Nutrient Trading in Lake Rotorua: Overview of a Prototype System

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Abstract

Water quality in Lake Rotorua has been declining for at least the last 30 years as increased levels of nutrients have entered the lake. Despite significant effort and expenditure, the level of nutrients entering the lake still exceeds sustainable levels. A nutrient trading system would help the catchment achieve this goal at least cost. Nutrient sources would bear the cost of their impact on water quality and hence take these costs into account in their decision-making. This paper presents a prototype nutrient trading system for achieving cost effective nutrient loss reductions for the Lake Rotorua catchment.[1]

JEL classification
Q53, Q57, Q58

Keywords
Water quality, nutrients, trading, Lake Rotorua

[1] This paper draws together preliminary conclusions from a series of papers on various aspects of design of a nutrient trading system for Lake Rotorua. It does not provide detailed justification for these conclusions. These arguments are provided in the underlying papers listed at the end which can be found at www.motu.org.nz/nutrient_trading.

1 Introduction

A nutrient trading system controls nutrient loss by setting the total amount of allowances equal to the environmental goal. All nutrient sources included in the system monitor their nutrient loss and must surrender sufficient allowances to cover their nutrient loss at the end of each trading year. Any source of nutrients can be included in the system, including landowners and sewerage plants.

The exact level of nutrient loss cannot be measured directly from most nutrient sources in the Lake Rotorua catchment. When the nutrient loss comes from diffuse sources (such as leaching through soil into the groundwater), models are required to estimate the nutrient loss off a particular property. Models for properties in the Lake Rotorua catchment have been developed by AgResearch, NIWA and GNS in conjunction with Environment Bay of Plenty. Within the nutrient trading system, one model, almost certainly incorporating a version of OVERSEER, will be used to calculate the nutrient loss for all properties in the system.[2]

If a source has insufficient allowances to cover their nutrient loss, they must purchase additional allowances from the market. If a source has surplus allowances, they can sell the extra allowances. Thus sources can receive direct financial benefits for reducing their nutrient loss. Nutrient sources that previously had sufficient allowances can sell their excess, and those that had insufficient allowances now need to purchase less to cover their nutrient loss. Trading allows sources with high costs of achieving nutrient loss reduction to pay the sources with a low cost of achieving nutrient loss reductions to undertake the necessary reductions, ensuring that nutrient reductions take place in the most cost effective locations.

[2] OVERSEER is a nutrient budgeting model that was developed by AgResearch. It estimates the nutrient loss of different types of properties based on geophysical properties such as soil type and rainfall, land use and farm management practices. Ideally, the same model will be used to model greenhouse gases in the New Zealand Emissions Trading System.

We envisage that this system would cover both nitrogen and phosphorus as both are important for long-term lake quality, and landowners need to collect the same information to calculate nitrogen and phosphorus loss. Thus the cost of including phosphorus in the system is low; however, the system administrator would need to maintain a registry for two types of allowances, and sources would have to balance two different nutrients against allowance holdings. These costs are low compared with the benefits of including phosphorus in the system.

2 Setting a cap and defining allowances

2.1 Setting a cap

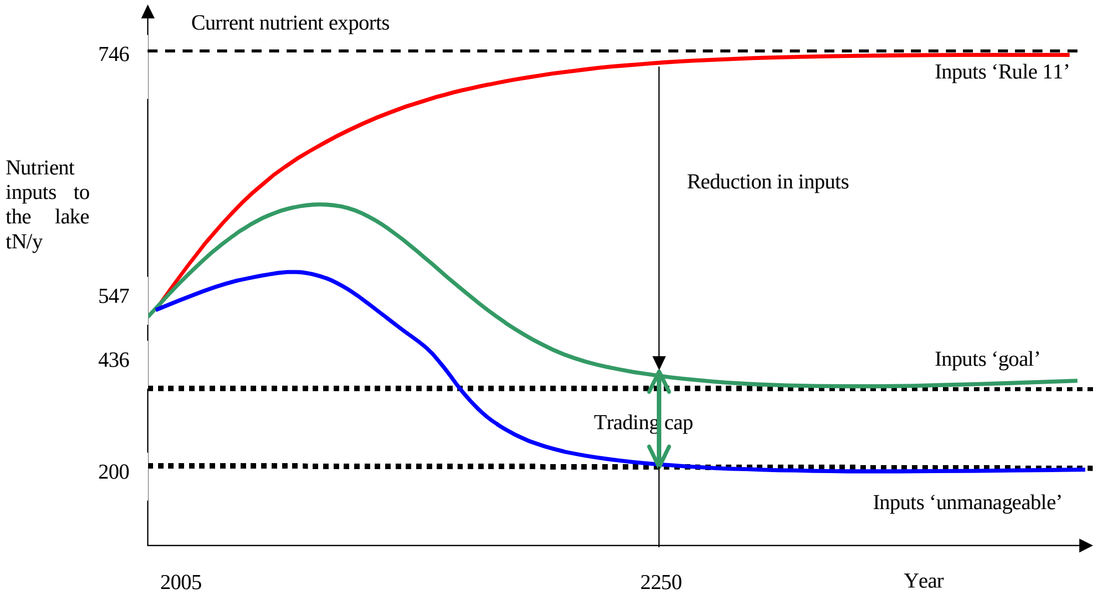
Before a nutrient trading system can be implemented, the acceptable level (or goal level) of nutrient loss into the lake each year needs to be determined. The exact path to these goals should be chosen through a well-informed political process that trades off both environmental and economic outcomes. Setting this path is beyond the scope of this project.[3] For the remainder of this paper we will assume that the path of these goals has already been determined.

For a nutrient trading system it is not the total amount of nutrients that reach the lake that is important, but the amount that is able to come from the sources within the system, or the ‘trading cap’ (Figure 1). A significant level of nutrients enter the lake from ‘unmanageable sources’ and in particular the nutrients already in the groundwater system in the Lake Rotorua catchment, which will enter the lake regardless of actions taken today. Other unmanageable flows include nutrient loss from rainwater, waterfowl and the baseline nutrient loss of 3 kg/ha/yr of nitrogen and 0.1 kg/ha/yr of phosphorus. In the nutrient trading system landowners will not be made responsible for the first 3 kg/ha/yr of nitrogen loss and 0.1 kg/ha/yr of phosphorus loss from their property as they cannot change land use to reduce below this level. To achieve the desired environmental outcome, the total level of nutrients able to enter the lake from sources within the

[3] We also do not consider action to divert nutrient flows or stabilise lake sediments.

nutrient trading system must be the goal level minus the amount of nutrients that will enter the lake from 'unmanageable sources'.[4] This will ensure that the environmental target is achieved, as the nutrient trading system will not exceed its cap. The trading cap determines the number of allowances created for each year.

Figure 1 The relationship between exports, inputs and unmanageable inputs in determining the trading cap



2.2 Vintage allowances

The position of each source in the Lake Rotorua catchment has significant implications for its contribution to the lake's water quality. While nutrients are uniformly distributed once they reach the lake, the location of a property determines how long they take to get there. Nutrient loss from properties in the catchment can take from 0 to 200 years to reach the lake because of groundwater lags. To account for this variability, we propose that a series of 'vintage' markets are used. Each market would cover the nutrients entering the lake in a given year and will have its own trading cap and allowances (Figure 1). In its simplest form, each allowance has a vintage associated with it and can only be used to cover nutrient loss that will reach the lake in that year. Thus the

[4] In this prototype system, all manageable nutrient sources are included in the system. If some nutrient sources were excluded from the system, then the trading cap would be even lower to take account of the nutrient loss from sources outside of the trading system.

nutrient trading system requires nutrient sources to be responsible for their input levels into the lake rather than the export levels off their property. As off-site attenuation does not play a major role in this catchment, the inputs and exports from a particular property can be considered equal, but these can happen in different time periods due to the groundwater lags. Each nutrient source in the catchment will be assigned to a single groundwater lag zone depending on how long their nutrient loss takes to reach the lake.

Vintage allowances will not make operating in the system more complicated for the nutrient sources as each will know what groundwater lag they have and therefore which vintage allowances need to be surrendered each year. For example, a property that has a one-year lag between the nutrients leaving the land and entering the lake will be in a one-year groundwater lag zone. The nutrient loss from the property will always need to be covered by allowances with a vintage one year from the current period. Thus in 2009 they need to surrender 2010 vintage allowances to cover their nutrient loss and in 2058 they need to surrender 2059 vintage allowances. A property with a 50-year groundwater lag will be in the 50-year lag zone and will always use allowances with a vintage 50 years from the present year: in 2009 they need to surrender 2059 vintage allowances and in 2058 they need to surrender 2108 vintage allowances. All nutrient sources in the catchment will surrender allowances each year to cover their nutrient loss but the allowance vintage used will differ across the groundwater zones.

Individual nutrient sources can trade with others in their groundwater lag zone, as well as with sources with different groundwater lag zones. Trading between different groundwater lag zones will impact upon the timing of exports from properties but not the timing of inputs to the lake. For example, using the properties described above, the 1-year groundwater lag property could buy 2059 vintage allowances off the 50-year lag property, shifting the exports from 2009 to 2058 but the same amount of nutrients will reach the lake in 2059.

If every nutrient source in the catchment were assigned an exact groundwater lag time, there would be up to 200 different groundwater zones since nutrients can take between 0 and 200 years to reach the lake. Thus in a given year, allowances of up to 200 different vintages would be surrendered. This is not ideal as the market for each allowance vintage will probably be too thin at any point in time, and in any case current groundwater modelling is not able to be this exact. Thus we suggest that groundwater zones are created where nutrient sources can use any allowance within their zone. For example, if there was a one to three year groundwater lag zone, a nutrient source in this zone could use any allowances with a vintage of 2010, 2011 or 2012 to cover their nutrient loss in 2009. More analysis is needed to determine the appropriate number and range of zones in a vintage allowance system for Lake Rotorua.

3 Who is included in the system?

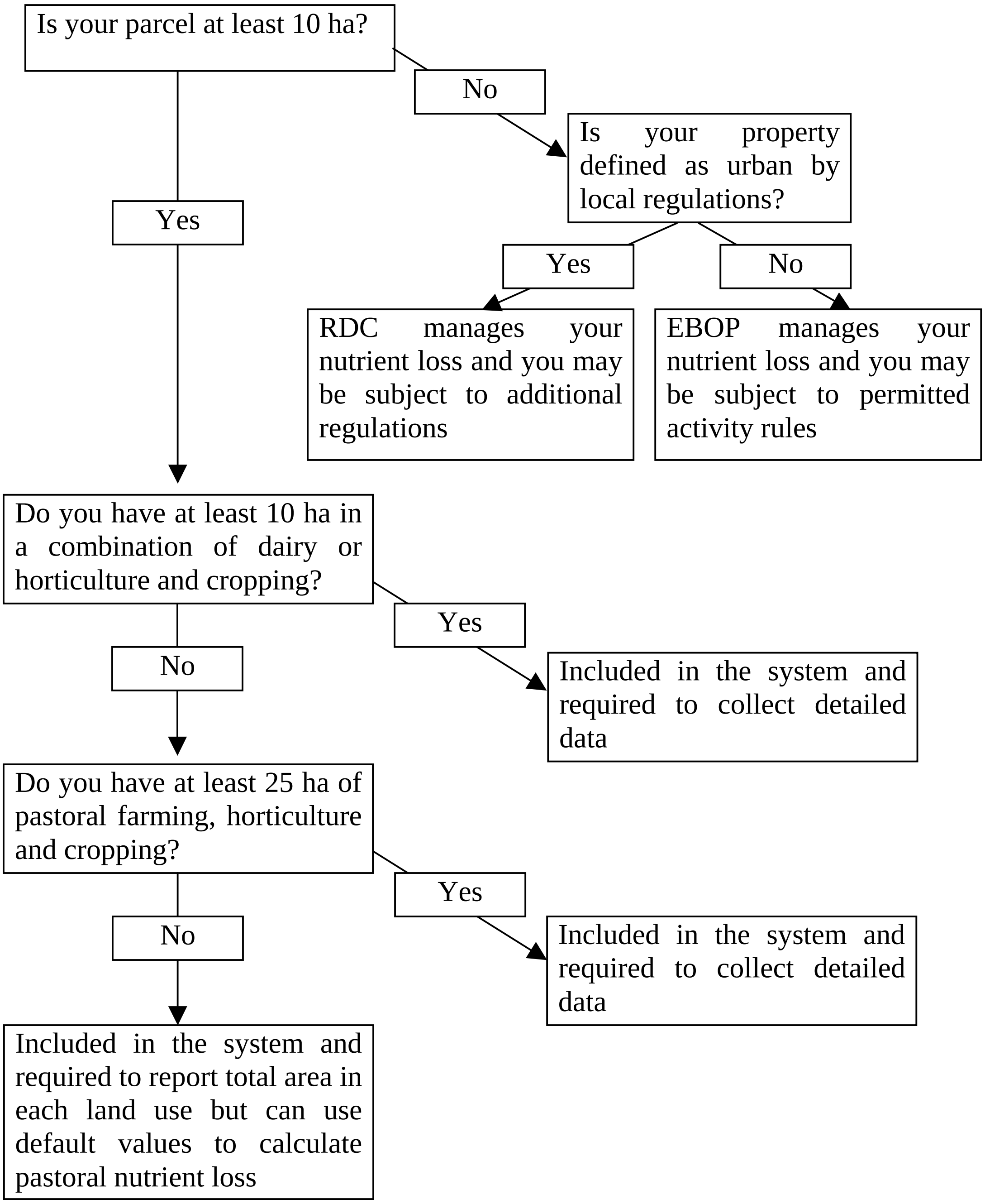
We propose to include all nutrient loss sources in the system as this provides the most nutrient reduction options and is therefore the most cost effective. To avoid high compliance costs for smaller nutrient loss sources, we propose three different forms of participation (Figure 2).[5] Nutrient sources will be direct participants in the system if the land use cover on their parcel exceeds at least 10 ha of combined dairy, horticulture and cropping land; or at least 25 ha of combined pastoral, horticultural and cropping; or they are point source dischargers. These participants are required to report detailed monitoring data to enable the nutrient loss model to be estimated. Nutrient sources that have parcels of at least 10 ha but which do not meet the above thresholds are included in the system but are only required to report the area of each land use. Their nutrient loss from pastoral farming can be calculated using default values provided by Environment Bay of Plenty (EBOP).[6] These landowners will have the option of reporting more detailed data. All parcels less than 10 ha are the responsibility of the Rotorua District Council (RDC) (if they are defined as urban under local regulations) or EBOP (if defined as non-urban).[7] The Department of Conservation is also responsible for nutrient loss off their land.

[5] These different forms of participation may need to be aligned with the emissions trading system if that system is introduced at a farm scale.

[6] The nutrient loss from exotic and plantation forestry is currently only a function of land use area. Therefore there is no need for default values for these land uses.

[7] Urban land is defined in EBOP's Regional Water and Land Plan as "an area which contains an aggregation of more than 50 lots or sites of an average size of no more than 1000m^2". The same definition should be used here to define urban and non-urban areas.

Figure 2: Rules for determining how a parcel is included in the nutrient trading system



Individual properties can be made up of multiple parcels, yet we propose that parcels rather than properties are used to determine whether land is included in the system. This is because parcels are less likely to change over time. Farmers often manage their parcels simultaneously, and the system would allow a landowner to submit a joint report. Since some of the parcels in a property may be less than 10 ha, the landowner can choose to include these parcels in the system.

However, to prevent parcels entering and exiting the system each year, we propose that once parcels are included they must stay in the system until the parcel is sold.

By including all nutrient sources in the system, we can ensure that the most cost effective nutrient reductions can be achieved while reducing compliance costs for small sources.

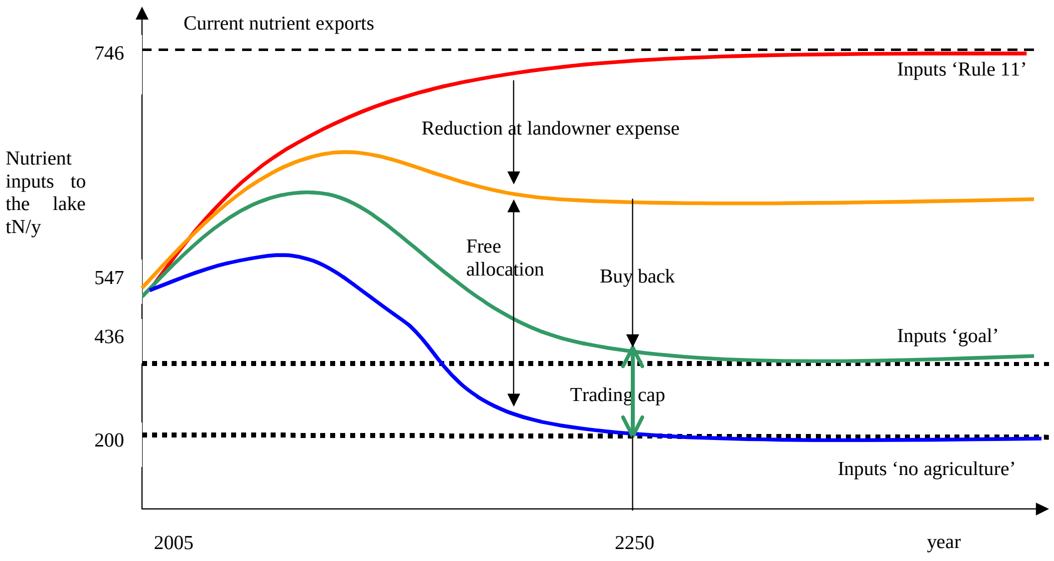
4 Who receives allowances?

Allocation of allowances is always one of the most contentious issues in any trading system because of the high value of the allowances and the considerable costs that regulation can impose. Therefore it is vital that the allocation rules are based on sound principles, are simple, and are based on readily available data that cannot be challenged.

We propose that the system initially allocates allowances to nutrient sources in proportion to their current nutrient loss to ease the initial economic impact. This does not ensure that nutrient loss sources receive sufficient allowances to cover their current nutrient loss, especially if the trading cap is lower than current nutrient loss levels. Also not all nutrient sources will receive the same vintage allowances. The vintage allowances received by the nutrient source will depend on their vintage zone. For example, a property with a 50-year groundwater lag will not receive any allowances from the first 50 vintages as the property will never be required to cover nutrient inputs for these years.

Allowing nutrient sources to maintain their current nutrient loss will not achieve water quality goals and therefore it needs to be decided who will pay for the required nutrient loss reductions. If only the number of allowances equal to the goal were allocated, the environmental target would be achieved but most of the cost of nutrient reductions would be borne by the nutrient sources. In contrast, if sufficient allowances were allocated to cover current nutrient loss, and the government bought back and retired sufficient allowances to meet the goal, then tax or rate payers would bear all of the cost and nutrient sources would actually profit from the system.[8] A point between these two extremes is likely to be ideal, with nutrient sources and central and local government each bearing some of the cost of achieving the reductions (Figure 3). In such a case, nutrient sources will be allocated fewer allowances than they need to cover current nutrient loss and central and local government will buy some allowances from the market to achieve the remainder of the reduction required to achieve the goal level of inputs.

Figure 3: Sharing the costs of reducing nutrient loss



The share of the reduction paid by each of the parties should be consistent across vintages and explicitly defined. For instance, it may look like the following:

- X% is through District Council buy-back
- Y% is through Regional Council buy-back
- Z% is through Central Government buy-back
- The remainder of the reduction is a proportional cut in unused allowance holdings of the appropriate vintage.

[8] The reductions that are funded by central or local government should be used to purchase allowances directly off allowance holders via a tender process where allowance holders submit tenders stating how many allowances of each vintage they are willing to sell and for what price. Allowances are purchased from the lowest price bids until the required allowances have all been purchased. A single buy back process could be used and the funding of the allowances split between the three funders.

This ensures that all parties bear some of the cost but that the reductions are not too great a burden on any party.

For allowances beyond the vintages that each landowner needs in the first few years of the system, the allocation mechanism will transition to one based on potential nutrient loss providing a more equitable system. This prevents landowners becoming trapped in their current land use if they do not have sufficient capital to purchase allowances and avoids rewarding high nutrient loss properties indefinitely. To enable this to happen, a measure of potential nutrient loss needs to be determined. Some potential options are land use capability (based on slope, soil type, etc.) and potential stocking rates applied through the OVERSEER model with 'standard' management practices.

The same calibration of OVERSEER (with add-ons) that is used to monitor the system should be used for allocation initially, to align allocation and obligations to surrender, and to reduce risk to participants. This limits the incentives for participants to bias model calibration. A landowner who increases nutrient loss to gain more allowances in the allocation process will be required to surrender more allowances each year.

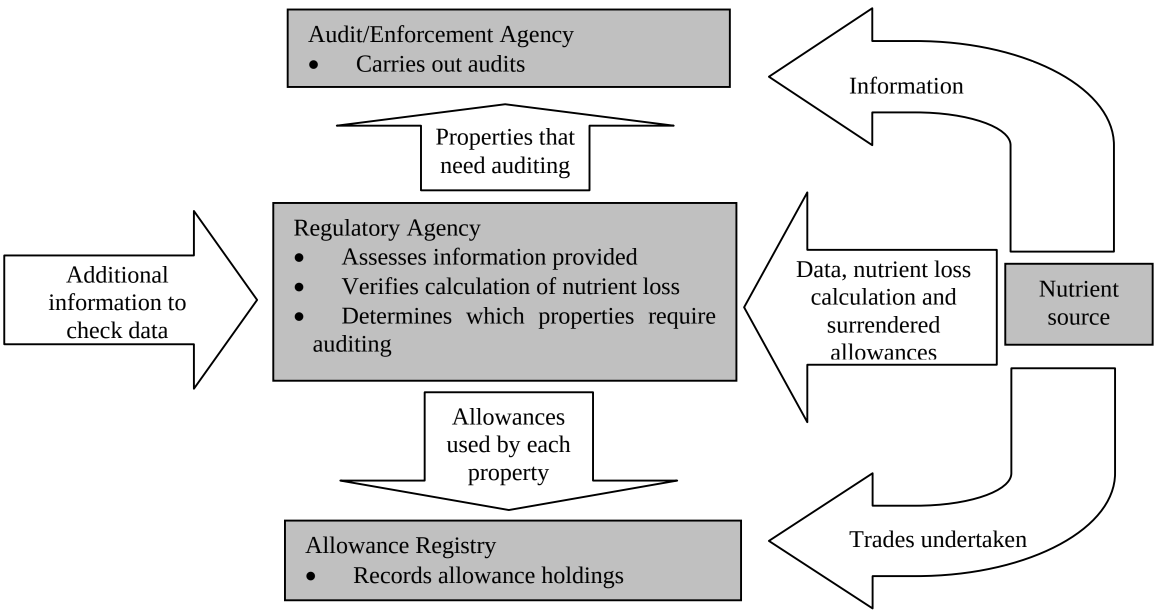
The allocation of allowances should be carried out in stages, rather than individuals receiving all future allowances at once. For example, individuals could receive vintage allowances relevant to their first five years in the system. This would protect those allowance holders who do not yet fully understand the system from selling allowances prematurely or at a low price. Initially only allocating five years of allowances also protects the system's credibility as it prevents the majority of allowances being used in the first few years. Using the majority of allowances early on would severely restrict future nutrient loss in zones with short groundwater lags. This would lead to increased pressure to increase the trading caps and/or abandon the system. Regular injections of allowances could also lead to periods of increased trading as individuals adjust their allowance holdings providing regular price signals for the market.

We propose that allowances are initially allocated as a proportion of current nutrient loss to ease the economic transition. After a few years this should transition to an allocation mechanism based on potential nutrient loss to prevent rewarding high nutrient loss sources and to prevent landowners feeling trapped in their current land use.

5 Reporting and compliance

The model used to monitor nutrient loss will be fixed before each compliance year so that participants can use it throughout the year when making management, compliance and trading decisions. To comply with the nutrient trading system, at the end of each compliance year sources must report data and run the model to calculate the nutrient loss off their property.[9] The landowner must have enough allowances in their registry account to cover all nutrient loss above the minimum 3kg/ha/yr baseline that plantation forestry achieves.

Figure 4: Information flows between different parties in the nutrient trading system

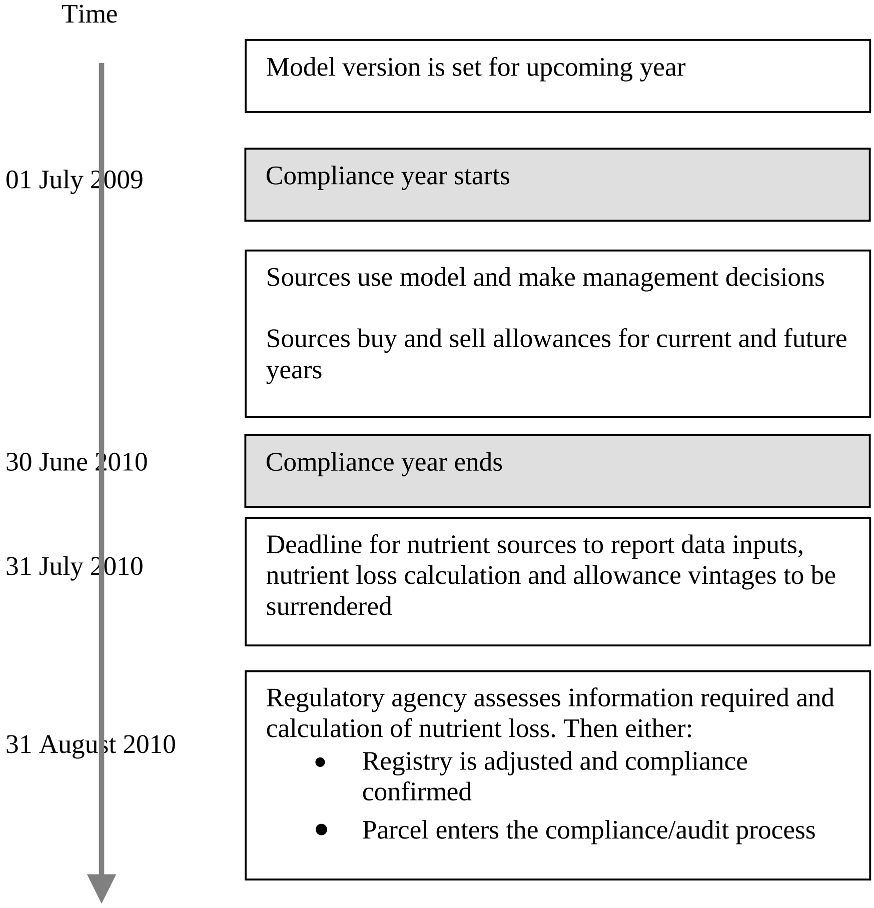


The administering agency checks the returns and, if satisfied, passes information on the number of allowances of each vintage to be surrendered to the registry. They also identify properties to be audited. Properties can be audited for two different reasons: as a spot check or due to suspicious returns. An auditing agency undertakes these audits. Once the returns from a property are accepted, the

[9] July – June years are probably the most suitable cycle for reporting nutrient loss and surrendering allowances. The timing of the trading year may, however, require further thought.

registry removes the surrendered allowances from the property's allowance holdings. Nutrient sources that have insufficient allowances to cover their nutrient loss will face a fine per missing allowance and will be required to 'make good' the damage. If the required allowances are of a future vintage and therefore still available to purchase, they will surrender these. If no appropriate vintage allowances exist (e.g. for the zero groundwater lag zone), they would surrender the next vintage. This penalty will probably need to be altered through time to ensure that it continues to be a deterrent against failing to cover nutrient loss.

Figure 5: Example of the possible timing of activities in the nutrient trading system



6 Trading

Individuals can trade allowances at any time. These trades can occur for any quantity and any vintages of allowances and the price is negotiated between the two parties. Once the trade has been finalised, both parties need to inform the registry to get the participants' allowance holdings altered. No pre-approval of trades is required.

There may be reasons for limiting who can hold allowances and how much any one entity can hold. For example, ownership of nutrient loss allowances could be restricted to individuals who own land in the catchment and therefore will actually be able to use the allowances. This would prevent outsiders from speculating on the market and potentially driving up the price and/or locking up the allowances so that they are not available for use. Other restrictions could be put in place to prevent monopolistic behaviour. Any restrictions should be strongly justified as they add complexity and reduce flexibility.

Our legal advice suggests that this simple form of trading can, in theory, be developed and operated within the context of the Resource Management Act (RMA) in its current form. This approach would involve a regime requiring regional consents (administered by EBOP under its Proposed Regional Water and Land Plan) for a range of activities that have the potential for nutrient leaching. The key element of the regime would be conditions on resource consents requiring specified numbers of nutrient allowances to be held and surrendered annually according to a process specified in the system rules. It is, however, important to note that the introduction and implementation of a nutrient trading programme is novel and to date legally untested.

7 Changing the system through time

A nutrient trading system that is designed for current conditions and with existing information will quickly become outdated as new information becomes available and social and political priorities change. In addition, this is an innovative policy instrument and unanticipated issues are likely to arise. To avoid a lengthy and potentially politically divisive process every time the system is altered, a clear adaptive management process should be put in place prior to the system’s introduction. First of all it is important to consider how to decide upon a specific change, then the process for implementing the change needs to be outlined. Two key features of the system are likely to require updating in the future are trading caps for each vintage and the model that is used to monitor nutrient loss.

7.1 Deciding on a change

The group who determines how and when changes in the system occur may face intense lobbying and pressure as various groups try to manipulate the system to their advantage. Thus we propose a two-tiered system: an advisory group and a smaller decision-making group. Firstly, a fairly large advisory group representing a range of perspectives considers the proposals for changes to the system, and then makes recommendations (which may not be unanimous). This group needs to be well supported by a strong research programme and technical advice. As it does not have decision-making power, this advisory group is more likely to make constructive decisions and achieve consensus when working through complex decisions. The group would present its recommendations, including any conflicting opinions, to a second smaller decision-making group. The smaller group is charged with making the final decisions about changes in the system. This group should use majority voting and be required to justify its decisions publicly.

Both of these groups should have a set of clear guiding principles. The groups should have open and generous discussion and base decisions on the strongest possible science (while not letting uncertainty paralyse the system). Futhermore, they should encourage innovation and avoid benefits to special interests. They should also aim to protect property rights and the system as a whole.

Once the smaller group decides a change, the initial system design needs to be modified to incorporate this change. Below, we discuss two of the most likely and disruptive changes to the nutrient trading system and how the process to implement them could be defined in advance.

7.2 Changing trading caps

A clear set of rules specifying how the nutrient trading cap is reduced should be outlined prior to the start of the system. These rules should specify how many years in advance the change is to be announced, and who will pay for the allowance reductions. This cost sharing should be based on the same principles as reducing nutrient loss when initially allocating allowances. For example, if allowance holders fund 30% of the initial reduction in allocated allowances, they should also fund 30% of any future changes in the cap. Similarly, if the trading cap were increased, allowance holders would receive 30% of the newly created allowances.

Fixing these cost sharing rules in advance ensures that future decisions are only about the appropriate levels of the caps and not about who is paying for them. This should focus discussion on the optimal social decision rather than being biased by special interests.

7.3 Changing the nutrient loss model

When changes are made to the model, landowners should not have to enter the market to purchase extra allowances in order to continue in their current land use and activities. Regulation should not impose retrospective penalties (or rewards) on specific properties. We propose that landowners' allocation of allowances are adjusted to account for the increase or decrease in allowances now needed to cover their nutrient loss. This involves giving allowances to or taking allowances from landowners to ensure that they are no better or worse off. If the new model alters the aggregate level of nutrient loss, the adjustments to allowance levels to restore the environmental goal should use the same mechanism to address changes in the trading caps as outlined earlier.

We hope that this prototype provides a good basis for assessing the feasibility and desirability of a nutrient trading system. We acknowledge that greater detail will be required to create a complete and functioning system. If a decision is made to explore this option further, this prototype provides useful guidance on areas that need more analysis and thought.

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