with the other $77 million.? We know that we have got to stop the nutrients from dairy farming and we are not going to disadvantage any farmers by doing it that way.

Simon Upton: Is there anybody here elected from the region? I have noticed we have had a lot of paid officials from regional councils but we have not heard a lot from any elected people.

Graeme Fleming, Taupo?: Simon, I am not an elected person either. I speak from the Lake Taupo Protection Trust. I have an answer around the question about dairying and farm sheds and those sorts of things. The Trust has put up some information regarding tendering, and is going ahead in the next five or six weeks with what we call an equi-tender for nitrogen. Essentially the Trust will be looking to farmers and land owners to come up with the sorts of solutions you are talking about. There will be a fund put up as part of that option, and if that is an option which is viable then I am sure a proposal will be put forward. The only kicker, and there is always a kicker, is that the Trust is required to give that permanence, [retain low nutrient levels on the land] so therefore any sort of proposal would somehow have to put a requirement on that, that is in perpetuity, and that is going to be a difficult issue for those sorts of proposals. But nevertheless there will be a chance for farmers to use their imaginations and come up with proposals to reduce nitrogen.

Stewart Ledgard, AgResearch: Guy will have confirmed the last point raised and it led to quite a lot of discussion at the Environment Court hearing about imposing or picking individual examples, and Herdhomes is probably a key one. If we look at when they were discussed with farmers within Rotorua and Taupo, they were seen as one of the few options from non-financial and financial criteria that they were not keen on adopting. So the idea of forcing an individual thing because it might be seen as a suitable stopgap and it could be put across all farmers, is of great concern. Even from a farming perspective, it is imposing a cost on a farm which then drives and censors how you can get the best value out of that which is often associated with more feed, more production and so on. Personally I would have great concerns about the idea of trying to impose something short-term especially if it is in common across them all. It has to be borne in mind the differences in setting something properly within farm systems that makes sense and that farmers are willing to work with.

Simon Upton: I think one of the reasons that people are driven to think about stopgaps, though, Stewart – perhaps not here, but in other parts of New Zealand – we are increasing production massively and increasing nutrient loading massively, in Canterbury and Southland. Now, should our approach to water quality in this country be: look, until we get the final legal deal done you can go on adding unlimited amounts; or should there

be a stopgap to at least try and hold things at the current level? There is a slight air of unreality about this, it seems to me; we are watching ongoing degradation.

Mary Stanton, Mourea resident: Kia ora, I represent Te Arawa Iwi: To the man who brought up that question, I commend what he is saying and I back him. I know what swamp land, riparian lands can do for the good of the quality of water. I see that stopgaps can help while there are huge decisions to be made around the Beehive, local authorities, you name it – we know how long this can go on for.

I was born in the swamp land, with all the insects and the birds, and I know what it is like to leave the swamp land to join the Air Force, but you can still hear the call of the birds which bring you home. There is definitely a future in swamp lands. Today we have had parts of the Ohau Channel taken from us because of progress, but it had its benefits, it has taken us out of the swamps, removed rheumatic fever and all the illnesses that can actually take your life from you. My dad was the one who told the Council to take the sewage out of Lake Rotorua and that took him a lifetime. He explained to us how it is so very difficult to convince people what to do and as you grow older they look at you as an old man, but you are experienced.

By all means the lakes need to be fixed, so I say do it, we are tired of arguing, we are tired of waiting for money. We need to get on with it so that the future generations can enjoy our wonderful paradise. It is the lakes that bring all the tourists here for us to share. I am a person who likes to see progress and money spent in the right direction. I support what this gentleman said about using stopgaps and let us get on with life. Thank you very much. Kia Ora.

Simon Upton: Thank you. Now can I move to the third question because it just links rather nicely and perhaps brings us to a more positive conclusion of our discussions. That question is in the hands of Don Atkinson from the LakesWater Quality Society. Don, you have got a question in the direction of what we can do in the next little while.

Don Atkinson, LakesWater Quality Society: Yes, that is correct, but I would first like to say that in 2001 we had our initial Symposium here. It is now 2008 and a lot of time has gone by. We saw today potentially 12% delivered from science in respect of a reduction in nutrients. My question is to Rick Vallance. In the next decade Rick, what does your Trust believe it can deliver in respect of nutrient reduction in farming?

Rick Vallance, CEO, Ngati Whakaue Tribal Lands Inc.: I think that Ngati Whakaue Tribal Lands will deliver something in the next 10 years in the order of 30% of the requirement for Lake Rotorua.

Don Atkinson: The Rotorua Lakes & Land Trust has effectively been set up with the responsibility of research under this programme.

Rick Vallance: Rotorua Lakes & Land Trust will be successful in achieving that level of progress that I have just described at Ngati Whakaue to spread around all the farms in the catchment. I am more confident than a lot of other people about what we will achieve, in the case of Ngati Whakaue, by changing some land use completely out of farming over the next ten years, basically a thousand hectares out of cow and beef farming. I would say that type of total land use change is available for perhaps up to 20% of the farms.

There is another 25% or thereabouts of total farm production that we will save just simply through introducing the research that Stewart Ledgard and co. have organised. If you get 20% of 700 then there is another 150 tonnes, so you hit your target. In terms of the speed of introducing it, I think ten is not quite the right number, it will be longer than that. But I am mindful of the success of the farming industry in the late 1960s and certainly it was

simple, it was just about production and production increase. They doubled the volume of production in their farming systems right throughout the country in the space of about ten years. That was by getting the leaders to lead, to demonstrate, to propagate that around the rest, and with that we achieve dramatic things in rural New Zealand. It is quite possible and I think it will be a mix of total land use change, farm system change and there will be some Herdhomes that will be viable. Time will tell.

There will be BCD's [fertiliser additives to reduce nitrogen leaching], there will be feed changes, there will be biological changes to the cow's stomach, there will be a range of things that will come in and we will surprise ourselves. The Rotorua Lakes & Land Trust, working with the Land Use Futures Board, will be in the game of propagating that stuff that AgResearch and Co. put out.

Simon Upton: Rick, just to be a little bit more precise, that is very helpful but there are a bundle of things there that you say are going to come along over a period and it might be a little bit more than ten years. Right now there will be some best practice. It is the level of leaders who are our problem is it not, the people who are not or will not follow. How quickly could we get, in the Rotorua catchment, everybody up to best practice? I mean, do we just need a season for that, or two seasons? What is your feeling there?

Rick Vallance: The first thing we have to accept, despite what Sally says, is that there is already change going on. I would argue that we are probably not as far back as everybody thinks. I would suggest that we are probably at 70%. So we have 30% perhaps dragging the chain. Environment Bay of Plenty has a role to play in that regard. There should be no excuses for the pond problems and that sort of thing. This should be done and people step up to the plate. For riparian planting we are probably at about 80%. We could speed up this which will achieve what you saw on the screen. I believe there are some major land use changes that could happen which are hopefully going to happen within the next ten years. One might happen next year if it is allowed – you know what I am talking about. So it is actually going quite well. EBOP is going to have to crack the whip on one or two matters.

Bill Bayfield: The Rotorua catchment has a phenomenal record of riparian management, it is well up there with 86%. I would not be quite so optimistic on other matters. I really liked Kit Rutherford's presentation in terms of the toolbox and there is an awful lot more that you can do. I have a fundamental question to which I hope the answer is Rick's positive one, which is: will that be enough in the Rotorua catchment? I am absolutely certain that those measures if utilised will be enough in the eleven other catchments, in line with other actions that we have taken on the lakes. But I have got to be honest with you, there is still a question mark in my mind for the *monster*, and that is why we have to take our time and work out exactly what will be the course of action. I had a delightful dairy farmer from the Rotorua catchment standing in front of me about a year after I got here and he said: "If the answer is no then I'm going to die. For God's sake have the balls to shoot me – don't let me die by slow strangulation".

Simon Upton: Maybe he should write the National Policy Statement on water!

Gifford McFadden: I am a bit concerned that when we go looking for every little piece such as has been described for what we can do right now, we are looking at a fifty-year plan. We need solutions, and the solutions that we have got are very minimal. I hope that we find that we should not spend all our time looking at minor things. That upsets everybody and involves a lot of resources. We should spend those resources on things that are going to make a difference. Right now the sort of sums that we are looking at, 50% in Rotorua, 40% suggested in Taupo, we do not have solutions.

Simon Upton: Does anybody want to confirm or challenge that gloomy prognosis?

Terry Wearmouth, Kauri Park, Maungatoroto: I have got a very general comment to make, that farmers as a general rule of thumb are probably the best people to adapt to most things. They could get a flood and they have to adapt to that, or costs that come on them all the time. Farmers are probably some of the best people to help make these policies because they have to adapt all the time. To go and look for every single little answer is going to take at least another nine years.

Chris McLay, Environment Waikato: The original question was: how do we get other farmers to follow the good leaders out there? One of the groups we have not heard from and talked much about here is the role of industry in all of this. To me, industry could provide the incentive. They certainly talk about increasing milk production and other types of production in other sectors. That is what we are going to be up against in trying to improve environmental quality at the same time. Certainly if the incentives are there for the good farmers, then it might be a good reason for others to follow.

Simon Upton: Is there anybody here from the industry in the sense of the people who are requiring processing and selling the products?

Ann Green, LakesWater Quality Society: You were asking for representatives from the region from industry but you also mentioned the regional councils and the district councils – the political representatives at one stage. Can I come in on that point? I would like to express a concern that has frustrated me, on the Rotorua District Council. We are very short here on their representation. I would like it to be recorded that we have had some people who have enrolled and registered from the District Council at $250 per person who are not here, and we feel they should have been here. I do not know if there is anyone here who would like to address that. It is a question - Where are they?

Simon Upton: I have heard a lot of people talking on behalf of regional councils on the paid staff but I have not heard anyone from the elected side. Is there somebody here from the elected side of the two regional councils who would like to say something?

Neil Oppatt, Environment Bay of Plenty, local Councillor for Rotorua: My feeling is from all the information that I have seen and read, and I have sat through hours and hours of information, my gut feeling is that best practice will get us part of the way towards our targets but at the end of the day there is going to need to be a degree of wholesale land change, whether we like it or not. Certainly in the case of Environment Bay of Plenty it is going to have to step up to the mark and have to look at maybe a combination of three things:

1) Working with land owners who are wanting land use change. A number of land owners who have come to me know that their farms are in a sensitive area. They would be quite happy if they could get some assistance and that is along the technical lines looking at what the economic alternatives are and maybe helping with costs of moving through planning processes.

2) I think another option that we are going to have to look at is the Council becoming a player in absolute land use change where you are in a critical catchment. Our CEO made it quite clear that we think that eleven lakes are ready to fix and we are talking about a handful of farms. In each of those catchments the farm owners are more than happy to talk about how they have a changed lifestyle. There needs to be a certain amount of land taken out of full dairy production to get our targets in a reasonable time frame.

3) Just one final note, I heard someone talking about alternatives for short-term stopgaps, Let us be clear about this. The Ohau Channel diversion wall is a short-term stopgap. The Resource Consent is ten years; if we are lucky it might be there for fifty years, but at the

end of the day it is about preventing nitrogen that is flowing into Lake Rotorua from getting into Lake Rotoiti. It is not a solution in its own right. The Phoslock capping – three doses in Lake Okareka was a short-term stopgap. So Environment Bay of Plenty is not adverse whatsoever to investing some of its money into short-term solutions that hopefully will give us a bit of breathing time to look at the long-term solutions.

Simon Upton: We are going to have to close the session here. I would like you to join me in thanking the speakers who responded but I also think we should say a special thank you to the LakesWater Quality Society because of the quality of exchange we have had and the range of views and people who have really pulled together in quite a special way. I do not know what EBOP thinks about this but if we did not have the Society I think you would have to invent it, because they are playing a very important role. So join us again in thanking them as well.

SUMMARY OF SYMPOSIUM ADDRESSES

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DAY ONE

SESSION 1 - THEME: EUROPEAN AND NEW ZEALAND PERSPECTIVES

1. Government Policy on Freshwater Management (Hon. Trevor Mallard, Minister for the Environment)

The Minister addressed the Government's recently released Proposed National Policy Statement on Freshwater Management, recording the $72.1 million Government contribution. He commented that the notion of diffuse run off was not one properly understood by farmers until recently. He noted that those who have enjoyed rights to use land as they wish (including the right to pollute) will lose those rights.

On the question of the proposed national water policy he emphasised that it was designed as a guide for local Government, commenting that social change in farming communities was already evident and that those who had, through bad behaviour, stimulated and attracted the unwelcome attention of authorities, were regarded poorly by their neighbours (SJEM made a reference to the changing of social morays through legislation, eg drink driving). The Minister encouraged local authorities to contemplate and utilise the prosecution processes under the Resource Management Act and emphasised that convictions against individuals rather than corporations might have more effect (SJEM commented that in the quota management system it was recognised by some judges that some fines could amount to little more than a "modest licence fee for the continuing of unlawful activity". The Minister noted the imprisonment provisions under the amended legislation.

2. European Case Study – Nutrient Sensitive Zones (Professor Erik Jeppesen)

The Professor commenced his address by noting that he came from a "smelly country" which has 20 million pigs and lots of cattle "which don't wear underpants". He noted that Denmark was not as bad as Holland where the smell of ammonia was evident even before the aircraft hit the tarmac. He noted that New Zealand was "on the same road" and that here "cows smell of money".

He referred to the European Union standard for groundwater being 25mg per litre, noting that many areas in Denmark exceeded 50mg, especially in the sandy and wet environments. This was not restricted to those areas, because similar concentrations were found much further south in the drier areas of Spain.

He described the evolution of the European Unions Water Framework Directive and referred to a 1980 comment attributed to the President of the Danish Farmers Union:

> *"And now I soon get very very very angry … any farmer who would add anymore fertilizer than the plants could take up would have to be completely stupid".*

However, since that evocative statement it is now accepted that there is a clear link between groundwater, high nutrient levels and the addition of fertilizer.

The answer in Denmark has been to establish a National strategy involving strong proscriptive regulation and to start at a modest and relatively low key level and become more proscriptive and onerous with time. By way of example he referred to the following:

1985 - limit of two stock per hectare
1987 - ban on slurry spreading in Autumn
1991 - limits on nutrients and fertilizer levels
1998 - restoration of wetlands
reduced nutrient levels in sensitive zones
reduced stock numbers from 2 to 1.7 per hectare.
2000 - aforestation programmes
2004 - tax on phosphorus (next move will be to tax nitrogen)

The consequences of this being that nitrogen and phosphorus levels reduce.

He spoke about the influence of climate change particularly in areas where there is already high rainfall. There will be more rainfall and thus additional pressure in limited areas to grow more crops. The areas where agriculture will be viable will reduce. Denmark will get more rain. With increased run off there will be greater nutrient loadings on groundwater. He talked about the reducing levels of macrophages, particularly Daphnia with increasing temperatures.

He said that there was a take home message with eight points:

1. Farming legislation should be strict, comprehensive and obligatory
2. Farming is an industry that needs to be treated as such
3. Good management is not enough
4. Early action is much cheaper
5. Good monitoring is a must
6. There must be political will to take strong actio.
7. Forget about fast, adhoc, solutions recommended by “smart guys”
8. What is now not a nutrient sensitive zone may well be in the future

There is an addendum to the above, in that Professor Jeppesen, having heard the day’s discussions, particularly in the context of exhortation to adopt co-operative approaches between polluters and those charged with responsibility of monitoring nutrient levels, said that it was a nonsense to think that those who seek radical reductions of nutrient inputs can sit down, co-operatively, with the polluters and work out an amicable consensus. He likened it to the hen and the fox; it’s all fine until the fox gets hungry.

SESSION TWO – THEME: WHAT'S HAPPENING TO OUR LAKES?

1. "Nutrient Sensitive Zones and Why do we Need to Manage Them?" (Dr Marc Schallenberg)

Dr Schallenberg discussed the distinction between nutrient management and nutrient sensitive zones and attempted a definition of a nutrient sensitive zone. He noted that in the last 20 years there has been more intensive farming involving high yield nitrogen sources resulting in a 20 fold increase in urea application. He referred to a study by Sorral (2006 ME Report) which recorded that 30% of the lakes in New Zealand have deteriorated in the last 20 years.

He discussed two case studies on nutrient limitation:

(a) Case study one involved the Waipori River Catchment (near Dunedin) where there were low intensity nutrient levels in the headwaters, bush and tussock leading to high intensity areas in the estuarine parts of the Taieri Plain. He described the bioassay tests and the responses noting that the headwaters provided the greatest responses to nutrients (ie the water was not nutrient rich with little or no response ie there was nutrient saturation) at the estuary.

(b) Case study two involved shallow lake studies noting that 100% of lakes have "regime shifts" where they are surrounded by pasture.

2. Current State of Rotorua Lakes and Lake Taupo (Professor David Hamilton)

Professor Hamilton told us that nitrogen and phosphorus are the key elements in restricting algal growth and that oxygenation is the key.

The key indicator is chlorophyll and he described where the deep chlorophyll maximum is sitting at 30 to 40 metres in Taupo and is right at the top in Lakes Rotoiti and Lake Rotorua.

He noted that the clarity of water is directly related to the types of algae which grow and described the difference between the algal blooms in Lake Rotoiti in 2002 versus 2006 and 2008 where, in the latter, there was possible macrophage action. He discussed the Rotoiti/Okere Armed diversion and touched on zeolite application in Lake Okere.

3. Nutrient Generation from the Land; How Best are They Managed and Measured? (Dr Stewart Ledgard)

Dr Ledgard started with the observation that agriculture will top $20 billion to the New Zealand economy next year. He emphasised five points:

1. Measurement of nutrient losses
2. Modelling to predict losses
3. Management of mitigation options to decrease nitrogen
4. Local research is critical
5. Adoption of multiple practices

Regarding management of mitigation options - he referred to the study in Wales where cattle's diet was altered by access to high sugar rye-grass. He also described the use of diuretics which resulted in larger volumes of less concentrated urine with a greater spread of urine and nitrogen over a wider area.

Local research has been undertaken of the 26 dairy farms around Lake Rotorua which resulted in an average of 12% reduction in nitrogen leeching but noted there was considerable variation between farms. He discussed various options such as:

- Increased effluent areas
- Wintering off
- No application of fertilizer over the winter

He concluded with the question "can we have intensive farming in the vicinity of nutrient sensitive zones?" He answered this question by saying -"maybe, but it will be very expensive."

SESSION THREE – THEME: NEW ZEALAND ENVIRONMENTAL POLICY AND LAW

1. National Policy Statement on Freshwater Management (Guy Salmon)

He noted seven problems with the NPS –

1. Unsatisfactory objectives
2. Onus falls on communities
3. No standards are established at national level
4. 2035 is the deadline but it has no legal affect (as compared with other international models)
5. Couched in and politicised language (eg "degraded freshwater resources").
6. Excessively cumbersome
7. Substantial policy gaps; eg who owns waters; how is it allocated

He said that it added very little to the RMA mandate as to water. It fails to provide an effective framework for holding landowners accountable. There should be a rent charge for the use of water (the proceeds of which would be applied to the restoration of waterways).

2. Regional Councils Have Tools to Act (Robert Brodnax)

The tools are the Local Government Act and the Resource Management Act. The Local Government Act is directed towards policy/philosophy and how local Government is to work with the community. The Resource Management Act is largely regulatory.

He referred to three case studies:

1. Waikato Regional Plan where all water bodies are classified and point source discharge is strictly regulated
2. Protecting Lake Taupo (RPV 5)
3. Waikato River - 90% of nutrient loadings are at present from dairy farms With increasing dairy conversion there is no chance that river quality can be improved without drastic changes.

He concluded that we have the tools to make a difference but need the community to act and the political will to implement.

3. Diffuse Pollution – Section 30 RMA (Simon Berry)

He referred to the recent litigation involving the variation to the Lake Taupo plan (RPV5). He noted that Regional Councils do have the power to exercise control over diffuse discharges, albeit through restrictions relative to the land use.

He noted that section 30 sets out the Regional Councils powers to manage water.

He described the rules which might influence diffuse discharge as being:

- These low leeching activities are permitted
- High leeching activities would require resource consent
- High leeching activities would be benchmarked at existing levels

SESSION FOUR – SHOULD FARMERS IN NUTRIENT SENSITIVE ZONES MAKE CHANGES TO PROTECT THE ENVIRONMENT?

1. The Case for the Environment (Dr Morgan Williams)

He started the discussion by answering the above question with "of course but …". He noted that it was important to value food in terms of what it costs to produce them, and that the power to distribute is aggregated in fewer and fewer hands (eg. supermarkets) which puts pressure on producers.

On the question of the management of the commons he said that we should concentrate on the soils which are "possibly the toughest commons of them all". He pointed out that at the moment we were building and developing on the best land (35,000 to 45,000 hectares per annum being developed for housing and lifestyle blocks). He said the time had come to rethink production systems -

- Lift our imagination
- It's all about leadership
- We have to be more efficient
- How do we get society to pay the actual cost of food production
- Reference to bio mimicry

2. The Dilemma: Regulation or Consensus? (Professor Ali Memon)

He outlined the two approaches in dealing with the dilemma.

(a) Regulation (the traditional approach)
(b) "Bottom up" approach – building partnerships

He referred to the dangers of "scientists as gladiators" in the use of scientific guns deployed to win cases on behalf of clients. He said that the RMA was not working as a regulatory tool and observed that it was time to "rethink the Environmental Court" because:

- Case law under the RMA is biased towards the protection of individual property rights
- Too much reliance is placed on case law and precedence
- Need to look forward. Environment Court is not a court to protect the environment. It only resolves disputes.

- It has become a de facto planning agency (problems with plans should be resolved at the political level).

3. Federated Farmers Dairy Perspective

As a dairy farmer from Reporoa, Mr McFadden referred to some local initiatives being implemented in the area namely:

- Wooden sills and grass filter strips (very successful in reducing phosphorus loss)
- Straw bale experiment
- Nitrogen trial.
- Watercress experiment (removes 60% of phosphorus and nitrogen)

He said that the state of Lake Rotorua was not as a result of farming but as a result of "60 years of granddad and grandma's pooh" and exhorted a co-operative approach involving solutions for a community problem. He noted that it was a "tardy few" who wreck it for the majority who are responsible. He said that farmers would not support environmental vandals.

DAY TWO

SESSION FIVE – THEME: SOLUTIONS AND A CHANGE OF MIND SET

1. Tradable Omissions Permit Programme for Nitrogen in Lake Taupo (Justine Young)

This address discussed the topic under four headings:

1. Policy context
2. Market design and nutrient management
3. Market design and redistribution of wealth
4. Conclusion

The question of the context was discussed by reference to the acknowledgement that farming necessarily produces omissions (principally nitrogen) which have an adverse affect on water quality. In the context of Taupo there was a consensus that something had to be done and the omissions required control. It was also recognised that there was a time lag where legacy pollution was involved and also that omissions varied depending on the topography of the land, stock concentrations, farming usages etc.

The questions which require answers include:

1. How does one estimate omissions for the purposes of establishing a trading scheme
2. Can the model chosen meet or be flexible enough to meet changing land uses and farming innovations

There was then a discussion about establishing nitrogen caps, ie. the amount beyond which any further increase would produce a long term deterioration in water quality (sometimes referred to as NDA or nitrogen discharge allowance).

There was also a discussion about the concept of redistribution of wealth and the fact that nitrogen usage cannot be extended without the need to obtain rights from others.

It was posed that it was the proposition the rights would be gifted to all but with a purchase back (20%) and placed in National and Local Government hands.

The cost of producing omissions would be shared between owners and the local community.

In conclusion it was recorded that setting nitrogen levels and establishing the NDA was the least inequitable mechanism for the protection of the lake, ie once the decision at Taupo was made to impose a variation in the plan this mechanism was the only realistic way to approach the problem.

2. Plan for the Future (Professor Neil Eriksen)

Professor Eriksen commenced by candidly accepting that he had no great expertise or knowledge of lakes and nitrification but noted that the application of wider principles and drawing from other models was instructive.

He dealt with the "RMA Ethic" and the" RMA Mandate" and posed the question "why did we not have National policies?". He postulated that the correct approach was to "educate … not regulate" recording that regulation may change behaviour and perhaps change attitude but education changed attitude and thereby behaviour.

He exhorted the audience to examine and consider various alternative systems eg:

- Organic farming
- Cessation of NPK fertilizers
- Use of aerobic cowshed waste treatment
- Use of methane gas for energy

To achieve this:

- A need to develop "focussed innovation" (as above)
- Identify partners for change (e.g. Fonterra, EBOP, Rural Bank etc)
- Identify those farmers who are disposed to change
- Provide incentives
- Ongoing education
- Networking with other strategic partners and others

3. Can we Prevent Nutrients Causing Water Quality Problems (Dr Kit Rutherford)

Dr Rutherford's short answer was "… in some catchments the answer is yes. In others it is no". He observed that there are some areas within the environment which are less sensitive to nutrient inflows and those are the places where we should be signalling those who are adversely affecting the environment should consider going.

He observed that there was a "tool box of mitigation methods" and looked at this question against the historical perspective of the removal of sewerage loading from Lake Rotorua and the immediate and consequential reduction of nutrient loadings in the Lake. This was then followed by a gradual increase in nutrients which was when the question of legacy/diffuse nitrogen phosphate inflows were discovered.

On the question of dairy shed effluent (which he described as the farming equivalent of sceptic tanks) were available including:

- Methane capture
- Contour filter strips
- Riparian buffers
- Combination (Rolls Royce) buffer
- Constructed wetlands (eg Lakes Okaro and Rotoehu)
  He observed that the latter systems work at their optimal when plants are young, vigorous and growing and where the water flows do not fluctuate.
- Pasture wetlands ("the boggy bits"), which occupy 15% of the topography in North West Taupo
- Recycling from the lake bed (NIWA's studies), putting a cap on the lake bed to prevent further recycling using:

  - Alum (proved to be ineffective)
  - Modified Zeolite
  - Phoslock
  - Allophane

  (The work/research in regard to these additives is still ongoing.)

Dr Rutherford concluded with the question "what are the nutrient sensitive zones" (ie identify those which are and those which are not)? There is a need to confront those cases where "it ain't going to work … cut our losses … may need to cost us".

4. Recreational Perspective (Rob Pitkethley)

Rob Pitkethley started by analysing the number of "angler visits". The National figure is 1,455,000 of which 106,000 descend on the Rotorua lakes.

He further added that from a survey of 1,000 households, 80% of Bay of Plenty residents were, at the very least, passive users of the Rotorua lakes.

When water quality deteriorates the following factors/issues emerge:

- The fish generally do not appear to suffer and continue to grow reasonably well
- Catch rates drop significantly
- There is a substantial decline in the use of the fishery (as measured in fishing licence sales)
- There was a 65% drop in angler usage on Rotoiti in the years when algal bloom affected it
- 45% of those interviewed said that water quality adversely influenced their enjoyment

In the years where there has been an algal bloom the usage of the lakes is only 60% of that in non bloom years.

90% of fresh water fishing and usage is carried out in lakes, reservoirs and lowland river catchments which are, necessarily, the most effected by diffuse pollution and declining water quality (and in Canterbury declining water quantity).

He posed the question "is it the tools we have which are not good enough or are we not using them well enough?" He observed that some were clearly working (rule 35), but some were not. He referred the audience to a "swim through" of the Mohaka River over a 100 metre distance which covered the river immediately above and below the Taharoa confluence demonstrating the pristine nature of the water course above the confluence

and the obvious deterioration immediately below (the Taharoa River catchment draws on high intensity farming).

He exhorted us to "get the tools right otherwise our nuts will fall off".

SESSION SIX – THEME: ECONOMICS, MARKETS AND CHANGE

1. Nutrient Sensitive Zones – Economics and Opportunities (Dr Dan Marsh)

He posed the question "how do environmental economists think about water quality issues". The answer is that they examine the "efficient" level of pollution which is really zero (e.g. are we willing to pay the price to get the Waikato River back to its state in pre-European times).
How should we get there and how can it be done cheaply?

On the question of how do we get a cost effective pollution policy he examined the upper Waikato catchment research which demonstrated:

- Nitrogen discharges highly variable between farms and activities
- There are differences between the dairy farms and what are they
- Not huge technical efficiency differences
- Larger differences in economic efficiency
- What is the environmental efficiency (lots of milk and less nitrogen discharge)

He examined the efficiency across 200 dairy farms of which 60% were less efficient than the most efficient, indicating a widespread inefficiency. The average farm may be able to produce the current level of output with less nitrogen discharge.

On the issue of abatement costs (ie. the cost of reduction of all nitrogen discharges) he said that the picture was clear. The paradigm is that with intensive farming there are relatively low costs associated with abatement. There are more low cost abatement options available to intensive farmers. This is in contrast to less intensive farming where the relative costs of abatement are high and profit levels drop directly as abatement costs increase.

In terms of policy implications he concluded:

- For low intensity farms profits will be reduced considerably without reducing nutrient discharges substantially
- For high intensity farming abatement costs are lower and the effectiveness of reduction strategies are necessarily higher

2. Market Based Mechanisms for Eco-Systems (Dr Suzie Greenhalgh)

Dr Greenhalgh started her address by examining market based instruments and identified the two most commonly used namely:

1. Reverse auctions/tenders
    - Competitive bidding systems for single buyer and multiple sellers
    - More effective than subsidies
    - Allocates funding on cost effectiveness

2. Water quality trading programmes
   Two basic steps:

- Set goal for total amount of nutrients
- Use lowest cost mitigation options

Internationally there are 24 active programmes (mostly in the US), 20 emerging programmes (including Taupo) and 11 inactive programmes.

She then turned to identify the common hurdles/barriers to trading, namely:

- Inadequate market drivers
- Time wasted on “reinventing the wheel”
- Inadequate stakeholder education
- Lack of transparency in policy/rule development
- Lack of “buy in” from regulatory staff
- Lack of goals
- Disagreement over load allocation

She said that it was time to broaden our thinking in answer to the tendency to focus on individual problems and solutions. By way of example she referred to the hypoxic zone in the Gulf of Mexico at the mouth of the Mississippi River where the state of the inshore coastal areas was not just a problem for those who inhabited the immediate area, but included those who had contributed to the high nutrient loadings thousands of miles north in the central United States and higher catchments of the Mississippi River.

Her final comments were:

- Market based instruments are theoretically and practically cost effective
- They work in high nutrient zones
- Policy and legislation is just the first step
- There is a need to look holistically about the wider eco system services, not just the ones being degraded

3. Land Use Change for a Brighter Future (Rick Vallance)

He started by identifying eight philosophical points:

1. Importance of choosing the right paradigm
2. Strategic, economic, political, cultural issues context -
   - Need to understand the culture of rural New Zealand (empathy and listening)

3. Changes to culture of leadership in New Zealand -
   - Used to be very close to rural New Zealand (possibly too close

   - Governance now made up of people who have only academic and not practical knowledge of the farming sector

4. Tensions arising -
   - Rural population is relatively small.
   - Consequential lack of understanding of challenges facing owners.
5. Importance of sustainable land use to all New Zealanders.
   - Not about killing the golden goose.
   - Danger of silos arising around activities.
   - Need to take a helicopter (holistic) view.

6. Land is owned by people.
   - Vote is urban based.
   - Land is privately owned.
   - Disconnect between urban and rural communities.
   - Sustainability is in the interests of both groups.
   - Solutions which are arbitrary and abusive of ownership rights are counterproductive.
7. Importance of property in a free democracy.
   - As we develop solutions we need to remember where we come from and learn from some of our historical blunders.
8. Particular issues for Maori land owners.
   - They are entitled to the same rights/approach of all other landowners.
   - Should not be treated as a separate of distinct category.

He said that land use change for a brighter future should be about:

- Acknowledging cultural aspects
- Increased wealth and increased sustainability
- Embracing environment sustainability
- Avoid rigidity

For pastoral farming, the focus should be:

- Develop new soil management systems
- Develop new plant systems
- Develop new animal biologies

On the question of leadership of land use change:

- Need to clear regulatory environment
- Best outcomes from effective leadership
- Move RMA from vexatious, envy driven handbrake on the future, back to its original purposes and principles
- Innovation, flexibility and leadership

SESSION 7 – THEME: NUTRIENT SENSITIVE ZONES

1. Environment Bay of Plenty Perspective (Bill Bayfield)

This address started with aerial photographs of two “jewels in the Crown”.

- Tauranga Harbour
- Ohiwa Harbour

Both of which drain from and are surrounded by nutrient sensitive zones.

Bill Bayfield then went on to describe the lakes in the region, noting that not all were equal although none are the same.

He discussed the treatment of Lake Okaro which he described as EBOP’s practice pond where Z2 Zeolite is being applied and research is being undertaken on how long the cap lasts. Land effects have been addressed and wetlands created with the co-operation of the local farmer.

He then went on to discuss the other lakes in the region, concluding with a reference to the four priority lakes of Okareka, Rotoiti, Rotoehu and Rotorua.

Lake Rotorua he described as "the monster" with more than 2,000 landowners in the vicinity, a huge catchment area with a long lead time of 60 years for diffuse/legacy pollution, but a recognition that the Lake's iconic status is such that it must be fixed up with 250 tonnes of nitrogen and 200 tonnes of phosphorus being removed per annum from the catchment.

He asked the question how is it done? Four possibilities:

1. Voluntary change/mechanisms.
2. Private/public partnership.
3. RMA procedures.
4. Rule 11 and turn to nutrient trading schemes.

2. National Party Perspective (Hon. Dr Nick Smith)

Dr Smith started with a truism, "water quality is an issue greater than it has ever been in the past".

He said that in terms of National's policy on the environment, water was a second most important issue after climate change and feature substantially in the proposed Blue-Green Issue document shortly to be released by the National Party for discussion.

He said there were five central issues which underline National's policy:

1. Sustainability
2. Economic. Are the economic instruments appropriate
3. Good sound science
4. Engagement of communities
5. New Zealand's unique heritage of access to waterways

In terms of the policy he observed:

1. There is a need for a better process of collaborative decision making.
2. Introduce an Environmental Reporting Act (which would have five yearly reviews.
3. There is a question around the effectiveness of the Government institutions which have responsibility for the environment. For example in the Ministry for the environment only three out of a staff of 262 were water quality experts.
4. An Environmental Protection Agency should be established through central Government which would leave the Ministry with the responsibility for policy issues and major consents.

He said the National Party recognised two issues:

1. A need for new tools. The RMA has worked well but there is a need to examine alternative/additional tools.
2. Allocation (the traditional concept of first in, first allocated, is not the best or preferable model).

He concluded that there was no choice between environmental health and economic wellbeing and that we must all lift our game.

3. What would a Nutrient Sensitive Zone Look Like for Taupo And Rotorua? (Dr Mark Shepherd)

Dr Shepherd applied his UK experience to the New Zealand situation, recognising that his experience with the latter was necessarily limited as he had only been in his present role for seven months.

He referred to the Water Framework Directive (UK) which:

- Cost effectiveness is a major consideration
- Multi disciplinary effort
- Emphasis on diffuse discharge
- Concentration on land use and management

He then referred to two UK case studies:

- Nitrate vulnerable zones
- Catchment sensitive farming priorities

As to nitrate vulnerable zones he observed that at present 55% of lowland England fits into this category and it is about to be increased to 70%. It is very much a regulatory approach.

As to catchment sensitive farming priorities, this scheme applied a "light touch" rather than a regulatory/prescriptive regime where:

- Sources of pollution are identified (primary sources are mostly under control but the real problem, as it is in New Zealand, is diffuse pollution).
- Farmers need to be provided with the evidential basis which will demonstrate there is an issue (more than 40% of farmers do not believe/accept that farming practices are responsible for water degradation.

In practice there are specific rules in force in relation to the control of nitrogen inputs which include the following:

- Closed periods for fertiliser application
- Limits on the rates of nitrogen application
- Limits on stocking rates
- Controls of nitrogen application periods
- Four yearly review of Action Programme

There are more solutions in addition to the above and Dr Shepherd referred to another 44 which is an ever expanding list.

He then referred the delegates to a series of graphs which demonstrate cost-curve calculations which demonstrated that low cost solutions were highly effective in nutrient sensitive zones and listed the "drivers for change" by farmers of which there were seven with the most influential being that farmers expressed concern for the environment down to the least influential being peer group pressure.

He concluded that there was a need for regulation to achieve the desirable results but compliance could only be achieved through voluntary adherence.

He said that the lessons for Taupo and Rotorua, following application of the UK experience and principles are that some issues are the same and some are different.

Those which are the same include:

- Source apportionment
- Developing an evidential base
- Working with stakeholders
- Getting the right policy mix
- Resourcing
- Assessing effectiveness

Those which are different from the UK experience and peculiar to New Zealand would include:

- Size does matter - our size allows us to be more discriminating in terms of specific responses
- UK does not emphasise a farm level approach
- UK is more input based
- New Zealand is looking at more innovative mitigations
- New Zealand is more “result orientated” in its approach

CONCLUSION

In summing up, Simon Moore postulated the question “can we get to where we need to be?”

An enduring theme throughout the conference is that there is no ready answer and the solutions will be different depending on the environment involved.

If there was a theme to this symposium it was that:

- In most cases there is the potential for improvement and mitigation but there are some nutrient sensitive environments where, irrespective of the energy and cost invested in mitigation, it is unrealistic on any objective analysis to tolerate certain high intensity land use practices.

The question is how can that issue be managed; a topic which may prove to be a fruitful source of discussion for another symposium.

POSTER PRESENTATIONS

WATER BALANCE FOR THE OKATAINA CALDERA LAKES

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A precise knowledge of the origin and transport of water through lake catchments is required in order to derive nutrient budgets and implement protection and preservation of lake water quality. A preliminary water and nutrient balance for Lake Tarawera revealed that 70% of the incoming water to the lake is ungauged. These inflows, assumed to be mostly direct groundwater contributions, need to be characterised to obtain a more precise nutrient budget. The Okataina caldera lakes include eight catchments: Okataina, Okareka, Tikitapu, Rotokakahi, Okaro, Rerewhakaaitu, Rotomahana and Tarawera. An interpretation of groundwater flow distributions between the catchments has been used to assess the groundwater inflow to the Lake Tarawera catchment. This assessment serves as a basis for assessing nutrient loads and land uses that are fundamental in considerations of protection of water quality of Lake Tarawera.

FARM INTEGRATED RUNOFF MANAGEMENT 9FIRM0 PLANS: A TOOL TO REDUCE DIFFUSE POLLUTION

Jennine Jonczyk[1], Paul F. Quinn[1], David. L. Rimmer[1], Sean Burke[2], Mark Wilkinson[1]
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A full-scale Farm Integrated Runoff Management (FIRM) plan has been implemented at Nafferton Farm, Northumberland, U.K. Temporary storage ponds, bunds, flow control structures, wetlands and a buffer strip have all been designed, constructed and tested. All features are designed to be multi-functional and aim to reduce pollution, lower flood risk, trap and recycle waste, use recycled materials and create new zones for ecology.

A combined sediment and phosphorus trap has shown an average percentage reduction of total phosphorus (TP) of 68 % for several small storms during March 2008 and 77 % during a larger storm in April 2008. The success of this feature can be explained largely by the reduction of suspended sediment concentrations. The combined sediment and phosphorus trap had little effect on reducing nitrate concentrations over the same storms. The average percentage reduction of TP by a 25m long within-ditch sedge wetland was 19 % during small storms in March 2008 but a negative impact during the larger storm was observed. There was little effect on nitrate reduction during small storms with the average removal of 1.5 % nitrate. This was most probably due to low soil temperatures in March 2008.

The size, location, materials and vegetation used in the features are the key to the practical, economical implementation and maintenance of FIRM plans. The goal of FIRM plans are simple but achievable: *intercept, store, slow* and *filter* runoff during storm events, using strategically placed soft engineered features. The experiment has given rise to a series of practical, fundable interventions for adoption on farms and we suggest that they would work at the larger catchment scale and address urgent Water Framework Directive needs.

HEAVY METAL BIOACCUMULATION IN TE ARAWA LAKES KOURA: SEASONAL CHANGES IN TOTAL MERCURY

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Analyses of rainbow trout from several of the Te Arawa lakes in the early 1990's identified bioaccumulation of mercury above recommended safe food limits (0.5 mg/kg) prompting advice to limit the consumption of trout from some lakes. Other edible biota in the Te Arawa Lakes includes koura and kakahi. We have examined concentrations of several heavy metals in the hepatopancreas (HP) and tail flesh of koura from Lakes Rotorua, Rotoiti, Rotoehu, Rotoma, Okataina, Okareka, Tikitapu, Tarawera and Rerewhakaaitu.

Patterns of metal accumulation in the tissues of koura reflect tissue-specific chemical partitioning (e.g., cadmium and manganese are strongly associated with the HP), lake geochemistry (e.g., cadmium is high in koura from Lake Rotoma) and lake trophic status (e.g., manganese is significantly higher in koura from eutrophic lakes).

Unlike trout, where mercury is preferentially associated with the liver rather than the fillet, koura exhibit higher concentrations of mercury in the edible tail flesh, reaching more than 20 times the safe food limit. Patterns of mercury accumulation indicate that mercury is higher in degraded lakes such as Rotoiti, and that mercury bioavailability shows a strong seasonality (high in winter, low in summer). We hypothesise that methylmercury produced in anaerobic lake sediments during summer stratification stays trapped within the hypolimnion or distributed among a large summer plankton biomass. Breakdown of the thermocline during autumn and a winter decline in plankton abundance allows mercury to redistribute to aquatic macrofauna where it accumulates to high concentrations. Further research is needed to test these assumptions and to examine rates of methylmercury elimination from edible macrofauna in the Te Arawa Lakes.

LAKE REREWHAKAAITU CATCHMENT – NUTRIENT MANAGEMENT PROJECT

Bob Longhurst [1], Martin Hawke [2], Bob Parker [3], Sheree Balvert [1]
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Lake Rerewhakaaitu is a shallow lake, unique amongst the Rotorua Lakes, for having a catchment mostly of dairy farms. In 2001, EBOP reported that water quality was satisfactory but noted that nutrient levels in streams flowing into the Lake were increasing. Farmers within the catchment were concerned about: 1) future condition of Lake and 2) possible imposition of constraints on their farming operations. A two-phase Sustainable Farming Fund (SFF) project was set up to address the water quality issues by identifying ways that pastoral management in the catchment could be changed to minimise the environmental impact on the Lake, while allowing sustainable dairy farming to continue.

Phase 1 focused on nitrogen (N) management. A farmer survey was conducted and OVERSEER® nutrient budgets were conducted for 27 dairy farms. Predicted average nitrate leaching was 38 kg N/ha/yr, a figure similar to other dairying catchments. From farmer discussions it became clear that accurate measurement of effluent blocks were essential as variations existed between actual and assumed areas. This resulted in nutrient loadings of nitrogen and potassium being in excess of pasture requirements. Farmers have made the following changes: reduced or nil N fertiliser applied to effluent blocks, reduced N fertiliser applications during autumn/winter, reduced total nitrogen inputs onto farm.

Phase 2 focused on phosphorus (P) management. Farm soil Olsen P averaged 65, exceeding the optimum (35-45). The farmers recognised the need to reduce soil Olsen P to optimum levels to reduce P loss. Pumice soils are amongst highest risk soils for P losses mainly coming from: 1) erosion of soil particles, 2) surface runoff, and 3) leaching on Tarawera ash soils. As P loss does not occur from whole catchment but rather from "critical source areas", the research focus was to concentrate on identifying the main pollutant form of P so that appropriate on-farm mitigations could be installed. Five sites were selected within the catchment for installing P mitigations and collecting surface runoff measurements to evaluate efficiency of P removal. The mitigations investigated have included filter strips (both grass and artificial), sediment traps, P-socks filled with steel/iron slag or a combination of these mitigations.

The success of the project has been the close interaction between the farmers and the science providers through frank discussions, regular farmer meetings and newsletters.

DISSOLVED OXYGEN DYNAMICS AND SIMULATION BASED ON DYRESM-CAEDYM IN LAKE ROTORUA, NEW ZEALAND

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Dissolved oxygen (DO) data at water surface and bottom were collected from a monitoring station at the centre of Lake Rotorua during 14 July 2007 – 30 May 2008. The bottom DO depletion occurred during stratification events with wind speed smaller than 4.0~5.0 m/s which is supposed to be the critical value for mixing in the lake. The lake was fully mixed when the wind speed was more than 6.0 m/s and there was little difference between the surface DO and the bottom DO. The bottom DO dynamics which may impact the sediment release in the lake is therefore mainly controlled by meteorological conditions.

The DO depletion events were reproduced very well by a 1-D model (DYRESM-CAEDYM). The correlation coefficient between the observed DO and the simulated DO was 0.70 at the water surface and 0.85 at the bottom. The simulated temperatures at different depth of the lake were very close to the observed values and all the correlation coefficients were more than 0.90, which indicates that DYRESM-CAEDYM is a good water quality management tool for Lake Rotorua.

IS GORSE (LEGUMINOUS WEED) A WATER POLLUTER?

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Introduction

Detection of increased concentrations of nitrate in surface water and ground water, and awareness of the economic and environmental importance of N losses from agricultural land, have drawn attention to nitrate leaching. Many researchers have estimated the amounts of nitrate-N entering receiving waters as a result of practices associated with agriculture and forestry; especially the use of fertilisers, grazing, and land application of N-rich wastes. However, such estimates are not available for N-fixed weeds such as gorse (Magesan et al. 2008).

Gorse is an invasive and N-fixing weed, and has infested approximately 900,000 ha or 3.3% of New Zealand's total land area. Egunjobi (1981) compared productivity of nine New Zealand ecosystems containing gorse, other shrubs and trees, while Dyck et al. (1983) measured nitrate-N concentrations in soil solution collected under different disturbed ecosystems. Within Rotorua lakes catchment many land areas have been colonised by gorse along side with pasture and forests.

Objective
Our study aimed to estimate the amounts of nitrate-N leaching from soil under gorse stands.

Materials and Methods
A field trial on two "typical" mature stands of gorse at Tikitere Forest and Wharenui Station was established – within the Rotorua lakes catchment. Soils at both sites are classified as Pumice Soils (Hewitt, 1988).

Samples of soil solution (leachate) were collected monthly. Six porous ceramic suction cup samplers were placed 90 cm below the soil surface at each site. A similar number of samplers was installed at the same depth at a nearby pine plantation forest (*Pinus radiata* D. Don) on each site, to serve as a control. The nitrate-N concentration of samples collected between March 2006 and September 2007 was determined, as ammonium N and organic N was negligible in the soil solution.

Results and Discussion
At both sites, the concentration of nitrate-N in leachate collected from control sites (nearby *P. radiata* forest stands aged between 7 and 20 years) was negligible (Figures 1 and 2). During the first 3-4 months of the soil drainage season, mean values for nitrate-N concentration in leachate collected beneath the gorse stands were greater than 11.3 g m^{-3}, the limit set for potable water by the World Health Organisation. At Tikitere, nitrate concentrations under gorse did not fluctuate as much as those at Wharenui, and between November 2006 and March 2007 only one sampler contained leachate. At Wharenui, nitrate-N concentrations under gorse were high at the start of the drainage season and decreased during winter and spring.

To estimate leaching losses from the soil, the average nitrate-N concentration in soil solution samples was multiplied by the volume of water draining below the level of the ceramic cups. When nitrate moves below 90 cm in the soil, it is probable that it will reach the groundwater system, since most plant roots are within this depth. Estimated nitrate-N losses under gorse in 2006 and 2007 were 63 and 40 kg ha^{-1} at Tikitere; 59 and 36 kg ha^{-1} at Wharenui, differences being attributable to drainage fluctuations. The losses are within the amounts leached from dairy farms in New Zealand. For control sites, nitrate-N losses over the same periods were 0.7-0.8 kg ha^{-1}.

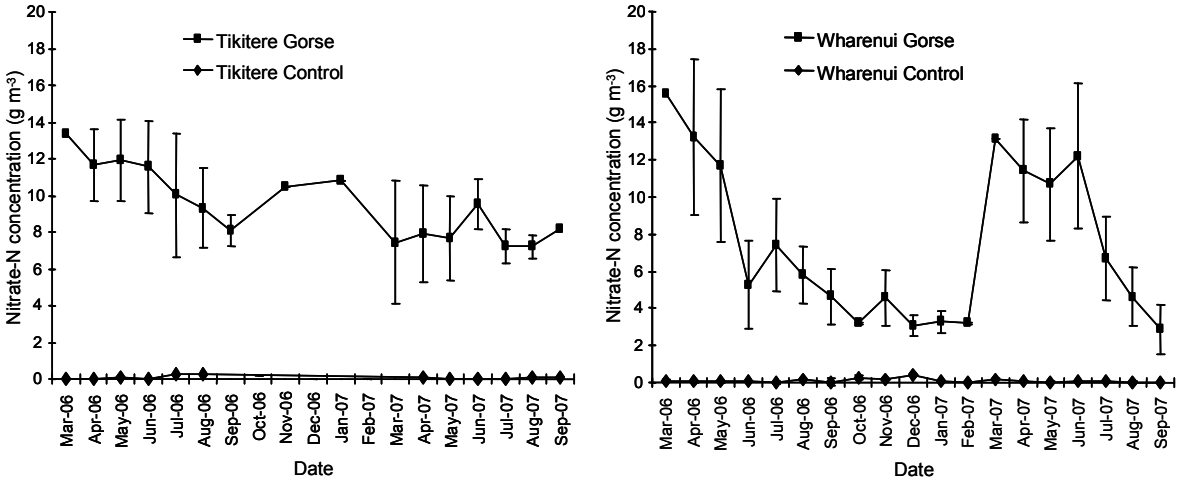

Figure 1. Mean nitrate-N concentrations in soil solution samples collected beneath the gorse stand at Tikitere (a) and Wharenui (b). Error bars represent s.e.m.

Conclusions

We conclude that considerable amounts of the N continuously fixed by gorse accumulate in soil and eventually pass into water draining from the site. Groundwater enriched with nitrate-N may enter the lake system and contribute to the eutrophication process. Nitrate concentrations in soil solution below the gorse rooting zone are sometimes higher than those acceptable for drinking water, but tend to decrease during winter months.

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HIGH FREQUENCY LAKE DATA FROM REMOTE MONITORING BUOYS

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A prototype monitoring buoy in Lake Rotorua and a meteorological station on land above Lake Tarawera have been in operation for more than one year. A further monitoring buoy has recently been installed in Lake Rotoiti and additional buoys are planned for Lake Tarawera and at another site in Lake Rotoiti. The monitoring buoys consist of a thermistor (temperature) chain, top and bottom oxygen sensors, a fluorescence (chlorophyll sensor) and an above-water meteorological station. The data can be accessed via a data management provider, iQuest (www.iquest.co.nz). The data have provided information about relationships between meteorology, stratification and deoxygenation in bottom waters, and have been used to examine associated changes in nutrient concentrations.

In Lake Rotorua, anticyclonic high pressure weather systems are responsible for inducing short-term stratification events (of order one week) during summer, leading to hypoxia of bottom waters and increasing nutrient concentrations up to five-fold. In the 2007-8 summer there were three of these events that led to complete loss of oxygen from the bottom waters, with each event generating nutrient release from the bottom sediments of similar magnitude to an entire annual supply from the lake tributaries. The inclusion of Lake Rotorua in a more extensive sensor network as part of the Global Lake Ecological Observatory Network (GLEON) will provide opportunities for more intensive testing and modelling of climatic effects on polymictic, eutrophic lakes; a group of lakes that may be quite sensitive to climatic change.

MONITORING WATER QUALITY IN THE ROTORUA LAKES USING WIRELESS SENSOR BUOYS

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Since 2006, Waikato University has been developing solar powered sensor buoys for monitoring water quality in the Rotorua lakes. In July 2007, a prototype buoy was deployed in the centre of Lake Rotorua. The buoy collects quarter-hourly data for meteorological (air temperature, wind speed and direction, humidity, barometric pressure, and rainfall) and water quality variables (chlorophyll fluorescence, dissolved oxygen, and water temperature through the water column). Data are collected via telemetry and posted in real-time to the Environment Bay of Plenty website. A second buoy was deployed on Lake Rotoiti in July 2008, and two further sites are planned before the end of the year. These monitoring stations enable the collection of accurate data at a high frequency not previously obtainable; important for detecting episodic events such as temporary stratification of Lake Rotorua. Buoy data will also serve an important purpose in establishing and validating lake ecosystem models for simulating current and proposed management strategies for lakes in Rotorua and around New Zealand.

RESTORATION OF LAKE OKARO

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Lake Okaro is a small, monomictic, highly eutrophic lake in the central North Island, New Zealand. It has a mean Trophic Level Index (TLI) of 5.5 (3-yearly average to June 2004), and is therefore classified as supertrophic. In the Lake Okaro Action Plan, the TLI objective for the lake is set at 5.0 and a nutrient reduction target is to decrease the nitrogen (N) and phosphorus (P) inputs from the catchment area over the long-term (15-20 years) and to manage the release of nutrients from the lake sediments in the medium term (5-15 years).

To meet the proposed target TLI, Environment Bay of Plenty formulated the following actions: (i) A P absorbent lakebed cap (that may also adsorb some forms of nitrogen), (ii) a constructed wetland to remove N and P from stream flows, (iii) protection of all riparian margins in the catchment, (iv) best management practices to reduce N leaching from land use over time.

This study focuses on the P dynamics and cycling in Lake Okaro in relation to restoration measures. Results show that the external loading of total phosphorus (TP) was reduced by around one-half after the wetland was constructed. The average TP concentration in the lake decreased roughly in proportion to the reduction in phosphorus input. Predictive models used to calculate the average TP concentration in the lake underestimate the observed data, indicating that internal P loading is a significant factor in Lake Okaro. Only for the last period from July 2007 until June 2008, when internal P loading appeared to have decreased substantially, did the predictive model approach the measured TP concentrations.

It is concluded that a combined effect of all restoration measures, which individually may be difficult to resolve, resulted in improved water quality in Lake Okaro leading to a TLI of 5.19 for the period of 2007 -2008.

THE SIGNIFICANCE OF SEDIMENTS IN MODIFYING THE AVAILABILITY OF NUTRIENTS IN TAUPO VOLCANIC ZONE LAKES – Ph.D Overview

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The North Island of New Zealand contains many lakes of volcanic origin which differ greatly in their trophic status and limnological characteristics. Preliminary research and past studies have shown that in some lakes there is significant natural denitrification (conversion of bioavailable nitrogen such as nitrate to inert nitrogen gas) taking place that confounds the existence of a direct relationship between nitrogen loads and within-lake concentrations. The purpose of my Ph.D. research is to determine the significance of diagenetic processes in volcanic lake sediments in influencing the availability of nutrients and consequently the trophic status of a variety of lakes in the Central Volcanic Plateau of North Island, New Zealand. Denitrification may provide at least a partial buffer against eutrophication caused by increasing nitrogen loads to the large volcanic lakes.

This research is highly important in linking effects of increasing nitrogen loads from land use change to the fate of the additional nutrients within the lakes themselves. This study began in August 2007 and will include an annual seasonal cycle for Lakes Taupo, Tarawera, Okataina, Rotoiti and Ngapouri; lakes of widely varying trophic status. The specific focus for my study includes:

a) Demonstration of the applicability of natural abundance nitrogen gas isotopic ratios for determining denitrification in lake waters and porewaters. This information can then be used to determine the extent of denitrification at the sediment/water interface and in the water column of lakes. This information will allow mass balance calculations to be made for nitrogen.
b) Determination of the oxidation/reduction reactions and concentration gradients of nutrients and metals across the sediment/water interface, to estimate internal loads of nutrients and metals through an annual seasonal cycle in lakes of different trophic status.

Knowledge from parts a) and b) will contribute to a process-based ecological model of the lakes, to obtain a whole lake perspective of the influence of denitrification and sediment-water exchanges on the dynamics of the lakes used for the study.

5000 YEARS OF HISTORY IN LAKE ROTORUA

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Analysis of a 10m long core taken from 24m depth water 1km north of Mokoia Island shows the influence of the changing environment around Lake Rotorua. The core terminated in 1m of Whakatane Tephra (5500 years BP) and contains several other recognizable tephras (Taupo, Kaharoa and Tarawera) from which accumulation rates can be estimated. Further time markers are provided by a peak in lead concentrations marking the use of lead as an antiknocking agent in petrol and 4 radiocarbon dates. Apart from the tephras, the sediment is dominated throughout by diatoms.

Most elements show a general increase in concentration starting 300 – 400 years ago, which we interpret as the result of increasing erosion from the catchment, possibly as a result of increasing frequency of fires and cultivation of kumara. Phosphorus concentrations begin to increase at this stage. A second trend seen in sulphur and arsenic appears to be driven by changing discharge of geothermal waters with pronounced peaks after the Kaharoa eruption (1314 AD) and about 200 years ago (prior to the Tarawera

eruption of 1886 AD). Recycling between the sediments and the lake water has modified the distribution of iron, manganese and phosphorus. There do not appear to be any obvious changes in the abundance of trace elements in the sediments which can account for the current eutrophic status of the lake.

VERMICOMPOSTING AND RECYCLING OF LAKE WEEDS

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Lake weeds are dug up along the lake shores of the Rotorua Lakes after strong winds or harvested by Environment Bay of Plenty to extract nitrogen from the lakes. Thousands of tons of lake weeds are currently disposed of in land fills and cause emissions to air and ground water. Compost worms have the potential to decompose lake weeds together with pulp and paper solids to produce a soil conditioner. This vermicompost could be applied to soils in lake catchments to improve soil function and nutrition and reduce runoff and leachate from soils.

A FLOW CYTOMETRIC METHOD FOR HAEMOCYTE COUNTS IN THE KOURA, *PARANEPHROPS PLANIFRONS*

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Enumeration of immune blood cells is an invaluable diagnostic tool in the assessment of human health, but its application to assessing the health of wild animals is limited by a lack of fundamental information about cell types and functions and a lack of suitable techniques to identify immune cells. A flow cytometric (FC) method for evaluation of total and differential haemocyte counts has been developed for the New Zealand freshwater crayfish *Paranephrops planifrons,* or koura. Of a range of anticoagulants and diluents, formaldehyde was found to be the only suitable medium for koura haemolymph sampling. Haemocyte populations were characterised by FC sorting based on differential light scatter properties, followed by staining with Leishman's-Giemsa and microscopic evaluation of cytocentrifuged isolates.

Cells were identified as hyaline, semigranular and granular, based on established invertebrate haemocyte classification. Hyaline cells were the smallest and were characterised by a high nucleocytoplasmic ratio and an absence of cytoplasmic granulation. Semigranular cells contained few to many translucent granules that did not generally respond to staining. Granular cells, the largest haemocytes, were packed with mildly to strongly eosinophilic granules. Total and differential counts were obtained on samples from two streams and three lakes in the Rotorua district, as an applied methodological evaluation.

Significant differences in total and differential counts were observed in one of the stream populations, potentially due to some local stressor. Specimens held in captivity for fourteen days experienced a 63% reduction in total haemocyte count, but no significant change in differential count was observed. The results indicate that flow cytometry may be valuable as a non-lethal diagnostic tool in determining how this culturally and ecologically valuable native species responds to environmental stress, in the broader context of environmental impact assessment.

RESTORING WATER QUALITY IN NEW ZEALAND LAKES – THE INFLUENCE OF INTERNAL LOADING AND FUTURE CLIMATE CHANGE

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The deterioration of water quality in freshwater lakes, due to human activities such as urban settlement, farming and forestry, has focused worldwide attention on the sustainability of lake environments. Today, great efforts are made to improve water quality using different lake restoration approaches. However, internal nutrient loading may delay or even prevent the water quality response to a restoration attempt. Concurrently, effects of climate change may interact to cause further deterioration of lake water quality, thereby rendering the present time-consuming and costly restoration efforts less productive.

In this study we used the one-dimensional DYRESM-CAEDYM model, developed at the Centre for Water Research, the University of Western Australia, to quantify the effects of climate change the ecosystem of Lake Okareka - a deep mesotrophic lake situated in the Bay of Plenty Region, New Zealand. This model includes a new complex sediment diagenesis module, which dynamically accounts for changes/responses in internal nutrient loading, thereby allowing us to estimate the consequences of future climate as well as the time scales at which the lake ecosystem will respond to changes in external nutrient loading.

GLOSSARY

This short glossary is intended as a guide to technical terms for those attendees who are not involved in science. Not all the technical words that you will hear can be expected to be listed below, but we have done our best! This is a shortened version of glossaries provided for our previous Lakes Symposia, reflecting the decreased emphasis on science this time.

UNITS

Abbreviation	Expressed as	Full name
mg	1×10^{-3} g	milligram (1/1000 gram)
μg	1×10^{-6} g	microgram (1/1000,000 gram)
ng	1×10^{-9} g	nanogram (1/1000,000,000 gram)

Abbreviation	Equivalent to
ppm (parts per million)	1 mg per litre (1 mg/l or 1 $mg.l^{-1}$) *or* 1 g per cubic metre (1 g/m^3 or 1 $g.m^{-3}$)

Algae
Primitive plants, often almost invisible to the naked eye. The term algae often also refers to microscopic plants that are suspended in the water of lakes or the sea (also known as phytoplankton). Excessive quantities of these can result in algal blooms.

Algal biomass
The amounts of algae present in the water. The concentration of chlorophyll-a is the most widely used method to measure and describe algal biomass.

Ammonia
Ammonia (NH_3 as ammonia or NH_4^+ as the ammonium ion) is the form of nitrogen that is easiest for plants to take up. It may be released from the sediment of lakes during periods when the dissolved oxygen concentrations in the bottom waters are low.

Anthropogenic
Derived from human activity.

Clarity
Often determined in lakes using a secchi disc (a disk painted in contrasting black and white 'pie wedges'). This gives a measure of the vertical distance that objects can be seen from the surface of the lake.

Chlorophyll-a
Often abbreviated to Chl-a. Chlorophyll-a is the major plant pigment responsible for photosynthesis. It is used to give an indirect measure of the amount of algal biomass in the water.

Cyanobacteria (cyanophyta)
'Blue-green algae'. Generally not regarded as algae (see above) these days, but are very primitive, usually microscopic, organisms that may sometimes produce powerful toxins. Common genera of cyanobacteria in the Rotorua lakes include *Anabaena*, *Aphanizomenon* and *Microcystis*.

Diatoms
Unicellular microalgae with silica shells, often very elaborate.

Dissolved reactive phosphorus
Phosphorus is an important plant nutrient. Dissolved reactive phosphorus is often measured in water as it stimulates the growth of algae.

Epilimnion
The upper, warmer, and circulating layer of a stratified lake. Generally high in dissolved oxygen. To clarify this in your mind, remember that a **hypo**dermic needle goes **below** your **epi**dermis.

Eutrophic
Eutrophic lakes have a high concentration of nutrients. This results in high algal biomass that in turn gives poor water clarity.

Eutrophication
Lakes develop from an oligotrophic state (high water quality) to a more eutrophic state (lower water quality) over geological time. Eutrophication is thought to be a natural part of lake development but the rate is increased by human activities which increase the input of nutrients, specifically phosphorus and nitrogen.

Hypolimnion
The cool and relatively undisturbed lower layer of a stratified lake. Often deficient in dissolved oxygen.

Limnology
Limnology is the study of surface freshwaters, their chemistry, interaction with land and air, and of the freshwater communities which they support.

Macrophyte
Macroscopic (i.e. larger than microscopic) plants. Aquatic macrophytes are water plants.

Mesotrophic
The water quality of mesotrophic lakes is intermediate between oligotrophic and eutrophic lakes.

Nitrate
Nitrate ($N0_3^-$) is a form of nitrogen readily available for plant growth.

Nitrogen
A major plant nutrient, occurring in various chemical compounds. Often abbreviated as "N".

Oligotrophic
Oligotrophic lakes have a low concentration of nutrients. This results in low algal biomass and high water clarity.

Phosphorus
A major plant nutrient, occurring in various chemical compounds. Often abbreviated as "P".

Phytoplankton
Very small plants or plant-like organisms living freely suspended in water

Plankton
Microscopic (usually) organisms living freely suspended in water

Stratification
In lakes usually applies to thermal stratification, in which warming of the surface waters leads to the formation of three layers of water, warm, sharply cooling, and cold (as seen from the surface down).

Thermocline
The layer (usually narrow) of water between the epilimnion and the hypolimnion is known as the metalimnion, where the temperature changes rapidly over a short distance in a stratified lake. This sharp temperature gradient is called the Thermocline. Also known as the discontinuity layer.

Total phosphorus
Total phosphorus includes dissolved forms, phosphorus adsorbed to particles and phosphorus in algal cells. Total phosphorus can be used to define the trophic state of lakes.

Toxins
Poisonous compounds or elements

Trophic state
Trophic state describes the productivity of lakes. It may be determined using single measures of water quality (e.g. algal biomass, clarity and nutrients) or a combination of measures.

Water column
The full depth of a body of water, from surface to bottom