NUTRIENT TRADING IN LAKE ROTORUA: WHERE ARE WE NOW?

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Abstract

A number of decisions need to be made when setting up a nutrient trading system including defining a target, allocating allowances and setting up a monitoring system. To ensure that the nutrient trading system implemented operates in harmony with existing regulation, existing work and institutions need to be used to guide this decision making process. This paper briefly explores each of the decisions required to implement a nutrient trading system and to what extent they have been addressed so far. This will provide context for following papers which will examine each issue in more depth.

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Q53, Q57, Q58

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Water quality, nutrients, trading, Lake Rotorua

Introduction

Water quality has been declining in Lake Rotorua for at least the last 30 years due to increased levels of nutrients entering the lake (PCE 2006). The increase in nutrient levels has led to increased frequency of algal blooms, which limit recreational water use and affect the local fish, plant and animal populations. Substantial effort has been undertaken to improve water quality through reducing the nutrient levels within the lake. Despite these efforts, the amount of nutrients entering the lake is still above sustainable levels and the costs of incremental improvements, and hence political resistance, are beginning to escalate. Therefore, new efforts are needed. One potential solution is the implementation of a nutrient trading system which, if designed well, would complement the existing policies. This paper will discuss the decisions that are needed to implement a nutrient trading system and how existing institutions, policies and research can be used as a basis for these decisions.1

A number of groups have already been set up to manage the problem. The Joint Strategy Committee was set up in 2002 to coordinate the efforts of Environment Bay of Plenty (EBOP), Rotorua District Council (RDC) and Te Arawa Maori Trust and monitor the implementation of policies. A substantial amount of research has been carried out in this region. To evaluate and coordinate this research, two Technical Advisory Groups (TAGs) have been set up. One of these groups focuses on the lake dynamics and hydrological/water quality interface while the other focuses on best land management practices and land use change options. To represent and liaise with the local community, the Lakes Water Quality Society (LWQS), which initially focused on weed issues, has been set up. This group has organised a number of symposia to educate the public on water quality and nutrient loss issues and has prepared submissions to EBOP and RDC.

In addition to the formation of these groups, a substantial amount of work has been carried out to actively reduce the level of nutrients entering the lake. For example, a sewerage reticulation system has significantly reduced the level of nutrients entering the lake from urban sources. Regulation has been implemented to prevent any increase in nutrient loss from non-urban areas. Under Rule 11, the nutrient loss from each property is benchmarked and prevented from increasing. Thus,

[1] This paper builds on Kerr et al (2007).

if a landowner wishes to change his land use or management practices in a way that will increase nutrient loss, he must offset this increase in other ways. He could, for example, create riparian boundaries. Programmes, such as those funded by the Sustainable Farming Fund (SFF), have focused on educating landowners and facilitating the adoption of technology to reduce nutrient loss.

The current work to improve water quality in Lake Rotorua has already identified a goal in terms of water quality and nutrients entering the lake. Research and administrative infrastructure have been set up. These can be used to guide the decisions needed for setting up a nutrient trading system.

A nutrient trading system would enable regulators to directly control the level of nutrients lost from the land and subsequently flowing into the lake. To implement such a system we need to do each of the following:

- Define goals
- Define tradable units: allowances
- Determine scope: who is included in the system; who is responsible for nutrient loss outside the system
- Set trading caps
- Allocate allowances to individual legal entities
- Monitor nutrient loss from each property and water quality
- Ensure that allowances are not exceeded
- Design a governance mechanism for adaptive management
- Source funding to operate system

The success of a nutrient trading system depends on each of the above factors. Thus, each needs to be carefully considered prior to the implementation of the system.

Building on existing efforts has two benefits. First, it ensures that work is not duplicated. Second, by utilising existing frameworks, the nutrient trading system that is developed will operate in harmony with other regulations. Many of the existing institutions and policies will be able to be used in either their current or a slightly modified form. However, in some cases, where the existing work is inappropriate or does not exist, new institutions and policies may need to be developed.

This paper briefly addresses the issues listed above, and to what extent they have been addressed, in order to provide a context for more detailed work on each issue in later papers.

Identifying the Goal

The water quality goal needs to balance the benefits of improved water quality to the local and wider community, against the costs of achieving it. Consequently, efforts are likely to be made to improve the water quality but not in a manner which cripples the local economy. The decision regarding the water quality goal needs to be made using a combination of cost benefit analysis and political processes. This goal needs to be defined in terms of things people care about directly such as water clarity or the probability of algal blooms.

Water quality depends on the level of nutrients in the lake. Once the water quality goal has been identified, it needs to be related to the level of nutrients in the lake because these can be measured, and more directly controlled, while having a strong relationship to the outcome in which we are really interested. We can identify the level of nutrients in the lake which will allow the water quality goal to be met, at least on average. From a management point of view, it may be more useful to know what level of nutrients flowing into the lake will allow the water quality goal to be met. Thus, the water quality goal may need to be expressed in two ways: the level of nutrients in the lake and the amount of nutrients able to flow into the lake. The difference between the ‘stock’ of nutrients and the flow depends on the residence time of the nutrients in the lake.

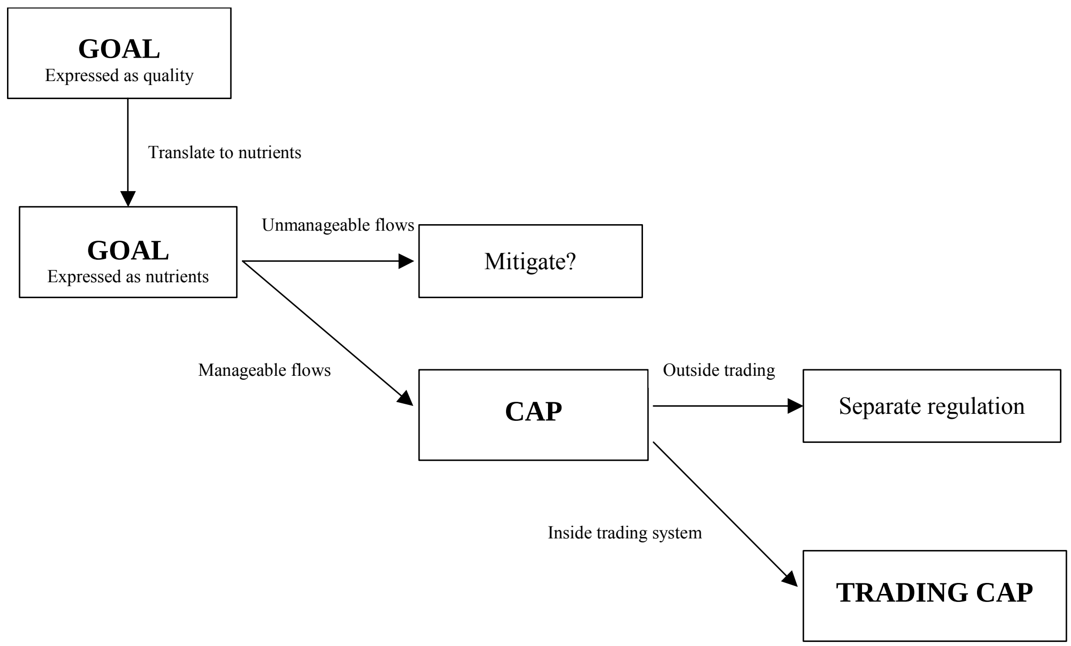
Water quality in Lake Rotorua is monitored using a number of different measures. The water quality goal that has been identified is defined using a summary measure, the trophic level index (TLI). The target TLI for the lake is set at 4.2 TLI but currently water quality in Lake Rotorua is 5.0 TLI. This goal has also been defined in terms of the amount of nutrients that are able to flow into the lake. Research has suggested that the water quality goal can be achieved with 435 tonnes of Nitrogen and 35 tonnes of Phosphorus entering the lake each year, if the lake is in equilibrium. These could be used as the basis for the nutrient trading system, but identified sustainable nutrient flows are currently being exceeded.

Setting the Cap

Once the goal is expressed in terms of nutrients, we can determine the amount of manageable nutrients able to enter the lake, or the cap (Figure 1). The goal provides a measure of the amount of nutrients able to enter the lake from all sources. However, some of these nutrients are going to be from 'unmanageable' sources and these will not be affected by any policy introduced now. This includes nutrients entering the lake from the sediment and nutrients that are already in the groundwater system.[2] Thus, to manage the nutrients entering the lake, we need to identify the amount of nutrients entering the lake from manageable sources. To do this, we need to realistically estimate the level of unmanageable flows. By subtracting the unmanageable nutrients from the level of nutrients defined in the goal, we can identify the nutrients able to enter the system from manageable sources, or the cap.

[2] Some of the nutrients entering the system from "unmanageable" sources can be mitigated through the use of flocculants for example. However, this mitigation is not an optimal long term strategy for addressing the problem of nutrients entering the lake.

Figure 1. The relationship between the goal, cap and trading cap for nutrients entering Lake Rotorua in a nutrient trading system.



The level at which the cap is set determines the environmental effect of the system. If the cap is set too high, more nutrients will flow into the lake than the lake is able to support and the water quality goal will not be achieved.

Estimates are available on the amount of nutrients entering the lake from various sources (Table 1). Estimates of the future flows of nutrients that are already in groundwater are also available. Combining these we are able to estimate the manageable and unmanageable nutrient flows into the lake.

Table 1. Lake Rotorua's nutrient inflows using land use nutrient export coefficients

Land use	**Area (ha)**	**N loss coefficient (kg/ha/yr)**	**N load (t/yr)**	**% of total N**	**P loss coefficient (kg/ha/yr)**	**P load (t/yr)**	**% of total P**
Native forest & scrub	10,588	4	42.1	5.4	0.12	1.31	3.3
Exotic forest	9,463	3	28.4	3.6	0.10	0.95	2.4
Cropping & horticulture	282	60	16.9	2.2	2.00	0.56	1.4
Pasture	20,112		563.0	71.9	0.84	16.93	42.5
• Beef	1,196	35	41.9	5.3	0.9	1.08	2.72
• Sheep	28	16	0.5	0.1	1.0	0.03	0.085
• Sheep & beef	10,240	18	184.3	23.5	0.9	9.22	23.12
• Deer	418	15	6.3	0.8	0.9	0.38	0.935
• Deer/sheep/ beef	1,294	18	23.3	2.9	0.9	1.16	2.89
• Dairy	5,883	50	294.1	37.5	0.7	4.12	10.3275
• Grassland	425	12	5.1	0.6	0.9	0.38	0.935
• Other	628	12	7.5	0.9	0.9	0.57	1.445
Lifestyle	556	20	11.1	1.4	0.90	0.50	1.3
Urban	3,267		50.1	6.4	1.17	3.82	9.6
• Sewage			28.0	3.6		1.00	2.5
• Septic tanks			12.0	1.5		0.53	1.3
• Stormwater			10.1	1.3		2.29	5.8
Springs						13.00	32.7
Geothermal			42.2	5.4		1.40	3.5
Waterfowl[1]			1.4	0.2		0.80	2.0
Rain	8,079.0	3.6	29.2	3.7	0.16	1.33	3.3
Total Catchment Inflows	**52,347**		**783.1**	**100**	**0.76**	**39.80**	**100**

[1] The nutrient inputs from waterfowl grazing will vary considerably from year to year as numbers of birds in the catchment fluctuate. In terms of "strict" nutrient budgeting, most of the nutrient inputs are termed "recycling" when the waterfowl eat lake plants. The waterfowl figures are included in this table for comparison only, and are not included in the total tonnages or percentages.

Source: Table 6, Draft Lakes Rotorua and Rotoiti Action Plan.

Scope of the Trading System

A nutrient trading system is only one way of managing nutrient flow into the lake and may not be appropriate for all sources of nutrient loss. Thus, some sources may not be included in a nutrient trading system. For example, it may be more appropriate for the nutrient loss from urban areas to be controlled under separate regulations.

New Zealand's fisheries management policy provides one example of a system where only some groups are included in the trading system, but where total harvest is controlled. Many New Zealand fisheries are harvested by three different sectors: customary, recreational and commercial. Only commercial fishermen are regulated under a tradable quota system, the Quota Management System (QMS). Prior to the start of the fishing season, the total allowable harvest for each species is set. Estimates of the current harvest levels by customary and recreational fishermen are calculated. Then, customary fishers are allocated a proportion of the allowable harvest that is large enough to cover their fishing entitlements. The remainder of the allowable harvest is then split between recreational and commercial fishermen. The allocation given to the commercial sector forms the trading cap required for the QMS. Thus, excluding some sources from the trading system does not need to compromise the ability of the system to achieve its goals.

The current regulations provide some potential guidelines for determining the scope of the system. Under Rule 11, the nutrient loss from all rural properties is benchmarked. Rural landowners are also restricted from making land use or management decisions that will increase the nutrient loss without mitigating the increase in nutrient loss. This rule excludes urban land uses. The nutrient trading system could follow this and exclude urban land uses. This would mean that the nutrient loss from urban land would need to be managed separately.

Setting the Trading Cap

Once the scope of the trading system is identified, the trading cap can be determined. To do this, the nutrient loss from the sources outside of the trading system needs to be estimated. The remainder of the cap once the sources outside the trading system have been subtracted equals the trading cap.

The trading cap must be expressed in a way that can be allocated to and monitored at the individual property level. This allows regulators to ensure that individuals are not exceeding their nutrient allowances.

Allocation of Allowances

One of the most politically difficult decisions when setting up a trading scheme is the initial allocation of the allowances. The allocation method used will not have any environmental effects. There are also no efficiency effects if the trading system works well. But there are large distributional effects associated with the allocation mechanism chosen. Once nutrient loss is limited, the resources devoted to controlling nutrient loss will rise and the allowances will become increasingly valuable. Those who must control nutrients will face high costs and those who are allocated allowances for free will receive something of high value. This makes it important to identify an acceptable mechanism for allocating allowances.

Through the benchmarking process carried out for Rule 11, we will obtain an estimate of current nutrient loss from all non-urban land uses. This benchmark could provide data for the allocation process. But as this data was not collected for allocation purposes, there may be resistance to its use in an allocation process. In any case, should we allocate allowances based in any way on current nutrient loss? This could reward landowners who currently lose a large amount of nutrients off their property and punish those who have taken steps to reduce nutrient loss. One alternative could be to allocate allowances based on long-term land use possibilities, but this may mean that some landowners would not receive sufficient allowances to cover their current nutrient loss. Rule 11 also creates a precedent that landowners may not increase their nutrient loss relative to today's level without offsetting that increase.

There is another precedent in the system for who pays for nutrient reductions. To date, the costs of reducing nutrients entering the lake are largely being borne by rate and tax payers through RDC, EBOP and MfE.

Monitoring Nutrient Loss

Once a cap has been put in place and allowances have been allocated, monitoring is required to ensure that allowance holdings are not exceeded. Landowners are going to have an incentive to exceed their allowances if a binding cap is placed on the system restricting nutrient loss. If all nutrient loss is covered by allowances, the cap will be met.

In an ideal system, we would like to directly monitor the nutrients lost from all properties and their impact on the lake but in reality this is not possible. Instead, we need to design a way to assess nutrient loss from each property and the relationship between nutrient loss and nutrient import into the lake and, hence, a way of relating the nutrient loss to the allowances needed. To achieve this, we need information on land use, management practices and location within the catchment, a model of nutrient loss and models of attenuation and groundwater lags (these may be combined). In addition to being able to model nutrient loss, we need to ensure that the information supplied for this model is accurate as landowners may choose to under-report their nutrient loss once the system is in place.

Under Rule 11, a nutrient leaching model, NPLAS, is used to calculate the nutrient loss from each property based on land use and management practices. This programme will be available to landowners to assist them with decision making in the future. A trial version is currently available on the web and an updated version of the model will be available shortly. Allowing landowners access to a model that predicts their nutrient run-off would enable them to calculate the nutrient remedial measure they would need to offset any increase in run-off resulting from changes in land use or management. Other models for attenuation and groundwater lags are also available.

The information feeding into the model must be verified and methods have been developed to verify data provided for Rule 11 benchmarking. Random audits are being used to deter landowners from misreporting nutrient loss. In addition to random audits, further investigations are carried out when reported data seems suspicious. For instance, satellite images and aerial photography are used to identify land use and information from the consent process is used to check management information provided by landowners. For example, consents provide information on the amount of dairy effluent from the property, which can be used to make inferences about animal numbers. Thus, by combining the land use and animal data, we obtain insight into whether a property is accurately reporting its nutrient run-off information.

Enforcement of Cap

To ensure that individuals do not exceed their allowances, enforcement mechanisms must be in place. A well-designed enforcement mechanism would reduce the likelihood of the trading cap being exceeded. If the monitoring and/or verification process reveals that an individual has exceeded their allowances, a penalty must be in place. Various options are available including requiring the individual to purchase enough allowances, fines and directly limiting future land use and management options.

If the nutrient loss was greater than expected, and consequently the allowances held by landowners were insufficient to cover losses, individuals could be forced to purchase extra allowances from the market. This could be expensive, and possibly infeasible, if there were limited allowances on the market. But if feasible, this method would ensure that the trading cap was not exceeded. Alternatively, individuals could be fined for exceeding their allowances. Unlike a requirement to hold allowances, using an enforcement mechanism such as a fine would have an environmental impact. Since the offending individuals would be exceeding their allowances without purchasing additional allowances, the trading cap would be exceeded, thus worsening water quality.

Enforcement mechanisms that limit use in a nutrient trading system need to be designed slightly differently to those used in an extractive tradable allowance system such as fisheries. In a fisheries system, once the cap has been reached, fishermen are prevented from harvesting any more catch until the following fishery season. But in a nutrient trading system, if the nutrients lost off the property reach the annual limit before the end of the year, it is not possible to prevent additional loss. Thus, if the regulator were to penalise individuals by preventing further nutrient loss, this would need to be through a reduction in future allowances or forcing the individual to reduce nutrient loss in the future. Because Regional Councils will run nutrient trading systems in New Zealand, the legal options for enforcement (and other issues) may differ from those available for a national programme run by Central government.

Under Rule 11, the nutrient loss from individual properties cannot be increased. Nutrient loss from each property is embodied in the resource consent. Thus, if the landowner exceeds their nutrient loss benchmark, they would be violating their resource consent and could be taken to court.

Governance mechanism: adaptive management

Any nutrient trading system that is designed for current conditions and with existing information will quickly become outdated as new scientific and economic information becomes available and social and political priorities change. For example, as new mitigation methods become available, the model for determining nutrient loss needs to be updated to ensure it remains as accurate as possible and provides the correct incentives for landowners.

Prior to introduction, the institution(s) responsible for managing the evolution of the system needs to be identified. Continued research will need to be carried out. Thus, a process for identifying the relevant research is needed. As research findings may lead to changes in the system, it needs to be clear what areas of the system can be changed and through what governance process. Any updating of the system needs to be carried out in a manner which incorporates new information and political decisions effectively without introducing unnecessary uncertainty.

The draft Action Plan created for improving the water quality in Lake Rotorua has a series of reviews scheduled. This will enable the report to be updated in the future. Nutrient reduction targets for land use are to be reviewed 3 years after the Action Plan is operative and the entire report will be reviewed after 10 years. But while this plan outlines time periods for revising the targets, it does not provide insight as to how this might be done. To provide certainty for landowners, a clear method of updating the system needs to be identified.

The governance of water quality work for Lake Rotorua is being carried out by a number of institutions. These include the Joint Strategy Committee, Environment Bay of Plenty, Rotorua District Council and the Technical Advisory Groups. These same institutions could be used to manage a nutrient trading system.

Funding the Operation of the System

Before a nutrient trading system can be implemented, the funding sources for the expenses associated with its operation need to be identified. The implementation and running of a nutrient trading system can be costly and have three distinct components. First, there are one-off costs associated with setting up the system including the trading mechanism. Second, there are on-going costs associated with the administration and monitoring of the system. Finally, there are on-going costs to continue research and carry out adaptive management to ensure that the system remains relevant and evolves in response to changes in knowledge and preferences. The funder(s) of each of these components needs to be identified prior to the implementation of the system.

Currently, work on water quality in the Rotorua Lakes is funded by a variety of sources at both local and central government levels. Environment Bay of Plenty, Rotorua District Council, the Ministry of Agriculture and Forestry and the Ministry for the Environment are all funding policy development regarding water quality in Lake Rotorua. Since the nutrient trading system is not currently in place, no organisation is funding its maintenance or the associated monitoring. But Rule 11 work is funded by Environment Bay of Plenty. On-going research costs are being borne by Environment Bay of Plenty, the Sustainable Farming Fund and the Foundation for Research, Science and Technology. Should these same organisations fund a nutrient trading system?

While these organisations may be potential funding sources for a nutrient trading scheme, stakeholders may also be a source of funding. In the Quota Management System developed to manage New Zealand's fisheries, the commercial fishing industry pays for all costs attributable to commercial fishing. The system is set up in this way so that those who benefit from the system (i.e. the fishermen) fund its maintenance and the research associated with it. Thus, the costs of the system are internalised. Should those who benefit from the improved water quality associated with the nutrient trading system fund the system's maintenance and the research associated with it? If so, which groups benefit? Tourists? Residents? Exporters who benefit from New Zealand's clean green image? Fishermen? This will ideally be decided prior to the system's introduction.

Conclusion

A number of institutions and regulations are already in place to improve water quality in Lake Rotorua. When setting up a nutrient trading system, we can use institutions, policies and research already developed as a basis for the trading system. But a trading system has many components and it is not possible to base all of these on current institutions and policies. In some cases, the institutions and processes in place are not relevant for a nutrient trading system. In other cases, institutions and processes required for a nutrient trading system are unnecessary under current regulations. But by working from existing policy, we are able to create a more harmonious system for managing water quality and preventing duplication of work. This is the first in a series of background papers. Future papers will address each of the components in a nutrient trading system in more detail.

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