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Cap-and-trade of diffuse emissions of nitrogen in Lake Taupo Catchment. Reviewing the policy decisions and the market

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Executive summary

In 2011, Waikato Regional Plan Variation 5 – Lake Taupo Catchment (Variation 5) became operative, providing long term protection of water quality in Lake Taupo, New Zealand's largest lake. It was the culmination of more than ten years of policy development by the Waikato Regional Council (the council), involving consultation with affected landowners and the Taupo community, technical investigations, formal submissions and hearings processes, and Environment Court.

This report describes the policy decisions that formed the cap-and-trade scheme that is part of Variation 5, examines the characteristics of the nitrogen discharge allowances (NDA) held by farmers in the Taupo catchment, and describes early behaviour of the NDA market.

The Taupo cap-and-trade scheme is a market-based policy approach to managing water quality. The cap limits the total nitrogen emissions from agriculture into the lake. NDA holders can trade their right to emit. For the council, the attraction of this solution is that it provides certainty regarding limiting the quantity on nitrogen emissions, and achieves the desired water quality objective at the least cost. For farmers, it allows them to continue to make their own business decisions, provided they stay within the bounds of their resource consents.

Introducing new property rights for a resource that was previously available to all requires complex and difficult decisions. The policy is an innovative solution for limiting diffuse nitrogen emissions, which are not directly observable or measurable. Modelling farm systems provides a consistent approach to estimating farm emissions.

Assigning initial rights is a contentious process with no method perceived as fair by everyone. The decision to allow landowners to continue with current business activities was a key factor in opting for historical allocation. The reduction to the cap was achieved via the purchasing of rights using a public fund. Ultimately the factors that made Lake Taupo a special case determined the decision to fund the reduction.

Well-defined and completely specified property rights are essential to a successful market. The formal process required for resource consents adds an essential element to the quality of the rights, providing the council with clear records of ownership, introducing certainty for rights holders, assisting monitoring and allowing charge back to landowners, and supporting enforcement.

Other characteristics of property rights include duration, transferability, flexibility and divisibility. While the duration of rights was dictated by legislation, it is sufficiently long to give the rights value. The legislation also provides for the reviewing necessary to enable incorporation of new scientific research that will assist in achieving the water quality target. Transaction costs are a key factor in transferability – the presence of trading suggests that these are reasonable. Transferability may be limited by the small size of the market. The rights are flexible, and can be transferred between different land uses, and are divisible down to small units.

The small size of the market and a relative lack of heterogeneity are potential market issues. The size of the market has benefits in that buyers and sellers can locate each other and farmers can share information, but presents possibilities of collusion where there are too few buyers or sellers. While heterogeneity exists in terms of different types of farming and farm size and in the social and economic objectives for farmers, the ability of OVERSEER® Nutrient Budgets[1] to model small nitrogen-reducing changes to farming practices is limited, although likely to improve with ongoing scientific research.

[1] OVERSEER is a registered trademark of the Overseer owners MPI, FANZ and AgResearch.

Poor water quality is an important environmental issue, with each situation different. Taupo was a special case: a nationally significant lake; a culturally valuable lake; a tourist destination; a high level of recent government involvement in agricultural development in the catchment; a small farming community; a large area of forestry; and a large area of undeveloped iwi-owned land. These characteristics contributed to widespread community support for change, and to a commitment from all levels of government.

The conclusions of the report include:

- The lengthy and uncertain outcome of the policy process required a high level of commitment from staff and politicians.
- Good scientific research identifies problems and informs policy decisions, but does not solve the policy problem.
- Lake Taupo was a special case; in other water quality situations the policy decisions will differ, even where a property rights approach is chosen.
- There is no method of allocation of rights that will be perceived as fair by everyone.
- The inability to observe and measure diffuse nitrogen emissions is an impediment to introducing cap-and-trade schemes. The model *Overseer* was essential to the Taupo cap-and-trade scheme. Its acceptance by farmers was necessary.
- Careful attention to the characteristics of property rights is vital to understanding the market, and to preventing or managing market problems.
- Complexity in the design of property rights does not necessarily improve the market; it may reduce the potential for efficiency.
- Effective monitoring and compliance effort is necessary to protect and retain the value of the rights of NDA holders.

A useful area of future research would be the examination of these findings and those of external studies to assess and apply the learning in other situations, for example, rivers, where markets might be considered as a means to managing nitrogen emissions and/or other pollutants.

1 Introduction

In 2011, Waikato Regional Plan Variation 5 – Lake Taupo Catchment (Variation 5) became operative, providing long term protection of water quality in Lake Taupo, New Zealand's largest lake. It was the culmination of more than ten years of policy development by the Waikato Regional Council (the council), involving consultation with affected landowners and the Taupo community, technical investigations, formal submissions and hearings processes, and Environment Court. The objectives of Variation 5 can be summarised as:

- maintaining the current water quality of Lake Taupo
- managing adverse effects of land use activities to Lake Taupo water quality
- avoiding near shore effects from wastewater
- minimising economic costs and mitigating social and cultural effects.

This review focused on one of the key elements of Variation 5: a cap-and-trade scheme for diffuse nitrogen emissions. The scheme introduces regulation containing a property-level limit of diffuse (non-point source) nitrogen emissions for high leaching farms and enables nitrogen allowance units to be bought and sold in a market.

The objective of this review was to record the decisions made that established the cap-and-trade scheme, the lessons learned, and to examine the workings of the market to date, with the aim of contributing practical information for the development and implementation of policy instruments that involve market mechanisms, under the Resource Management Act (RMA).

A cap-and-trade scheme has potential benefits, including:

- providing flexibility to market participants
- encouraging mitigation by those who can do so at least cost
- providing certainty about achieving the environmental target through specifying the total quantity of emissions (the cap).

The Lake Taupo policy solution is ground-breaking in that it is the first operative market for diffuse emissions of nitrogen in New Zealand, and few such markets exist in the world. The existing literature in this important area of environmental management is therefore largely theoretical, thus the lessons from this experience with policy development and implementation are valuable in informing theory and practice.

The report is structured as follows: The methodology is described in section 2, and the background leading to the decision to introduce the cap-and-trade scheme is described in section 3. Section 4 records decisions made in the development of the cap-and-trade market, including the environmental target, the cap, the initial allocation, means of achieving reductions, and rules for trading. In section 5 the characteristics of the property rights provided by the Nitrogen Discharge Allowance (NDA) are identified, trading in the market is discussed and relevant market issues identified. Section 6 provides a discussion, followed by conclusions in section 7.

This report does not attempt to identify all possible alternatives to policy decisions made during the development and implementation process of the Taupo cap-and-trade scheme.

2 Methodology

This report reviews the decisions that established the cap-and-trade market for NDAs within the RMA regulatory framework of Variation 5, using an economic markets framework. It examines the rights conferred, the conditions in which the market operates, and the functioning of the market to date.

Economic theory on markets defines the pre-conditions required to set up a market for an environmental pollutant as:

- establish the environmental target
- define the commodity to be traded and assign rights
- establish the cap and the means of reduction
- set up monitoring and enforcement mechanisms.

This framework is applied to the Taupo cap-and-trade scheme through the identification and discussion of the decisions made in Variation 5.

A well-designed market can provide an efficient and effective means of achieving an environmental objective. Efficient markets depend on valuable rights. The value comes from the scarcity of the right, and the attributes of the right. The value creates incentives for good stewardship and for reducing emissions. Conditions leading to market failure should be avoided or managed. To understand the role and conditions of the market in the Taupo cap-and-trade scheme, the following are examined and discussed:

- the value and attributes of the right
- trading to date
- transaction costs
- information issues
- thin markets
- heterogeneity.

Within this framework, documents relating to the Taupo cap-and-trade scheme were reviewed, including Environment Court evidence and decisions, papers specific to the Taupo cap-and-trade scheme authored by external parties (for example Department of Primary Industries; MOTU), and theoretical papers on cap-and-trade markets. Interviews were conducted with key parties, including farmers and landowners in the Lake Taupo catchment, policy makers, scientists and implementation staff from the council, scientists and economists from outside organisations, and staff from the Lake Taupo Protection Trust (the Trust). The resulting review describes the establishment and functioning of the Taupo cap-and-trade scheme, designed to limit diffuse nitrogen emissions in the Taupo catchment.

3 Background

Lake Taupo is situated in the centre of the North Island, and covers an area of 61,600 hectares. It is not only New Zealand's largest lake but is iconic to most New Zealanders. The lake's pristine waters attract domestic and international visitors for a multitude of water based recreation and sightseeing activities. At 348,700 hectares, the Lake Taupo catchment is approximately 5.7 times the area of the Lake.

The lake is within the rohe of Ngati Tuwharetoa, the indigenous people of the area, who own much of the land in the catchment, including the bed of the lake. Ngati Tuwharetoa's role includes "kaitiaki" or guardianship of the lake for future generations.

Declining water quality in Lake Taupo

Historically, land use controls to manage water quality in the Waikato region were focused on reducing contaminants entering water bodies from point source discharges. Farm management of diffuse sources of contaminants from land use activities had focused on fencing of erosion-prone areas and riparian zones. The Regional Plan was silent on water quality effects of the diffuse nitrogen emissions from pastoral farming (Young and Kaine, 2010).

In the late 1990s, long term monitoring of Lake Taupo water was showing a deteriorating trend in quality and reductions in the clarity that the lake is famed for. The monitoring of streams draining from pastoral land and flowing into the lake showed steady increases in inorganic nitrogen levels (Vant and Smith, 2002).

Land use in the Taupo catchment comprises forestry, pastoral farming, undeveloped land and urban land use (Figure 1). In 2005, undeveloped land (including indigenous forest) was the dominant land use, making up 56 per cent of the catchment. Forestry comprised 23 per cent of land use, and pastoral farming 19 per cent – most of this in sheep and beef. Ngati Tuwharetoa, the major private landowner, owns approximately 40 per cent of land in the catchment, including a third of the undeveloped land, and around half the forestry and pastoral areas.[2]

[2] Changes in land use and ownership have occurred since this table was constructed.

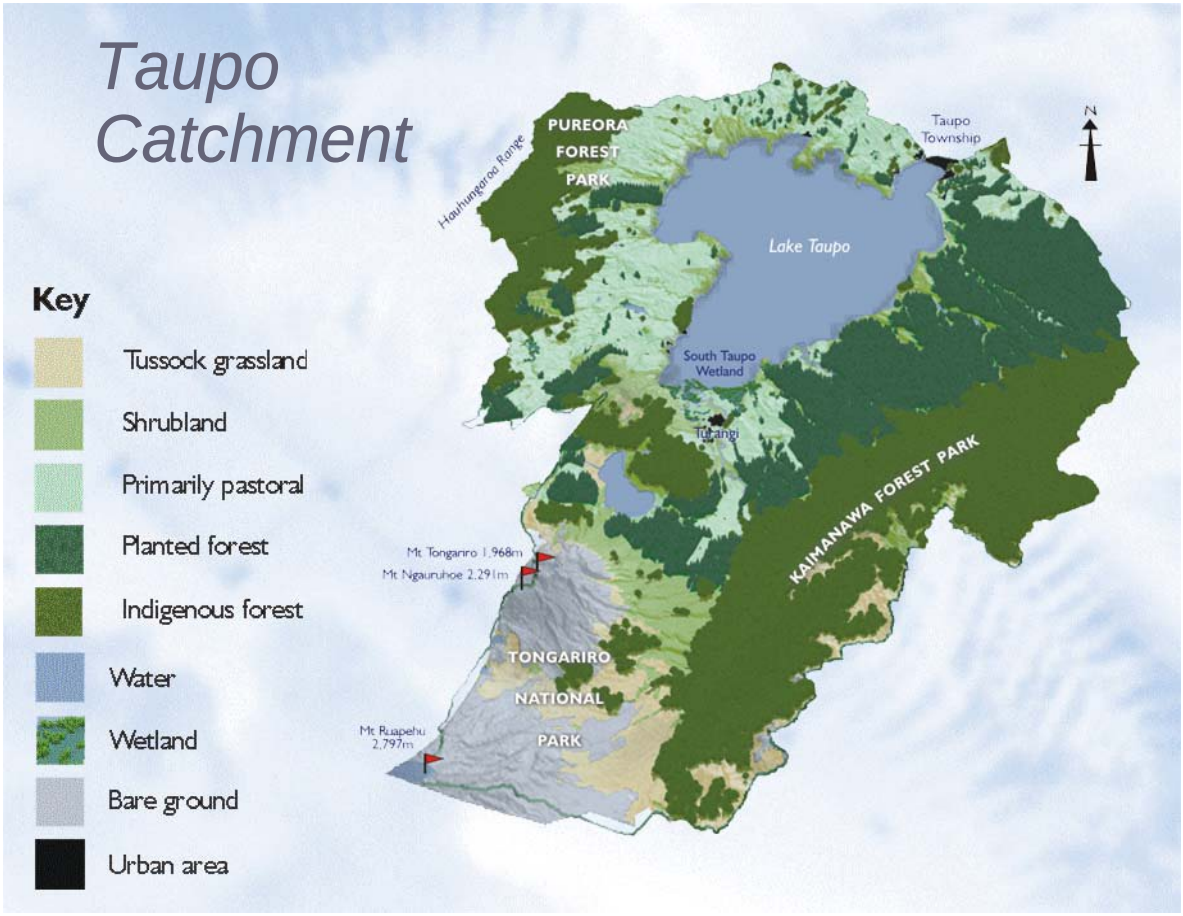

Figure 1 Land use in the Taupo catchment

High levels of nitrogen entering the lake threaten the colour and clarity of the lake water through increased levels of algal growth. Nitrogen arrives at the lake through natural and human-induced processes. The majority of the nitrogen entering the Lake is through natural processes and cannot be reduced. This includes nitrogen in rainwater and leached from underneath native and exotic forestry.

Sources of nitrogen that can be reduced through management are relatively limited, and primarily include human wastewater and pastoral farming. Pastoral farming represents around 40 per cent of the total load of nitrogen to the lake, and 93 per cent of the manageable load. Sewage represents 1 per cent of the total load (Vant et al, 2008).

Council response to declining water quality

In 2000, responding to evidence of declining water quality, the council resolved to take action to address the problem by undertaking a policy review process that would result in a variation to its regional plan. Based on consultation with the Taupo community about the desired water quality, the council concluded that water quality should be maintained at existing 2001 levels (Young and Kaine, 2010). While this initial decision was centred on the need to limit nitrogen emissions, it started a 10-plus year process that resulted in the establishment of a cap-and-trade scheme to manage water quality in the Lake Taupo catchment (Young, 2007).

The policy process began with the decision to cap manageable nitrogen emissions to the lake, and ended with Variation 5 becoming operative in 2011. Variation 5 is made up of a raft of regulations designed to manage human-induced emissions[3], and

[3] Policies specific to the cap-and-trade scheme include (Waikato Regional Council, 2011):

- Policy 3: Cap nitrogen outputs from land in the catchment
- Policy 5: Review of nitrogen reduction target and its method of achievement
- Policy 8: Determining applications under Rule 3.10.5.9
- Policy 12: Public fund to share costs of reducing nitrogen from rural land in the Lake Taupo catchment

includes the components of a cap-and-trade scheme that limits diffuse nitrogen emissions from high leaching land uses.

Young summarises the process (2008, p.5):

> *…consultation with key groups of affected people such as Ngati Tuwharetoa land owners, other farming and forestry landowners and representatives and community groups. Technical investigations and discussions with key stakeholders resulted in a strategy to undertake a planning or resource management approach under the RMA to cap nitrogen discharges and secondly the establishment of a Public Fund, contributed to by local, regional and national communities. Ngati Tuwharetoa, Taupo District Council, WRC and Central Government were involved in discussions on options to address the potential social, cultural and economic effects of a 20 per cent reduction in nitrogen entering the Lake from pasture and wastewater. These discussions led to the development and operation of a Public Fund and the set up of the Lake Taupo Protection Trust through Local Government Act 2002 processes in 2004 and 2005.*

The process from initial consultation to the implementation of Variation 5 took more than 10 years. The complex technical, social and economic issues required time to resolve and strong commitment from politicians and staff at central, regional and local government.[4]

- Policy 13: Effectiveness of the public fund
- Policy 14: Nitrogen trading (offsetting).

[4] At the time of the planning and early implementation the Chair of the Council was convinced that nitrogen emissions were an issue to be dealt with, and was committed to moving ahead with the cap-and-trade scheme as a means to achieving this. This commitment was influential in taking the balance of the council along this track (Abercrombie, 2011). Young also agreed that the consistency of political will was important, given that the policy process spanned three election terms and the changes within that period (de Jong, 2008).

4 Description of the Taupo cap-and-trade scheme

A cap-and-trade scheme[5] is a market-based policy approach. The 'cap' is an effective means of limiting the quantity of an input or output where a limit is necessary, as is the case with nitrogen emissions into Lake Taupo.[6] The level of the cap determines the scarcity of the right, and provides the impetus to trade. The ability to 'trade' the right to emit nitrogen provides efficiency gains; emitters whose marginal costs of reducing emissions are lower than the market price of the right can sell their rights to those with higher marginal costs of reduction.[7]

In the Taupo cap-and-trade scheme, the cap limits nitrogen use through the resource consenting process. A resource consent, applied for by a farmer, sets the property-level nitrogen limit in the form of a Nitrogen Discharge Allowance (NDA). Farmers must prepare a Nitrogen Management Plan that describes how the farm will be managed over the farming year. The plan includes livestock levels, nutrient applications and stocking policies. The NDA can be held, enabling farmers to continue farming activities, or traded (in full or in part) as a right to discharge diffuse nitrogen emissions. A cap-and-trade scheme was identified as an effective and efficient policy response, providing certainty of achieving the environmental limit, leaving farmers with the flexibility to make farm business decisions within the bounds of their resource consent, and encouraging farmers who can reduce emissions at least cost to do so.

4.1 Establishing the water quality target

In 1999, having established that there was an issue with deteriorating water quality in Lake Taupo, the council presented the scientific evidence to the Taupo community. The initial meetings with the community were uneasy, sometimes fraught, as the community came to terms with the water quality issue. For pastoral farmers, the news that their farming activities were the main source of human-induced nitrogen leaching into the lake was particularly difficult to accept.

The council presented four options for levels of water quality, and the changes in land use required to achieve the different water quality options. The options outlined by the council were (Waikato Regional Council, 2000a):

1. Better water quality, reductions in nitrogen output from existing land use, less intensive land use than currently.
2. Current water quality, reductions in nitrogen from existing land use, no further intensification of land use.
3. Slightly lower water quality, status quo land use, no further intensification of land use.
4. Lower water quality, no controls on land use, increased intensification of land use.

As a result of consultation option 2 was selected, and consequently an objective in Variation 5 is to maintain the current water quality level of Lake Taupo:

> *Objective 1: Maintenance of the current water quality of Lake Taupo*
> *The effects of nutrient discharges in the catchment are mitigated such that by 2080 the water quality of Lake Taupo is restored to its 2001 levels...*

In the objective, current water quality is defined as the 2001 level because it is the year that the council made the public resolution to take regulatory action. The long term nature of the target reflects the timeframe for nitrogen in the groundwater system to

[5] A cap-and-trade scheme may also be referred to as a transferrable permit scheme.
[6] As opposed to taxes or charges for example, that set a price.
[7] Contrast this with a regulation that imposes the same rules on everyone, regardless of their situation.

come through to the lake.[8] The establishment of a numerical, time bound water quality target establishes a quantitative goal, which assists in determining the regulatory actions required.

The council estimated the current total load of nitrogen delivered to the lake using experts to construct a detailed catchment model. This model was corroborated by measured nitrogen inflows to the lake. The model used the best available knowledge about expected nitrogen emission processes. It also made some assumptions about the amount of nitrogen that is removed from the system, and therefore is not delivered to the lake due to natural processes generally referred to as attenuation. The results of the catchment model were summarised into a simple table that aggregated the amount of nitrogen each source contributed.

While the water quality objective relates to the effect of nitrogen in the lake, it is the amount of nitrogen from land use activities that is controlled by policies and rules in Variation 5. Nitrogen lost below the root zone in the catchment is referred to as 'leached nitrogen.' Pastoral farming results in diffuse sources of leached nitrogen that can be managed through changes to farm practices and land use.

When the load of nitrogen delivered to the lake was estimated at the beginning of the policy process, the 'leached nitrogen' component was taken from 'average' farms, rather than individually measured or modelled nitrogen leaching. Over time, initial estimates of tonnes of nitrogen from pastoral farmed land has been refined. Numbers have changed slightly due to different methods of calculating the nitrogen from individual farms. However, there has been no change to the percentage of historic 2001 pastoral nitrogen contributed to the lake relative to other sources. Therefore the council's decision to cap nitrogen from all land use continues to achieve the water quality objective. This is a key anchor point for the council and Lake Taupo Protection Trust as they make operational decisions to implement Variation 5.

4.2 The tradable commodity: Nitrogen emissions from agriculture

In designing a market to limit pollutants, ideally the pollutant is defined as the tradable commodity. An observable indicator of environmental performance is required in order that trading is enforceable, and under the control of the polluter (OECD, 2010). For the Taupo cap-and-trade scheme, the commodity is diffuse nitrogen emissions from agricultural and horticultural land in the catchment. Diffuse nitrogen emissions are not observable and measurable. In Taupo, the major contributor to agricultural nitrogen emissions is livestock, so livestock units could be used as a proxy. This approach would limit the options for reducing emissions to reducing livestock. The Taupo cap-and-trade scheme uses modelling to estimate the unobservable emissions at an individual farm level. Modelling nitrogen emissions broadens the options for reducing nitrogen and so increases management flexibility for farmers.

4.2.1 Modelling nitrogen emissions

Diffuse pollutants are rarely the focus of cap-and-trade schemes. In theory, the commodity to be capped and traded must be observable and measurable. It must also be under the control of the polluter, thereby allowing acceptance of responsibility for non-compliance. In practice it is difficult to directly observe or measure the emissions from diffuse pollutants. The Taupo cap-and-trade scheme overcomes this challenge by modelling outputs using *Overseer*, a model developed in New Zealand that calculates an annual nutrient budget representing the long-term annual average nutrient flows for farm systems, including off-farm losses of nutrients and greenhouse gas emissions. *Overseer* can model pastoral, horticultural, arable and vegetable farm systems (Wheeler and Shepherd, 2013). In pastoral systems, inputs to the model include

[8] For example, groundwater in the northern and western catchments has been aged within a range of 20-180 years (Morgenstern, 2008).

livestock numbers, stock ratios by class and sex, fertilisers used, feed brought onto the farm, and winter management practices such as the number of animals wintered on the property. The Nitrogen Management Plan provided by farmers describes these inputs. The model identifies and quantifies nutrient inputs and outputs to and from the farm, based on farm management practices, and determines the resulting expected average nitrogen leaching in kilograms of nitrogen per hectare per year.

Modelling farming operations under a nitrogen cap

The use of *Overseer* for estimating nitrogen emissions was contentious throughout the policy process. Farmers raised questions about *Overseer's* ability to accommodate the complexities of pastoral farming practices, such as the changes in livestock numbers and classes that occur depending on feed availability and market prices. An issue raised by farmers was how complex off-farm stock trading policies would be modelled. The solution was by calculating total cow-grazing days, and converting these to a total stock number for the year (Hania, 2008). Finding solutions to accurately and consistently record farm practices in the model was essential to the effectiveness of the scheme, and to gaining farmer confidence in the model.

***Overseer* versions**

The Taupo cap-and-trade scheme relies on the use of the Overseer model version 5.4.3. Historical allocation 'fixes' in time each property's individual mix of nitrogen leaching farm practices. The historical nitrogen leaching benchmark data is retained by the council. The council emphasised that any modelling of nitrogen leaching practices should be done in a consistent and comparable way by using the same version of the model.

In addition, the council had legal advice during policy development that led it to stipulate the version of *Overseer* that must be used for resource consents to benchmark historic nitrogen and for any trades. Because the version is stated in the rule, a formal RMA First Schedule process of public notification and submissions would be required to change the reference to the version of *Overseer*.

The advantages of allowing people to use subsequent versions of Overseer is that scientific research continues to improve the ability of *Overseer* to model farm systems. From a farmer's point of view, *Overseer* should include all agricultural innovations that reduce nitrogen leaching, and thus free up additional nitrogen to increase productivity, or be leased or sold. Wheeler, a scientist working with *Overseer*, states that ongoing scientific research since Version 5.4.3 has resulted in the better capture of farming systems, particularly in May, June, and July, which are critical periods for nitrogen leaching. Improvements have also been made in integrating inputs in the farm system, such as chemical nitrogen, crops, livestock and effluent onto land (Wheeler, 2012, Wheeler and Shepherd, 2013).

Further investigation into the implications of this will be the subject of another report.

4.2.2 Assigning rights: The initial allocation

> *While there are many ways to allocate the initial NDAs, ranging from grandparenting to auctioning, the norm around the world for trading schemes...has been grandparenting. Economic theory shows that irrespective of the way the initial [Nitrogen Discharge Allowances] are allocated, an effective trading scheme will result in an efficient outcome, i.e. pollution control at the least cost* (Meister, 2008).

Historical allocation, also known as 'grandparenting', was the elected method for initial allocation of NDAs. Historical allocation is the distribution of rights based on past use. An advantage of this method is that it enables farmers to continue their land use activities at existing levels. The benefits of historical allocation were described by Meister (2008):

- achieving buy-in by those affected, least disruption from historic patterns
- smaller financial burden on users than auctioning (for example)
- less social disruption than other methods
- recognition and protection of investment by landowners.

Under historical allocation, landowners receive allocations based on the point in time that the policy decision is made. In the Taupo catchment this meant that farmers at different stages of business development received higher or lower nitrogen allocations. This allocation method means financial costs can be high for owners of undeveloped or forestry land wishing to change to more nitrogen-intensive land uses. Ngati Tuwharetoa, holding a large area of undeveloped land in the catchment, face particularly high opportunity costs with historical allocation.

The allocation methods discussed in Environment Court evidence for the Taupo cap-and-trade scheme included averaging nitrogen emissions across all land, phased in or delayed averaging, and averaging by industry sector. An averaging approach would have resulted in large up-front costs for pastoral farmers, who would be faced with buying NDAs from those landowners for whom the averaging method netted greater allowances than they needed for business-as-usual. The low levels of cooperation that may have resulted under averaging may have led to high enforcement costs. Delayed averaging, which would allow a timeframe for adjustment, was considered likely to result in conversion to higher leaching farming activities on undeveloped land, risking meeting the policy objective. Ultimately farmers would be faced with buying NDAs to continue current business activities. Additionally, averaging would penalise those farmers who had invested heavily in development of their farms (Meister, 2008).

The auctioning of tradable rights is another method of allocation. Drawbacks to auctioning include a highly uncertain outcome and significant social and economic disruption should existing landowners be outbid to the extent that they cannot continue their current business activities (Waikato Regional Council, 2004).

Historical allocation was contentious throughout the policy process. Kaine (2006, p.6) noted that:

> *...grandparenting is no more efficient than other allocation mechanisms and...allocation of rights is contentious because of wealth and political implications.*

However, Kaine stated that allocating landowners NDAs that were less than required for business-as-usual required assuming that landholders (2006, p.8):

- were deliberately engaging in behaviour they knew to be undesirable
- engaging in behaviour the community did not sanction, and
- had the means to control nitrogen emissions.

There is not a method of allocation that will be perceived as 'fair' by everyone. To assist in addressing the inequities arising from historical allocation in respect to undeveloped land in the Taupo cap-and-trade scheme, a 'flexibility allowance' was negotiated through the Environment Court for use by owners of undeveloped land. These provisions allow landowners an additional 2kgN/ha/year, with a collective total of 11,000kg and 3100 kg for Maori-owned land and non-Maori owned land respectively. This is available on a first-come, first-served basis, and is time bound. Designed to assist owners to develop some of their land to higher nitrogen leaching activities without having to purchase nitrogen allowances, these NDAs cannot be on-sold.[9]

[9] At the date of writing, nil of the 11,000kg for development of Tuwharetoa-owned land had been allocated, while about 60% of the 3,000kg for non-Tuwharetoa land had been allocated (Hayward, 2012a).

Benchmarking
Establishing the initial allocation of NDAs required the benchmarking of previous nitrogen use. This involved modelling farm nitrogen emissions based on nitrogen inputs (including livestock numbers) for the 2001-2005 period. The selection of 2001 as the start of the period was because that was the year that the council publicly resolved to take action, while the four year period smoothed the variation in climatic and weather conditions (Young, 2007). The council favoured using the average of the 2001-2005 years for the initial allocation, but farmers successfully argued that in the absence of a nitrogen cap, farmers maximise farm return by adjusting the amount and type of stock depending on market price and feed supply. Allocation based on the average year would fail to take account of the drought conditions experienced during part of the benchmarking period, and would inhibit the ability of farmers to maximise profits in good farming years. Farmers contended that they therefore should be able to establish a benchmark based on their choice of any single year in the 2001-2005 period. Initially rejected by the council, the 'best year' allocation became part of the policy through mediation during the policy process.

Benchmarking was the first step in the resource consent process for farmers. Upon being granted a resource consent by the council, each landowner has rights to an individually specified tradable NDA, for the duration of the consent. All resource consents have a common expiry date of 2036, and are subject to changes that may occur as a result of the 2018 review of the nitrogen removal target and its method of achievement.

4.3 The 'cap' and reducing emissions

The objective in Variation 5 is to maintain current water quality. The council realised that further increases in nitrogen entering the lake would compromise the publicly desired water quality. In order to achieve the objective, the policy states that nitrogen emissions from all land in the catchment will be capped at historic levels, and a 20 per cent reduction in nitrogen emissions is required. The reduction in nitrogen emissions is to compensate for the nitrogen already in the system from past farming activity, which will arrive in the lake over the next few decades (Environment Court Interim Decision, 2008).

Cap on nitrogen emissions
The nitrogen cap applies to all land in the catchment. At council meetings the decision to allocate nitrogen on a historical basis was described as "allowing all landowners to keep doing what they have been doing". A requirement of historic allocation is that all emissions are benchmarked at an agreed point in time.

The amount of nitrogen entering the lake from different land uses and other sources, such as rainfall, was defined in council documents as a percentage of the total load and as estimated tonnages. Nitrogen that is leached from pastoral land use is the focus of the 20 percent reduction and is subject to benchmarking processes before resource consents can be granted. Consequently, there has been intense scrutiny of the tonnage figure. Council has continued to refine these estimates.

Amount of nitrogen to be permanently removed
Public submissions provided differing opinions on the level of reduction required to reach the target. Some submitters requested that the reduction be as high as 40 per cent, while others considered that 20 per cent was too high, and questioned the scientific research leading to this decision (Waikato Regional Council, 2005). At the Council hearing process and then Environment Court, technical experts from the different parties were required to meet separately to clarify technical issues. In summary the agreed technical position reported to the Environment Court and signed by experts from all parties was that a 20 per cent reduction was 'scientifically defensible'. The Environment Court decision notes that the social and economic costs

of increasing the target beyond 20 per cent 'cannot be justified at this time' (Environment Court Interim Decision 2008).

The opportunity to review the nitrogen reduction target will arise in the review scheduled for 2018. Policy 5(f) states that:

> *While a figure of 20 per cent is appropriate over the ten year life of the [Regional] Plan, scientific opinion in 2007 was that in the longer term a figure in the range of 30 to 40 per cent may be more appropriate* (Environment Court Final Decision, 2011).

The 2018 review allows an increase in the nitrogen removal target should a longer term figure be found to be appropriate. The method to achieve a further reduction, should it be required, will be determined through consultation at that time (Environment Court Final Decision, 2011).

Refining initial estimates of manageable sources of nitrogen

Early in the policy process it was estimated that 1360 tonnes of nitrogen enters the lake annually, including some 510 tonnes (or around 40 percent) from pastoral farming (Vant et al, 2008).[10] Estimates of the amount of nitrogen actually delivered to the lake took into account that some nitrogen was lost from the system through natural attenuation processes. The pastoral land estimates used AgResearch data on 'farm averages'. The same estimates were used when policy decisions were made during the Environment Court case about the method of establishing historic nitrogen leaching (where the method of taking the average of four years farm leaching was changed to each farmer being able to choose one 'best' year out of the four). The council refined the initial pastoral nitrogen land use tonnage after requiring every farm to undergo a benchmarking exercise. To do this, each farm's historic allocation of nitrogen leaching was modelled through Overseer.

Refining estimates of nitrogen from pastoral land use did not change the relative proportion of manageable nitrogen from farming, compared to other sources. The political decision to allocate nitrogen based on a point in time, meant that every farm was able to continue farming in the same way they had, regardless of changes in methods of calculating tonnages. Farmers were told that their 'share' of the 2001 pastoral nitrogen would not change.

Reducing nitrogen emissions

Agreement between local and central government was needed to form a public fund to reduce nitrogen from manageable sources. The parties agreed to focus the fund on nitrogen reduction from pastoral land. The amount of money needed had to be estimated in the absence of full knowledge. Uncertainty was focused in two areas:

1. How much nitrogen needed to be permanently removed. The tonnage of nitrogen that must be permanently removed to maintain 2001 water quality over the long term, is the amount of nitrogen from past land use that is already in transit to the Lake but has not yet affected water quality ('the load to come')
2. The best use of public money. The method chosen to reduce nitrogen needed to be the most cost effective and efficient process and consistent with the structure of the public fund.

The means to achieving the 20 per cent reduction

The reduction in nitrogen emissions from agriculture will be achieved by means of buying back NDAs using an $81.5m public fund, made up of contributions from local, regional and national communities, of 22 per cent, 33 per cent and 45 per cent respectively. The rationale for central government involvement was set out in the First Cabinet Paper, and included the national and international importance of the lake both environmentally and culturally, Treaty of Waitangi obligations, the protection of

[10] By contrast, the estimated contribution of urban runoff and sewage is 33 tonnes, or 2 per cent (Waikato Regional Council, 20008a).

economic and cultural values, the legacy of central government involvement in farming development, and enhancing the credibility of the RMA in tackling diffuse pollutants (Hobbs, 2003). The reasons for sharing the costs across the national, regional and local communities were (Young, 2007):

- the costs were beyond the capability of regional ratepayers to fund
- shared benefits result from the policy
- to minimise local social costs
- the advocacy by Central Government of land development in the catchment
- the significant costs already faced by local ratepayers for upgrades to wastewater systems.

The public fund was in keeping with an early commitment by the council to farmers; farmers would be able to continue their current business activities.

The use of a public fund for NDA buy-back was not universally popular. Some public submissions argued that the full cost of the nitrogen cap and the 20 per cent reduction should be borne by farmers in a 'polluter pays' approach. Opposition to the buy-back was focused on the perception that the fund would set a precedent by compensating farmers and funding research which would benefit only farmers (Environmental Defence Society, 2004).

An alternative to the buy-back was a sinking lid on nitrogen emissions. Under this 'polluter pays' solution, the allocated tonnage of NDAs held by each landowner would be reduced by a percentage to meet the target. This type of approach was rejected in part because of the active and relatively recent role of central government in developing pastoral farming in the catchment. Government agencies had developed and sold ballot farms in the Taupo catchment as recently as the early 1980s – some of these farms were still owned by the original purchasers (Yerex, 2009).

Another option for achieving the 20% reduction was the conversion of government-owned farms in the Taupo catchment, including those owned by Landcorp Farming Limited, to low nitrogen land uses such as forestry. This option was discussed in the First Cabinet Paper but did not fit with the principle that state-owned enterprises should be treated in the same way as any other private land owner (Hobbs, 2003). Further, it was not seen as in keeping with the 'whole of community' approach advocated by central government.

Changes to the amount of money needed by the public fund

Limited public money to permanently remove 20 percent of the 2001 pastoral nitrogen means the Lake Taupo Protection Trust is directly affected by any refinements to initial estimates of tonnage.

Achieving the council's goal of capping nitrogen from all land uses was not affected by changes in tonnage after the detailed farm by farm benchmarking. The formal Trust documents were written to ensure that any refinements did not penalise the Trust, and are given as a percentage of manageable load rather than an absolute figure. However, the money available to the Trust is limited.

Table 1 shows that a combination of factors has changed the amount of money the Trust needs to achieve a 20 percent reduction in manageable load of nitrogen from pastoral land.

Table 1 Nitrogen emissions from pastoral farming

Source	Tonnage	20% reduction
Estimated figures (based on AgResearch data of Taupo sheep and beef farm average of 14 kg/ha)	765	153
Best year figures (post EC decision)	837.5	167.5
Plus flexibility allowance for forested land	14.0	2.8
FINAL TOTALS	851.5	170.3

Source: Hayward (2013)

Activities of the Lake Taupo Protection Trust

The Lake Taupo Protection Trust was set up as a Council Controlled Organisation under the Local Government Act 2002 to administer the public fund. In doing this, it would be accountable to the three funding partners. Accountability, transparency and independence were seen as benefits of establishing the Trust.

The Lake Taupo Protection Trust's role was to (Young, 2007, p.24):

> *…achieve the 20 per cent reduction in the manageable load from rural land…support land use change by funding research and development, and cover the initial start up costs of benchmarking the existing nitrogen discharges from pastoral farms in the catchment…*.

The Trust started business in 2009. Initially the Trust purchased pastoral farms, converted them to forestry (a low nitrogen land use), and then sold the farms without the NDA. This practice would implicitly provide a market price for the NDAs – the difference between the land purchase and sale prices. Six farms were bought, converted, and then sold.

This proved a risky strategy; the initially high land prices had fallen and therefore the costs of reducing NDAs were higher than anticipated. The transaction costs were also high. The amount of funding had been estimated based on the price differential between pastoral and forestry land (Journeaux, 2013). The risk was that the fund would be insufficient to achieve its purpose (Fleming, 2011a).

As a result the Trust moved to buying NDAs directly. Following the change of strategy, the Trust took a pragmatic approach and set its price by dividing the available funding by the required NDA reduction. This could be tested to some extent with Journeaux's calculations and the information gained by the earlier land deals.

Fleming, the Trust CEO, saw an opportunity in facilitating agreements for NDA sellers in the carbon market created by the New Zealand Emissions Trading Scheme (ETS), thereby making NDA sales more attractive to farmers. He considers this strategy contributed to the success of the Trust in meeting the reduction requirement (Fleming, 2011a).

The Trust's swift start in buying up NDAs saw it make good progress towards the reduction target (Figure 2). At the time of writing the Trust has purchased 151 tonnes (99 per cent) of the pre-benchmarking target of 153 tonnes of NDAs. The three funding partners have recently agreed to provide additional funds to meet the revised target of 170 tonnes.

The greatest reduction in NDAs was made in 2010, with 56 tonnes of nitrogen purchased and 1727 hectares converted into forestry. In 2012, ten deals by the Trust saw 27.3 tonnes of nitrogen purchased, and 1805 hectares converted to forestry. The smaller size of the recent deals suggests that the bigger deals may have been done. In

a small market, this may present challenges to the Trust in completing the final purchases.

NDA purchases by the Trust saw the total area of land converted from pastoral farming to forestry (a low nitrogen use) increase steadily, reaching around 7000 hectares in 2013 (Figure 2). Some NDA purchases yielded no change in land use, while for others the sale of NDAs along with carbon farming opportunities encouraged geographic concentration of farming effort and forestry planting. In some cases, farmers retired areas of farm, for example steep faces, and sold the resulting excess NDAs.

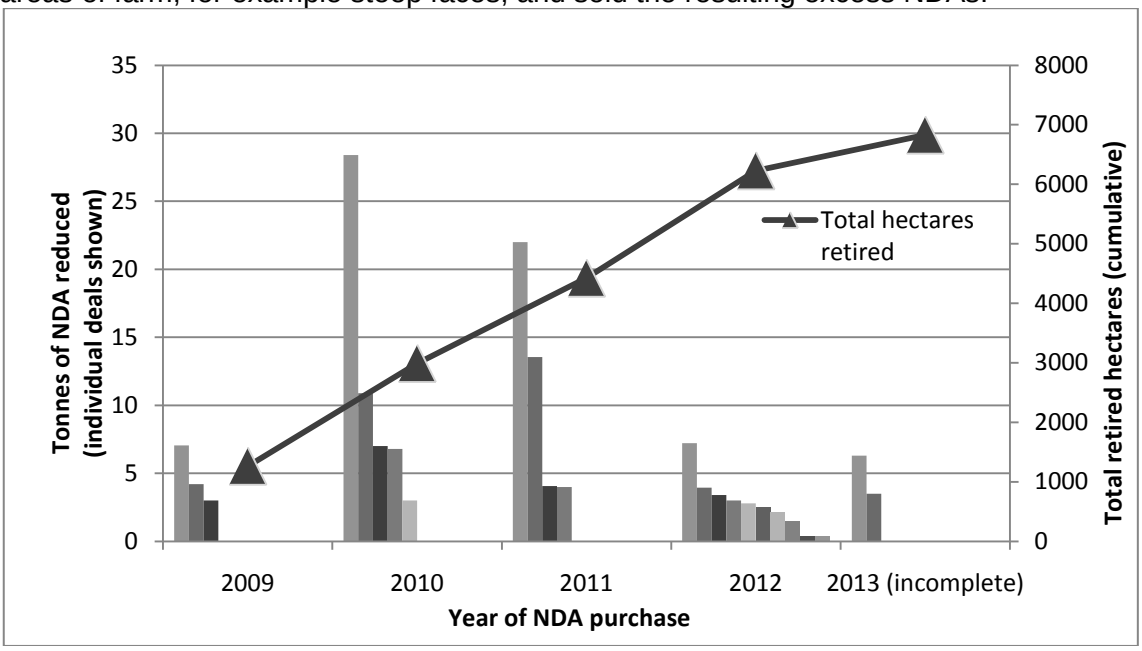

Figure 2 Purchases of NDAs by the Trust and total hectares retired

The Trust is independent of the council (and other funding partners). The benefits of this independence are flexibility in negotiating and carrying out NDA deals with landowners (Fleming, 2011a). The Trust can complete an NDA purchase within days, where local government might be unable to move quickly to secure purchases (Fleming, 2011a). A challenge for the Trust has been the necessity to work within the budget prescribed by the annual payment system that delivers the public fund. This has required corresponding annual payment deals with NDA sellers (Fleming 2011a).

4.4 Monitoring and enforcement

In Variation 5, Policy 7 aims to promote (Environment Court Final Decision, 2011):

> *…sound working relationships between landowners in the catchment and Waikato Regional Council [to]…ensure compliance with regulation… [and] …confirm that the regulatory auditing process is fair and transparent…*

To meet monitoring requirements, farmers must maintain a current Nitrogen Management Plan that lists the 'nitrogen critical' elements of their current farm system, such as winter stock numbers for the different stock classes and sexes. Changes in farm system must comply with their resource consent conditions. If a farmer decides to buy or sell all or part of their NDA, the change will be reflected in their resource consent. The altered Nitrogen Management Plan must comply with the farmer's NDA once the trade has been completed. Activities producing leaching in excess of the NDA contravene resource consent conditions and invoke non-compliance provisions (Young and Kaine, 2010).

Monitoring priorities have been established to achieve the policy objectives. Priority One sites include those farming close to their NDA, farms that have sold nitrogen allowances to the Trust, and intensive farming operations. These farms are likely to

receive one to two annual visits from council officers, and will be audited annually. Priority Two farms are those operated at more than 90 per cent of their NDA, large operations and sheep and beef/drystock. Priority Two farms are likely to have an annual visit by council officers, plus an annual audit. Priority Three farms, those farming well below their NDA may be visited every two years, and will supply annual accounts to the council (Hayward, 2011).

The annual farm business accounts required by the Inland Revenue Department provide key evidence for annual audits for Variation 5. Utilising the full amount of allowable nitrogen specified in the consented NDA, requires careful monitoring on the farmers part to ensure that stock purchases during the farming year allow them to remain in compliance with the new regulation. For many farmers the policy decision to allocate based on the best year has provided an amount of nitrogen that can be used as a buffer, giving them flexibility while staying within their NDA. To date, enforcement mechanisms have not been tested.

Under a resource consent regime farmers bear the costs of monitoring. These are estimated to be around $1000/year (after year one). Farmers also face administration costs of $300/year.

5 The NDA market

> *Markets usually create rights to use natural resources or to pollute the environment, up to a predetermined limit and allow these rights to be traded, providing incentives for those who can cheaply reduce their environmental impact to do so and then to sell the improvement to others* (Greenhalgh et al., 2010).

Well-designed markets can have benefits above and beyond those of a rules-based policy. The establishment of a right to emit a specified quantity leaves farmers the flexibility to make decisions about how to work within their specified limit. The differences in farming systems lead to different reduction opportunities on farms. In this way, a market is expected to be more efficient than the imposition of rules, which fail to take into account the individuality of farming systems.

The rights provided by the NDA have a value. The cap should create scarcity, which incentivises reductions. An NDA is a capital asset – an investment needed for farming in the catchment. When the right is sold, the value of the investment is realised. Well-defined and completely specified property rights are valuable and create incentives for good stewardship of natural resources.[11] To this end, the efficiency and effectiveness of a cap-and-trade regime is dependent on the value of the rights associated with the resource.

5.1 The rights provided by NDAs

The value of the right is strongly linked to the characteristics of the right, and what the bundle of rights allows the owner to do. The characteristics of a right are quality of title, transferability, duration, exclusivity, divisibility and flexibility (Scott, 1988, Johnson, 1992). The following provides a brief definition of each characteristic and its application to NDAs in the Taupo catchment:

1. Quality of title: Enforceability; legal protection and security; certainty; ease of establishing ownership to enforce other characteristics.
    - The initial NDA is established through benchmarking. Ownership is registered and changed in the resource consent process. The consent provides the right to emit at a stated level for the duration of the consent (until 2036 in the first instance), subject to a review in 2018. The consent process assists the council in enforcing rights, identifying those who do not hold rights, and in enforcing compliance. This formal process contributes to establishing clarity of ownership and security of the right. Ineffective monitoring which allows farmers to emit beyond or in the absence of an NDA, would challenge the quality of title, as would the inability to impose adequate penalties on transgressors. The council has a crucial role in monitoring and imposing appropriate sanctions on offenders.

2. Exclusivity: The strength of the right; strength of acceptance by the community; freedom from disturbance; the ability to exclude others from using the right.
    - NDAs are specific to the holder and cannot be used by another except by formal agreement. Agreements are formalised in the resource consenting process, (required for all transactions) contributing to exclusivity. Important to this characteristic is acceptance and respect of the right by the community. Lake Taupo may be a special case in terms of this; there is wide community commitment to a clean lake.[12]

3. Duration: The lifetime of the right and arrangements for renewal.

[11] The theory is applicable to all markets, not just those for natural resources.
[12] Yerex (2009) notes that a clean lake was part of the commitment by farmers in finding a way to an acceptable policy.

- The Resource Management Act specifies that 35 years is the maximum term for which a resource consent can be granted. All farming consents expire in July 2036. In addition, each resource consent has a condition setting out the 2018 review. Consent holders have fair warning that NDAs may change within the life of the consent. The 2018 review will consider whether the nitrogen removal target should be increased based on its meeting water quality objectives, reductions achieved and updated estimates of the nitrogen load in transit (Environment Court Final Decision, 2011).[13]

  Duration contributes to the value of the right. Rights with a short duration are likely to have lower value, and the short life may inhibit investment. Where this is the case, the efficiency gains from a market instrument will be restricted. As the review and the expiration of the resource consents draw nearer, the effects of duration may become visible, depending on the degree of certainty NDA holders have regarding renewal.

4. Transferability: The ability to trade or exchange the right at a reasonable cost, including through temporal accession; the number of parties that the right can be transferred to.
   - NDAs can be sold, leased or otherwise traded with other qualifying landowners in the catchment. Holding and trading NDAs is restricted to resource consent holders in the catchment. A resource consent holder can hold any quantity of NDAs desired, for example, more NDAs than they have use for on their land. Trading costs include revisions to the Nitrogen Management Plan for the farm, and changes to the resource consent.

     Although NDAs are transferable, the small size of the market is likely to mean that at times there are few willing buyers and/or sellers, which may at times lead to collusion between buyers of sellers. The requirement that NDA buyers hold a resource consent (and therefore own land in the catchment) increases entry barriers, and may therefore limit the contestability of the market.

5. Flexibility: The discretion to change land use without losing the right; the extent to which the rights holder has to consult with others to make changes; ability to adapt to change.
   - Farmers can make business changes, such as increasing livestock numbers, changing livestock type or moving to a different land use, provided they stay within the bounds of their resource consent. The NDA is not forfeited by these changes, but a formal process must be adhered to. Flexibility contributes to the efficiency of the cap-and-trade scheme through the value of the right, both in terms of what farmers can do on their land, and the ability to trade when making changes that reduce or increase nitrogen emissions.

6. Divisibility: The ability to create joint ownership, to divide the right across time and space.
   - NDAs are defined by kg/ha/year. Units are divisible down to this level and can be sold or leased. Practicality and transaction costs will likely determine the size of trades. The Trust, for example, buys in lots not less than one tonne. NDAs cannot be banked or borrowed – that is, saved from this year for use in the future, or borrowed from the future for use in the current year.

[13] Method 3.10.4.3 requires regular and ongoing monitoring (Waikato Regional Council, 2011). In 2018 analysis of monitoring will determine whether there is a need for further intervention.

The ability to divide the right in this way is essential to realising the efficiency gains through trading – the ability to sell off small amounts of NDA can incentivise small beneficial changes in farming practices, as well as larger changes. This attribute will become more relevant as the capacity of *Overseer* increases to take in a wider range of practices.

The inability to bank or borrow emissions – that is, to save this year's allocation for a future date, or to use a future year's allocation sooner – is a limitation of the right, and would have added value.

In summary, the design of NDAs provides value to the rights holder and contributes to the potential for a successful market. Three areas for particular attention are enforcement (in terms of quality of title), duration, and the size of the market (in terms of transferability). Ensuring compliance through effective monitoring and enforcement is essential. If the expected benefits of non-compliance are such that it is worth taking a risk, the environmental objective may be compromised and the establishment of efficient prices in the market becomes problematic. While duration is limited by scientific uncertainty in terms of 2018 review, and by legislation in terms of the life of the consent, it will be important to provide certainty to NDA holders where possible. The transferability of NDAs may, potentially, be inhibited by the smallness of the market; issues relating to competition are likely to be a problem from time to time. Whether, and the extent to which these issues need addressing will become clearer as the market settles. In the meantime trades, independent of those by the Trust, are occurring.

5.2 Trading

NDA trading has occurred since 2009 when the Trust began operations. Trades to date have occurred through reductions in livestock and by changing land uses. An example of a livestock reduction is Taupo Beef, a boutique farming venture selling sustainably produced beef. Land use changes have included shifts from pasture to forestry and a venture in olive growing. Pasture-to-forestry conversions have included shifts of marginal or less productive land to forestry (Fleming 2011a). At least one farmer has increased NDA holdings to expand dairy operations.

To June 2014, 147 tonnes of NDA was traded, including 129 tonnes bought up by the Trust (Figure 3). The Trust accounted for 24 of the 37 trades that occurred in this period. While the number of private trades is fairly small, this may indicate that historical allocation has served most farmers well, allowing them to continue with business-as-usual (as was expected). It is also likely that private trading has been restricted by the activities of the Trust. Alternatively, the small number of private trades may indicate insufficient flexibility, lack of encouragement of innovation, low levels of heterogeneity, and high transaction costs. There is little evidence, anecdotal or otherwise, to suggest that this is the case.

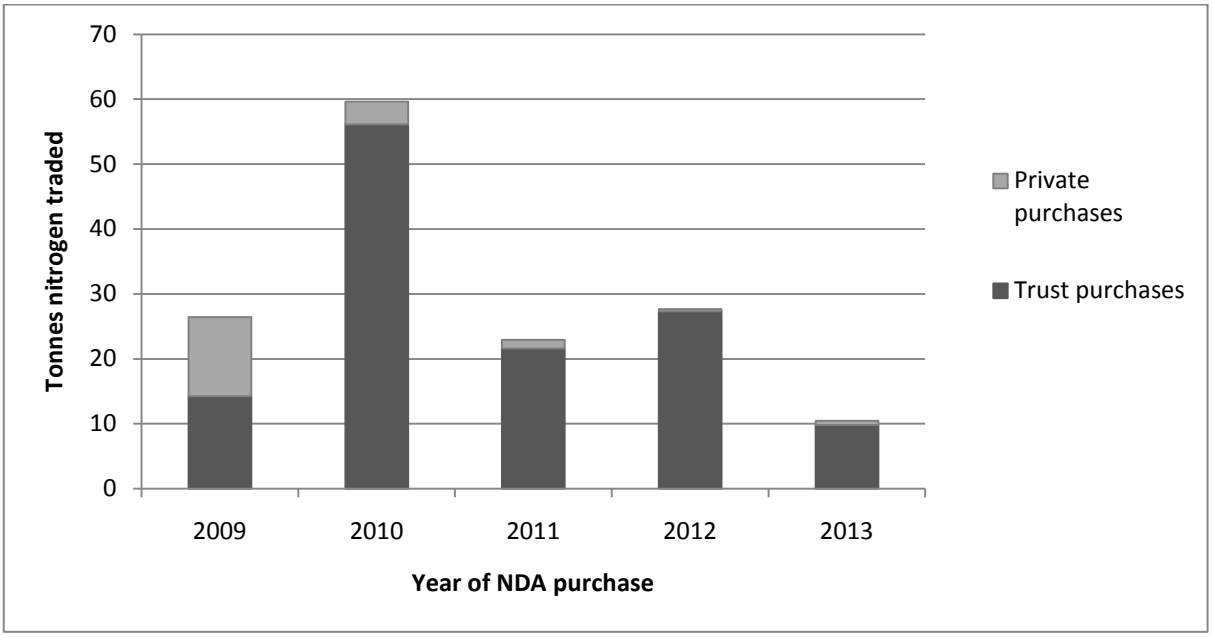

Figure 3 Private and Trust trading of NDAs[14]

Risk concerns may also reduce the volume of trading. Prospective traders might consider that trading will increase the likelihood of an audit, or that selling NDAs will reduce their farm value, or they may want to hold additional NDAs as insurance against possible future reductions. Of the latter, Barton, a farmer in the catchment, states (2011a):

> *Some [farmers] are worried though about the review of the [Variation 5] in 10 years time and wish to hang on to the excess NDA in case they are reduced by that review.*

The council sought to facilitate trading of NDAs by setting up an exchange market[15] but transactions undertaken to date have generally been through private one-to-one negotiations, with prices determined by the parties involved. In certain circumstances, direct bilateral trades can have high transaction costs, but the relatively small size of the Taupo catchment, both geographically and population-wise, lends itself to private trading. The exchange market may be utilised in future as farmers become more confident and familiar with trading.

5.3 Addressing market issues

Cap-and-trade schemes have benefits relative to other forms of regulation, such as (Greenhalgh, et al., 2010):

- lowering compliance costs for regulated parties
- providing regulated participants with incentives to innovate
- lowering regulator costs (administration, monitoring and enforcement).

Factors that prevent the successful functioning of the market include high transaction costs, lack of or incomplete information, and lack of competition in the market. These issues and their impact on the market should be acknowledged, and addressed where possible. This section discusses transaction costs, information, thin markets and heterogeneity in the context of the Taupo cap-and-trade scheme.

[14] In some cases the trades by the Trust span several years. The date used here is the date that the trade was agreed.
[15] See:www.waikatoregion.govt.nz/Community/Your-community/For-Farmers/Taupo/#consent%20holders

5.3.1 Transaction costs

> *Polluters will only seek to trade if the gains from trade are sufficiently large to cover the transaction costs of searching for trading partners and entering into agreements* (OECD, 2010).

Low transaction costs contribute to the value of a right by facilitating transferability. Transaction costs are the costs incurred in participating in a market. They typically include search and information costs, and contracting costs. Transaction costs associated with trading NDAs include finding a buyer/seller, negotiating a deal, and completing the deal. Direct costs imposed by the council are associated with the requirement to update Nitrogen Management Plans and the application to the council for a resource consent to confirm the changed NDA. The presence of private trading in the market suggests that transaction costs are not prohibitively high.

If high transaction costs were found to be an impediment to trading, there are several ways that the council might consider to reduce these costs for farmers (Greenhalgh, 2008b):

- Streamlining the consent process so that information entered into the NDA marketplace can be automatically sent to the council
- Aligning the consent database with the nitrogen marketplace
- Enabling on-line submission of changes in Nitrogen Management Plans and on-line approval of the changes in the Nitrogen Management Plans
- Enabling the online submission of changes in consent conditions through trades (recording changes to the NDA) and the on-line approval of those applications

5.3.2 Information

Encouraging participation in the market

Lack of confidence can be an impediment to market participation. Trading NDAs will be a learning process for farmers, who may initially be slow to make decisions on buying or selling allowances. In Taupo, the provision of information and support via council staff has been a key means of addressing landowner concerns. In early trading the Trust has had a role assisting traders with providing business advice, and in this way helping them to avoid making ill-informed early judgements. Two to three private trades have occurred each year since 2009, which may be reasonable, given the Trust's strong presence in the market.

Learning how the market works is a necessary process for NDA holders. Enquires from farmers to council officers about leasing agreements and the appearance of public advertisements suggests that learning is occurring and farmers are becoming more confident about asking questions (Ryan and Palmer, 2011).

Future value uncertainty

In the Taupo catchment, the timing and amount of nitrogen-impacted groundwater entering the lake is central to the policy.[16] Variation 5, Policy 5 provides for a review of the nitrogen reduction target and its method of achievement to commence by June 2018. Future lake water quality and scientific information will assist in determining what changes are (or are not) required. At that time, the method to achieve these will be decided (Environment Court Final Decision, 2011). While some uncertainty cannot be avoided, as far as possible NDA-holders should be kept fully informed in order to provide certainty and maintain the smooth functioning of the market.

[16] Policy 5 (f) of Variation 5 notes, regarding the 20 per cent reduction, that 'scientific opinion in 2007 was that in the longer term a figure in the range of 30 per cent to 40 per cent may be more appropriate (Waikato Regional Council, 2011).

5.3.3 Thin markets

> *Environmental markets are typically thin because of the geographical scale of the market or the low number of eligible participants* (Greenhalgn et al., 2010).

The size of the market can be a determinant of the level of efficiency. Where there are too few traders, and there is little opportunity to enter the market, there are opportunities for collusion between buyers or sellers, reducing the efficiency and effectiveness of the market. With regard to the Taupo cap-and-trade scheme, Greenhalgh (2008a, p.8) noted that:

> *With around 190 pastoral farms requiring consent within the Taupo catchment, in my view there should be a sufficient number of potential buyers and sellers for a nitrogen market to operate efficiently and effectively…'*

The number of participants in the Taupo cap-and-trade market is limited by the restriction of NDAs to resource consent holders (with the exception of the Trust).[17] This condition limits the potential efficiency of the market, for example an external party might be willing to pay the going price for NDAs to remove that nitrogen discharge permanently from the catchment.

5.3.4 The importance of heterogeneity

The importance and existence of heterogeneity was discussed at length in the evidence for the Variation 5, with Greenhalgh (2008a) identifying several areas of heterogeneity including:

- management option heterogeneity, illustrated by the different types of farming and the size of the farms in the catchment[18]
- social and economic heterogeneity such as management goals, financial rewards, environmental consciousness, workload, lifestyle and beliefs and values provide a further source of diversity within the catchment[19]
- biophysical heterogeneity includes different amounts of nitrogen from different areas, in the Lake Taupo catchment arising from the land use type, and leaching the spatial impacts of emissions, e.g. distance from the lake.

Heterogeneity in the market is essential to creating incentives and opportunities for trading. Trading viability is enhanced when landowners face 'different sets of mitigation options, different cost structures and different management opportunities to reduce their pollutant discharge' (Greenhalgh, 2008a). These differences are necessary to provide the incentives that make a cap-and-trade scheme preferable to regulation.

The ability of *Overseer* to capture heterogeneity will determine the level of efficiency of the market and the effectiveness of the policy. In 2008, Greenhalgh noted of *Overseer* that 'there are limited nitrogen management options currently available…' (Greenhalgh, 2008a). Development on *Overseer* continues, but it is still driven largely by livestock numbers, with many inputs that cannot be changed (Ryan and Palmer, 2011).

[17] The resource consent is a 'land-use consent' rather than a consent to discharge nitrogen, thus can only be held by landowners (Young, 2011).

[18] In 2007, land use in the catchment included dairying (1800 ha); sheep and beef (50,700 ha); forestry (64,500 ha) undeveloped land (154,500 ha). Of this, 900-1200 blocks were less than 20ha; 100 blocks were of 20-100 ha; and 92-100 blocks were greater than 20 ha (accounting for 5%, 8% and 87% of the land respectively (Young, 2007).

[19] Barton (2011a) perceives differences between farmers, stating that sheep and beef farmers tend to farm for lifestyle and are not risk-takers, whereas dairy farmers tend to be more 'business savvy' and inclined to be take more risks.

6 Discussion

The policy process

Policy processes can be lengthy and uncertain. As with any policy, a long timeframe gives those likely to be affected the opportunity to move strategically to take advantage of the policy. Where farmers perceive that historical allocation may be the method of distributing initial rights, they may be tempted to increase production – a long timeframe gives more opportunity to do this. In the Taupo catchment, strategic changes in land use occurred, for example Landcorp Farming Limited sold its farming interests, which resulted in additional land in dairying and intensive sheep and beef farming.

The policy timeframe can intensify uncertainty about the future for their farming businesses. This can have social and economic costs. For Taupo, the early scientific estimates and the actual nitrogen leaching from pastoral farming differed. Decisions through mediation, hearings and Environment Court included the shift of benchmarking from average year to best farming year, and the addition of a flexibility allowance. These policy decisions increased the nitrogen to be reduced by 17 tonnes, or 11 per cent of the pre-change total. At $400/kg, this change represents $6 million. These examples illustrate the uncertain nature and difficulties associated with the policy processes and outcomes.

For the council and central government, the implementation of the Taupo cap-and-trade scheme was successful in part because of the high level of commitment from politicians and staff over the 10-plus years.

Science

Science research was essential to the policy process. Monitoring identified the water quality issue, and scientific research provided the necessary information on nitrogen sources, pathways and longevity in the system. Scientific research had a crucial role in establishing a numerical and time bound target for the policy. The 10 year policy process also relied on communication, relationships, compromises and formal court processes, and an understanding of the wide range of benefits and costs to the local, regional and national communities. Scientific research informs policy, but does not solve the policy problem.

Reducing nitrogen leaching

Lake Taupo is recognised as a special case for declining water quality. The iconic nature of the lake, its value to the economy and the government's recent role in land development contributed to the decision to publicly fund the reduction of nitrogen emissions. Strong arguments for a polluter pays approach were made in the public submission process. It seems unlikely that public funding will be available to support other situations where a reduction in nitrogen emissions is required. As a compromise to the polluter pays principal and the burden of cost, Kerr et al (2012) suggest a method that includes a mix of government funding and a proportional reduction by landowners at their own expense.

Initial allocation and perceptions of equity

Historical allocation has been described by Fleming (2011a) as rewarding farmers who were 'pushing their land' to and beyond sustainable levels. Fleming (2011a) suggests that these farmers were rewarded in comparison with those who were farming more conservatively. For example, a farm with relatively low stock numbers allocated 5kg/ha/yr, versus a farm of similar size and topography receiving 15kg/ha/yr. This difference in allocation could amount to hundreds of thousands of dollars (Table 2). Allocation based on 'best' year made these differences more extreme.

Table 2: An example of potential allocation differences

Intensity	Farm size	NDA	Price per kg	Total value
Low	300 ha	5	$400/kg	$600,000
High		15		$1,800,000

The distribution effects of historical allocation are long lasting. In discussing equity issues with regard to allocation of allowances in a cap-and-trade scheme, Kerr and Lock (2009) suggest the consideration of long term development potential of land. Allocation based on land use capacity[20] may better represent development potential, as opposed to historical allocation or averaging, and is worth considering in this regard. Alternatively, a hybrid of historical allocation and carrying capacity to limit the potential for large gains from farming beyond land use capacity.

An argument for a phased introduction of allocations in a cap-and-trade scheme has been proposed. Kerr (2012) describes a method that starts with a five-year allocation based on historical emissions, with a planned move to another allocation method where costs are distributed more evenly, such as land use capacity. The supporting argument is that it allows a smooth transition to the new system. While in the short term, producers can do little to pass on costs and implementing mitigation ideas and innovations may take time to develop, in the longer term:

- international agreements and regulations can evolve, allowing more costs to be passed on to end users
- markets mature, making trade easier
- capital depreciates e.g. older farmers retire, younger people retrain
- new investment is not disadvantaged
- technology develops and is diffused
- land does not depreciate.

Despite the arguments for alternative allocation methods, allocation methods that reward low emission landowners and penalise high emissions landowners are based on assumptions that landowners with high emissions are deliberately engaging in undesirable behaviour, that the community did not sanction this behaviour, and that the landowners had the means to control nitrogen emissions (Kaine, 2006, p.8).

The initial allocation of rights and the method chosen for reducing the cap determine the distribution of costs among current, past and future landowners and the local, national and international beneficiaries of improved water quality (Kerr and Lock 2009). While economics can show who bears these costs, ultimately the decision on allocation is likely to be a political decision.

Overseer – modelling emissions

In the Taupo cap-and-trade scheme, *Overseer* is the tool used to model nitrogen emissions. It provides a consistent and accepted means of estimating diffuse nitrogen emissions.[21] In *Overseer*, changes in nitrogen emissions are largely driven by changes in stock numbers, and although Version 6 contains a range of mitigation options, many of these are not relevant for sheep and beef farming. Version 6 mitigation options include (Wheeler and Shepherd, 2013, p.16):

- Varying stock type, animal numbers and stock performance, including grazing off
- Varying the timing and amount of nitrogenous fertiliser applications
- Changing pasture quality (metabolic energy and nitrogen content)
- Varying timing and amount of supplementary feed
- Use of wintering pads, animal shelters

[20] Kerr and Lock (2009) suggest using carrying capacity maps and allocating fixed emission rates per stock unit.
[21] *Overseer* was not developed for the cap-and-trade scheme.

- Use of DCD
- Adding wetlands or riparian strips
- Changing effluent application area or methods and timing of application

Overseer provides a means to investigate potential mitigation options to reduce nutrient losses (Wheeler and Shepherd, 2013). Over time it is expected that further development and refinement of *Overseer* will increase its sensitivity to the innovative changes farmers make on their farms, and in this way improve the functioning of the market. In the meantime it is likely to impact negatively on the efficiency of the scheme because of the limited nitrogen-reducing activities that can be modelled. Attention to this by way of funding for exploration of alternative farming practices and land uses could be beneficial to achieving the potential gains from a market.

Increasing complexity

The Taupo cap-and-trade scheme does not address temporal differences in nitrogen reaching the lake. In a case study for Lake Rotorua in the Bay of Plenty region, Kerr and Lock (2009) investigated allocating nitrogen allowances using a 'vintage' system to address temporal issues. The investigation was based on:

> *Depending on the property and its characteristics, the time from when a nutrient is applied to the land until it reaches the lake through the groundwater system can be between zero and 200 years. Allowances will each have a declared 'vintage' corresponding to the date the nutrients reach the lake…*

Similar to Lake Rotorua, the timeframes for water feeding into Lake Taupo can be lengthy and widely variant. Introducing this level of complexity into the NDAs would reduce the value of the transferability characteristic of the right – the already small market would be further reduced because of the need to trade within vintages, and transaction costs might become high in terms of finding potential traders. Of Lake Rotorua, Kerr and Lock concluded that 'the extra complexity associated with accounting for groundwater lags would at best not be worth the additional difficulties associated with implementation, and at worst could be counterproductive' (Anastasiadis et al., 2011).

In the Taupo catchment, point source emissions were addressed through regulation, and are not part of the cap-and-trade scheme. A benefit of including point sources in the cap-and-trade market would be additional heterogeneity between sources, providing the potential for greater efficiency in the market. Trading ratios (for example, 2 kg of point source equals 1 kg diffuse emissions) can be used to address imperfect substitution between point source and non-point source trading (OECD, 2010).[22] In summary, while there may be benefits to using ratios as scientific information increases, or other pollutants are added to the scheme, it is not clear that the use of ratios would provide any advantages in the Taupo cap-and-trade scheme.

Transaction costs

High transaction costs can be an impediment to an efficient market. To date there is little evidence that transaction costs are inhibiting trading in the Taupo cap-and-trade market. The controlled activity status of farming in the Taupo catchment results in transaction costs for updating Nitrogen Management Plans and making changes to resource consents. A benefit of the controlled activity status is that it is clear, binding and enforceable, and monitoring costs are recouped by the council (Hayward, 2011). Managing water quality under the permitted activity status has been suggested as a means of lowering transaction costs. As a permitted activity, a registry of trades could be used, rather than the requirement of a resource consent for each trade[23] (Kerr, 2012). The relative informality of a permitted activity status would lower transaction

[22] For examples of the use of ratios between point source and diffuse pollutants see Selman et al. (2009).

[23] Greenhalgh (2008a) refers to issues on buyer liability in terms of meeting regularity obligations. The requirement for both parties to complete the section 127 change in resource consent and the subsequent approval and changes in the NDA legally allow the buyer to discharge up to the increased NDA, and the seller to only discharge to the reduced NDA.

costs, but the trade-off would be disadvantageous to both farmers and the council. For farmers, disadvantages of permitted activities concern the loss of the resource consent attributes in terms of legal protection of rights, its relative certainty around duration and the formal process of trading that secures ownership. For council, the disadvantages of permitted activities include less certainty around monitoring and charging for targeted monitoring. Permitted activity status was considered at length for the Taupo cap-and-trade scheme, and dismissed during the Environment Court process for these reasons.

Monitoring and enforcement

Compliance is essential to the successful operation of a market; enforcement must be effective and timely. This may not be achievable under the RMA (Kerr 2011). Where non-compliance is not addressed, the value of rights is likely to decline, the incentives to trade will reduce, and consequently the environmental goal will be jeopardised. In reviewing the legal issues around design, implementation and enforcement of a nitrogen trading scheme for Lake Rotorua, Rive (2012) suggests that enforcement cost issues could be 'significantly addressed' if a tailor-made legislative regime were put in place, such as that of the ETS. Key areas for compliance identified by Rive (2012) are:

- ensuring that everyone who is required to participate in the cap-and-trade scheme does so (and having an effective way of dealing with people who…delay or refuse to apply for and obtain consents)
- ensuring accurate information is provided by consented parties so that compliance monitoring can occur
- ensuring that council officers can inspect properties to check that obligations are being met
- dealing with situations where participating parties do not have sufficient allowances to cover assessed emissions.

For councils, the costs of prosecutions for non-compliance with regional rules can be high. The Taupo cap-and-trade scheme is yet to be tested in terms of non-compliance prosecutions. Rive (2012, p.10) contends that lack of knowledge of the precise consequences of non-compliance may mean:

> *People may be more willing to take their chances on a prosecution, delaying putting their own systems in place to monitor and account for their emissions-relevant activities, knowing that the council will have to go through an expensive and time consuming process to enforce the scheme, and at the end of it, even if successful, may only secure a 'token' penalty from the Court.*

Legislation designed for the purpose of a nitrogen trading scheme, which includes a clear enforcement regime including the ability to initiate debt recovery without the need to establish grounds for a prosecution, would be a useful tool (Rive, 2012).

Addressing uncertainty

One of the drawbacks of cap-and-trade schemes is that they do not typically allow for increases in scientific information or changing societal attitudes to contribute to decisions around the property right, and therefore may not achieve optimal resource management (Greenhalgh et al., 2010). The 2018 review goes some way to addressing this limitation, however the uncertainty as to what it will mean and how any necessary changes will be implemented may be problematic. Issues related to this, such as an unwillingness to trade, are likely to be particularly apparent close to the time of the review, depending on the perceptions of landowners regarding the direction of change expected and whether compensation is expected. The lack of a method also leaves the process open to strong political lobbying from stakeholder groups (Kerr et al., 2012).

Uncertainty may also be an issue for farmers with regard to participation in trading. A farmer may miscalculate his or her nitrogen emissions and sell too many NDAs, or buy

too few. To reduce this risk and to save time and auditing costs for farmers, Barton (2011b) suggests that the council could:

> *…develop an intranet site that all farmers could access using their rating number and a password. This [site] should house all their farm details and be driven by Overseer. This would allow farmers to explore changes to their NMP on that website before submitting them…from an auditing point of view WRC could use the site to view current farm [Nitrogen Management Plans] and records.*

This has not been considered by the council at this time, and may be a matter for discussion.

Achieving synergies

Policy does not exist in a vacuum. In the wider environment, macroeconomic events and other policies have impacted on the success of the Taupo cap-and-trade scheme. Commodity prices, such as for sheep and beef exports, changes in land prices, and ETS are all potential factors in landowner decision making. Prices can move either way. For example, depressed commodity prices and a strong price for carbon credits may make farmers more receptive to selling NDAs to the Trust.

The ETS provided an incentive to NDA holders. Under the ETS, putting land into forestry can provide landowners with a regular income, and it is low nitrogen-leaching land use. Fleming (2011b) suggests that without the ETS, the funding to buy up NDAs would be about half of what was required. In this way, the Taupo cap-and-trade scheme assisted the establishment of carbon farming in the Taupo catchment.[24] Of the ETS, Fleming says (2011b):

> *'…the emergence of a developing carbon trading marked formed by the Emissions Trading legislation remains a significant driver of land use change and business opportunity…it is international movements in such matters as carbon trading, sheep and beef prices, dairy prices, forestry returns and the NZ dollar that can have significant and immediate effects on the Trust achieving its aim within given financial constraints…'*

The ETS has been a factor in the success of the Trust - Ngati Tuwharetoa transactions in particular, which make up some 60 per cent of the Trust NDA purchases. Ngati Tuwharetoa has land with capacity for pastoral farming, but difficulties in raising capital for development. For Ngati Tuwharetoa, selling NDAs brings in capital, while conversion to forestry brings the advantage of regular payments for carbon sequestration, plus the harvest proceeds at some future date. The income from carbon farming also provided farmers with an incentive to plant forestry on marginal land (Fleming, 2011a).

The carbon price has fallen sharply since the ETS contracts Fleming facilitated were made. How the Trust would perform given the current price for carbon credits is a matter for speculation.

[24] Refer to Appendix 1 for scenarios for dry stock conversion under Taupo cap-and-trade and ETS schemes.

7 Conclusions

- The introduction of policy can be lengthy and outcomes uncertain. In Taupo, the process that started with a decision to limit nitrogen emissions developed into a cap-and-trade scheme, in part because consultation revealed the need for flexibility in decision making for landowners. This policy process required a high level of commitment of council staff and politicians to bring the cap-and-trade to fruition.

- Good scientific research was essential in identifying the policy problem. It provided information to inform decisions and assisted in the identification of a numerical, time bound target.

- Lake Taupo was a special case for water quality. The factors that made it special – including its history and its social, cultural, economic and environmental value – contributed to decisions that are unique to this case. The public funding of the reduction in nitrogen emissions is a decision that may not be repeated elsewhere.

- Careful attention to choosing the method of allocation of rights is necessary. There is no method that will be perceived by everyone as fair. Understanding the distributional impacts in terms of who bears the costs, how big those costs are, and what they are, will help to ascertain whether these can or should be addressed.

- The design of markets for diffuse pollutants is in its infancy. The inability to observe and measure diffuse pollutants is an impediment to setting up a market. The Taupo cap-and-trade scheme overcame this impediment through modelling nitrogen emissions. The model, *Overseer*, is consistent across farms, and is accepted by farmers.

- The benefit of a market over rules is efficiency. A market approach has the potential to achieve the desired level of nitrogen emissions at the least cost to society. To achieve this efficiency, careful attention should be paid to the characteristics that make property rights valuable.

- Complexity in the design of property rights will not necessarily improve the market; it may reduce the potential for efficiency.

- Quality of title is a chief characteristic of property rights. Effective monitoring and compliance effort is necessary to protect the rights and retain the value of the rights of NDA holders. Legislation designed to support cap-and-trade markets, especially in terms of compliance and enforcement, would be useful in this regard.

Taupo is a special case and possesses factors that are unlikely to be present in future market schemes for diffuse pollution from agriculture. These include:

- a limited number of farmers/small catchment
- a large funding contribution from government
- a Trust

It is likely that any cap-and-trade market for diffuse emissions is unique in its details. Despite this, the experience and lessons from the implementation and operations of the Taupo cap-and-trade scheme will provide useful knowledge for other situations. Future research could focus on how these findings will apply to other types of water bodies, and to other situations with different characteristics than Lake Taupo.

Glossary

Cap-and-trade scheme: A market-based tool that sets an overall limit on a commodity, establishes rights to the commodity (e.g. to pollute), and allows that commodity to be traded. The 'cap' is an effective means of limiting the quantity of an input or output where a limit is necessary. The ability to 'trade' the right creates the market.

Commodity: A (environmental) good or bad that will be traded in the market. The commodity must be a reasonably homogenous representation of the good. In the Taupo cap-and-trade, nitrogen discharge allowances (NDA) serve as the commodity.

Cost effective: Achieving the objective at the least cost.

Economic efficiency: The efficient use of resources maximizes the production of goods and services. In the cap-and-trade market, an efficient outcome will be when production is maximised at the least cost – that is, when the allowances are allocated in such a way that production is at its highest given the total allocation.

Environmentally effective: Successful in achieving the environmental objective.

Flexibility allowance: To assist in addressing the inequities arising from historical allocation in respect to undeveloped land in the Taupo cap-and-trade scheme, a 'flexibility allowance' was negotiated through the Environment Court for use by owners of undeveloped land. Provisions allow landowners an additional 2kgN/ha/year, with a collective total of 11,000kg and 3100 kg for Maori-owned land and non-Maori owned land respectively. Available on a first-come, first-served basis, the flexibility allowance is time bound and not tradable.

Market: A market is a space where buyers and sellers can trade.

Trading ratio: A trading ratio may be used to equate different sources of emissions. For example, to account for uncertainty between non point-source and point-source emissions, a 2:1 ratio might be used – surrendering 2 units on non point-source for 1 credit of point-source emissions.

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Appendix 1

The Taupo cap-and-trade scheme and Emissions Trading Scheme relationship

The 2011 pre-tax income from sheep and beef farming was approximately $200/hectare (Ministry of Primary Industries, 2011). When carbon payments are at a long-term and consistent level of $10/tonne, the income from carbon farming is similar to drystock from the fourth year of operation, assuming that drystock farming income remains steady. When an up-front payment for NDAs is added to the carbon farming option, and an income from forest harvest is expected at year 20-30, the carbon/forestry option is financially more attractive that drystock farming.

Scenarios

The net present value (NPV) for pre-tax incomes for drystock and carbon farming is presented in three scenarios: Two scenarios for forestry/carbon farming and a third scenario for sheep and beef farming. The forestry scenarios serve to illustrate the difference that an NDA can bring to forestry investment in the presence of the ETS. The scenarios are described below and illustrated in Figure 4. All scenarios are based on a 100 hectare block and a discount rate of 5 per cent is applied to income and costs. The forest is comprised solely of *Pinus radiata* grown for framing. Carbon sequestration and payback at harvest figures are provided by the Ministry of Primary Industries.[25]

1. Scenario 1 is a sheep and beef operation. A pre-tax income of $200/ha is based on the returns in the National Sheep and Beef Pastoral Monitoring Report 2011 (Ministry of Primary Industries, 2011). The scenario assumes that the per hectare pre-tax income increases with inflation, at a rate of 3 per cent per annum. The farm is solely sheep and beef.

2. In Scenario 2 forest is grown for carbon farming and harvest. There is no cap-and-trade scheme so no NDA sale. Harvesting nets $25,000/hectare at year 25. At price zero for carbon farming (i.e. no carbon farming) the NPV for forestry is $589,000. Although higher than that for sheep and beef, the income is well out into the future. Under this scenario, when the ETS is at a long term price of $10, the NPV rises to $771,000 – nearly double the NPV from sheep and beef. From year 4 the annual income under the ETS is comparable to that from sheep and beef farming. In the absence of an NDA capital must be raised to set up the forestry operation. This set-up cost is ~$160,000 over the first two years.

3. In Scenario 3 forest is grown for carbon farming and harvest, and the Taupo cap-and-trade scheme is in place. Harvesting nets $25,000/hectare at year 25. The scenario assumes that the landowner has 400kg of NDA per hectare which is sold for a total of $120,000 to partially finance the set-up of the forestry operation. At price zero for carbon farming (i.e. no carbon farming) the NPV for forestry is $710,000. When the ETS is at the long term price of $10, the NPV rises to $891,000 – more than double NPV from sheep and beef farming. As with Scenario 2, from year 4 the annual income under the ETS is comparable to that from sheep and beef farming.

[25] Forestry costs include initial planting, aerial spraying and blanking at year 2, thinning at year 9, and harvest at year 25. Cost estimates sourced from Gerard Horgan, Ministry of Primary Industries.

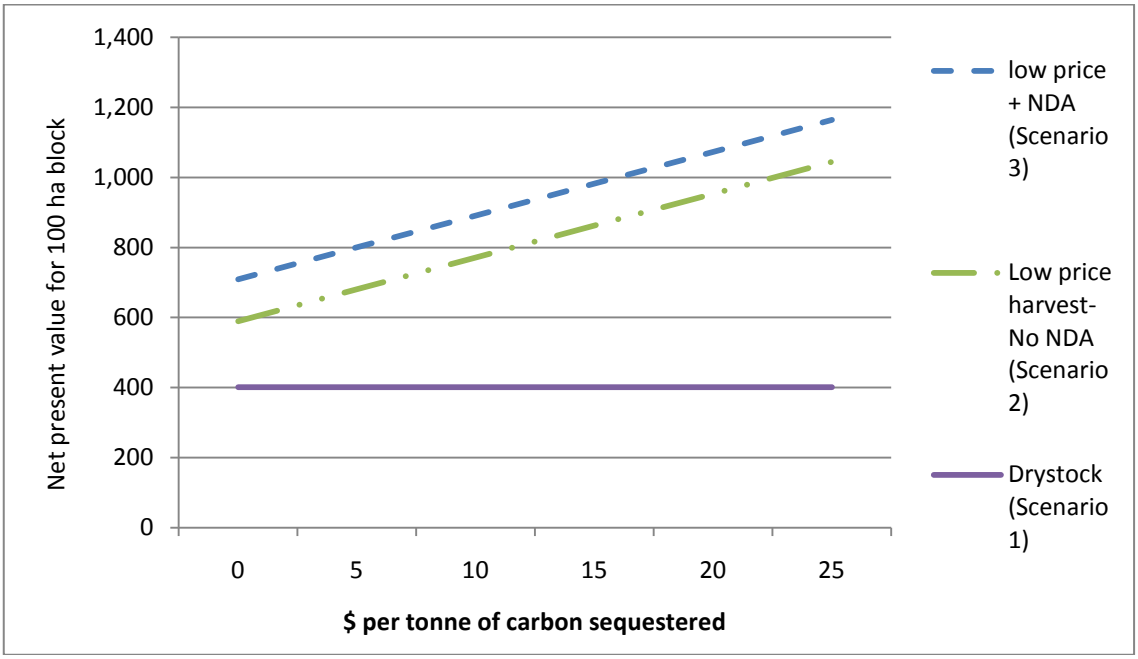

Figure 4 Net present value from forestry/carbon farming vs drystock $(000)

This illustrates a reciprocal relationship between the cap-and-trade scheme and the ETS. An up-front payment for sale of NDAs provides capital to establish forestry, and provides income for the initial years until the carbon sequestration levels achieve a reasonable income. The absence of the cap-and-trade scheme may limit take-up of the ETS due to capital requirements, while the absence of the ETS is likely to deter investment in forestry, given its long term and uncertain income.

A benefit of the sheep and beef scenario is that the landowner continues to hold the NDA, an asset that contributes to farm income, and can be on-sold separately or with the farm or can be leased. Holding the NDA gives the landowner the option to continue farming in the current mode, or to convert to some lower nitrogen land use. It also keeps opportunities open for someone buying the farm in the future. Conversely, the carbon farmer must buy up NDA to change to a more nitrogen intensive land use, and has a commitment to continue farming until the trees are harvestable, or face a loss in respect to harvest income. The carbon farmer has options in managing price risks, with the ability to delay harvesting until the prices for timber are high and the prices for carbon are low. Tables provided by the Ministry of Primary Industries show carbon farming income continuing with forest growth up until year 50.