Lough Melvin Nutrient Reduction Programme

Strand 3: Technical Report

"To investigate the use of nutrient trading"

Dr Claire Cockerill and Professor George Hutchinson

Gibson Institute for Land, Food and Environment

Queen's University Belfast

David Keir Building

Stranmillis Road

Belfast

BT9 5AG

December 2007

Disclaimer

This publication may be of assistance to you, but Queen's University Belfast and The Lough Melvin Nutrient Reduction Programme Partners and their employees do not guarantee that the publication is without error of any kind, or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence which may arise from you relying on information in this publication.

Acknowledgement

The Lough Melvin Nutrient Reduction Programme has been funded by the EU INTERREG IIIA Programme for Ireland/Northern Ireland and the project partners: Northern Regional Fisheries Board; Agri-Food and Biosciences Institute (AFBI) Northern Ireland; Queens University (AFLU) and; Teagasc Research.

Environment & Heritage Service
www.ehsni.gov.uk

An Agency within the Department of the Environment
www.doeni.gov.uk

AN ROINN COMHSHAOIL, OIDHREACHTA AGUS RIALTAIS ÁI
DEPARTMENT OF THE ENVIRONMENT, HERITAGE AND LOCAL GOVERNMENT

INTERREG IIIA

1 Nutrient Trading

1.1 Introduction

In order to manage the nutrient levels in Lough Melvin, a holistic and integrated approach is necessary to address the various sources of nutrient exchange into the lake. Sources of pollution in the catchment vary and include both point sources i.e. two sewage treatment works and septic tanks, and non-point (or diffuse) sources, i.e. agriculture and forestry.

In terms of management of nutrient output from agricultural land, Agri-Environment schemes are commonly used and offer a single fixed payment for compliance with a pre-determined set of management prescriptions. Agri-Environment schemes currently run in both Northern Ireland (e.g. Countryside Management Scheme, Organic Farming Scheme, Environmentally Sensitive Area Scheme) and the Republic of Ireland (Rural Environment Protection Scheme). Whilst the Agri-Environment Schemes are a widely used policy tool, Latacz-Lohmann & Schilizzi (2005) list several problems which commonly limit their success:

- Farmers who already manage their farms in a way that minimises nutrient runoff (e.g. maintaining a low stock density, spreading slurry to comply with carrying capacity of fields) will have a greater incentive to participate in such a scheme, resulting in overcompensation of compliance costs and a relatively lower level of additional environmental benefits.

- Lack of adequate monitoring provides an incentive to farmers to renege on their agreed course of action. This incentive will be affected by factors such as the probability of detection, the level of fine, the payment method and level of flexibility relating to the agri-environment contract.

- There is a lack of incentive for farmers to devise alternative, innovative or joint solutions to reducing nutrient runoff.

- It is difficult to prevent farmers returning to their ‘old ways’ as soon as the contract is completed, obliterating any improvements which may aggravate the public who have essentially funded the scheme.

- Transaction costs associated with delivering such an agri-environment scheme may be unknown and administrative costs could potentially restrict the funds available to pay for implementation of agri-environmental policies.

A further difficulty associated with the Lough Melvin case study particularly arises from the cross border location of the lake. This may make it more difficult to co-ordinate an agri-environment scheme that is equivalent under the frameworks set by agencies in Northern Ireland and Republic of Ireland.

Given these problems, there is strong justification for investigating the possibility of adopting more cost efficient alternative policy approaches to engage landholders in a program to reduce nutrient levels in Lough Melvin.

One such alternative is the 'command and control' approach where environmental legislation is,

"implemented via regulatory instruments coupled with systems of monitoring and sanctioning of non-compliance" (Pearce & Turner, 1990)

One of the major disadvantages with this approach is that it fails to account for the *costs* of control which are likely to differ across polluters and be unknown to the regulatory agency. As a result, the system limits flexibility, offers no incentive to go beyond control targets and does not account for economic growth (Ribaudo, 2007). Empirical simulations have also suggested that regulation costs associated with command and control policies are higher than incentive based instruments (Atkinson & Lewis, 1974; Roach et al, 1981; Hahn & Noll, 1982; Seskin et al, 1983) as a result of their inability to address the disparities in the costs of pollution control across landholders.

1.2 Market Based Instruments

Another alternative approach to environmental regulation that has gained popularity in recent years is the use of Market Based Instruments (MBIs). MBI[1]s are defined by Stavins (2000) as,

"regulations that encourage behaviour through market signals rather than through explicit directives regarding pollution control levels or methods".

The advantage of market based instruments over command and control policies are that they provide the incentive for those that can achieve reductions at least cost to do so. Therefore, it is a more cost effective approach because it maximises the environmental benefit per pound/Euro spent. In addition, by operating through a market, it is not necessary for the regulator to know each firms' costs to achieve the least cost outcome because costs are based on individual costs and benefits.

In order to meet their objectives, which include '*halting the loss of biodiversity*' and '*preserving natural resources that are under pressure*', the European Commission are increasingly favouring Market Based Instruments because they '*provide flexible and cost effective means for reaching given policy objectives*'. Such policy tools are advocated in the European Union's 6th Environment Action Programme, the Sustainable Development Strategy and the Lisbon Strategy. Furthermore, the EU specifically encourage the use of MBI's to help manage natural resources in order to comply with the Water Framework Directive.

---

[1] Markets are institutions through which potential buyers and sellers operate in exchange processes. In the context of conservation, the buyers and sellers will consist of polluters who want to purchase or sell pollution reduction in order to comply with the environmental targets set.

Grafton (2005) sets out elements which are necessary for successful implementation of any Market Based Instrument. The first step is to gain '*an understanding of the cause and effect of conservation actions and environmental outcomes*'. Secondly, this information is utilised to design the policy instrument appropriately. The next step is to test the mechanism in order to ensure that it has been '*suitably adapted and tailored to the specific scenario*'. This can be achieved through a series of economic experiments initially conducted within a laboratory setting and then with a number of landholders in what is termed a field experiment. Finally, pilot tests are also advisable to refine the design of the scheme. Such testing is favourable to ensure that any adjustments can be made before the mechanism is fully implemented.

There are a variety of Market Based Instruments[2] including offsets, tradable permits (which encapsulate both 'cap and trade' and credit programs) and auctions.

Offsets describe the situation where landholders are permitted to,

'undertake developments that may be damaging on the condition that they fund offsetting conservation practices that more than compensate for the damage they cause'. (Grafton, 2005)

Offsetting conservation practices can occur either on-site or off-site. The former aims to restore natural resources at the actual site where damages have occurred. Off-site projects aim to improve conditions at a different location providing comparable resources to those damaged at the actual site. Given the aim of the Lough Melvin Catchment Management Plan is to preserve the mesotrophic status of the lake and the unique species it supports, such offsets would have to consist of on-site (rather than off-site) conservation practices. This option would have the potential

[2] See Grafton (2005) for a review of MBIs that have been applied or tested within natural resource management in Australia.

to allow for building development within the lake catchment, for example, without increasing the overall level of nutrients in the Lough.

A number of problems commonly associated with offsets, reduce their attractiveness. These include: difficulties in identifying suitable offsetting projects; potential for project failure due to lack of compliance or unanticipated detrimental externalities; and, difficulty in proving 'additionality' ie. that offset projects are additional to what would otherwise have occurred. In addition, there is uncertainty regarding the operation costs associated with this particular approach. The lack of application of offsets within a catchment scenario makes it difficult to be confident of their successful implementation as a viable policy tool to achieving nutrient reduction in Lough Melvin.

The remaining examples of Market Based Instruments mentioned above are increasingly utilised as effective tools for managing land and will be further explored in the next sections.

1.3 Tradable permits

1.3.1 Definition

Tradable permits are a form of Market Based Instrument applied to help achieve the goals set out by environmental policies by allowing the market to reveal those firms that can obtain environmental improvements at lowest cost (Stoneham, 2000). Tradable permits operate either as credit trading or 'cap and trade' systems[3].

[3] Ellerman (2005) also identifies 'averaging' as a third type of trading which operates as a specific type of credit trading without certification by the regulator that reductions are beyond that which would have occurred naturally.

The credit program assigns credits when a source reduces pollution below a baseline level. These credits can be transferred to help another firm comply with the targets. Therefore, transferred credits represent the right to pollute a set amount that is established by the regulatory agency and will be identical for all market participants, i.e. landholders. This approach is reliant upon an ability to measure and enforce discharge targets. As this approach awards credits when reductions are made beyond a baseline level, there is no restriction on the total amount of pollution.

'Cap and trade' systems, which have been more commonly adopted, impose an absolute limit on total emissions. This usually takes the form of a mandatory 'cap', for example on the total quantity of nutrients entering the water. This is often referred to as a Safe Minimum Standard (SMS)[4]. This cap will prevent the total load of pollutants increasing to a level that exceeds what society deems is acceptable (Stoneham, 2000).

Once a cap has been set, it is specified as 'legal partial property rights'. These will be held by individual firms and will define their allocation of the cap. These permits represent a tradable right to emit pollution by engaging in a polluting activity and therefore represent the benefit of polluting. Permits will be allocated to each individual firm either by 'grandfathering' (i.e. freely distributed) or through sale e.g. auctions. The last step in the process is to set up the necessary market infrastructure to facilitate trade of permits between landholders (Grafton, 2005).

Firms that exceed reduction can sell their permits to firms which find it more costly to do so. Permits will be held where the incremental or 'marginal' cost of pollution equals the marginal profit gained from an additional unit of the polluting activity. In equilibrium, the marginal cost of reducing pollution will equal the price of the permits as no firm will abate where permits can be purchased at

---

[4] According to the NutrientNet group, the goal could be a percentage reduction goal that is pursued through a voluntary, open program.

a relatively less cost (assuming that transaction costs were zero). Incentive payments can be introduced as an additional enticement to encourage trading where payment is made if the mandatory reduction is achieved.

In both cases, firms which do not hold sufficient permits to cover their discharge levels can: buy additional permits; control their discharge of nutrients through installing abatement technology or increasing efficiency; or both. Firms which fail to hold permits or credits that equate to their level of discharge will face a financial penalty.

The success of a cap and trade system is dependent upon a number of factors outlined by Grafton (2005):

- The costs of reducing pollution must differ between sources in order to achieve gains from trade
- Monitoring and enforcement must be effective in order to ensure compliance with the environmental targets
- Links between sources and discharge should be clearly identifiable
- Trading markets must be competitive so that the permit price reflects marginal abatement costs
- Trading costs are not so high as to deter market participation.

1.3.2 Point-Nonpoint Trading

One of the major difficulties associated with trading in a water catchment is that pollution is typically discharged by a combination of both point and nonpoint sources. As described above, a key feature of the successful implementation of a trading programme that achieves cost efficient pollution reduction is effective monitoring and enforcement. For nonpoint sources, effective monitoring and enforcement is complicated by the uncertainty concerning the transport of discharges from nonpoint sources.

In order to address this issue, biophysical modelling techniques can be used to gain a better understanding of the relationship between land use and management and discharges from nonpoint sources (Horan & Shortle, 2005). This will help to estimate discharge loadings from individual nonpoint sources and to monitor the anticipated impacts of any pollution reduction management actions.

Such modelling can be expensive as it requires detailed information about land characteristics and land management practices. Obtaining this information can be time consuming and may be difficult, particularly in the case of private land. Even with monitoring, uncertainty will still remain in relation to nonpoint source control and its impact on water quality.

To take this into consideration, regulatory agencies can incorporate a 'trading ratio' within the rules of trading for point and nonpoint sources. This ratio defines the number of nonpoint source permits that will trade for one point source permit (Horan, 2001). A trading ratio in excess of 1:1 allows for an error of margin where point and nonpoint source pollution reduction does not have equivalent impact on water quality. Allowing for the uncertainty in this way, increases the chance the environmental standards will be attained.

If the trading ratio is set unnecessarily high, this will limit trade since point sources will be forced to purchase a large number of nonpoint source permits in exchange for a single unit of their pollution (Malik *et al*, 1994). Conversely, if a ratio is set too low, this increases the likelihood of failing to meet the environmental targets due to trading of disparate pollution reduction permits.

Typically, ratios of two or three to one are utilised to compensate for the uncertainty regarding the impact of reducing nonpoint source discharges. Horan & Shortle (2005) investigate if this practice is optimal. They find that because the number of permits is not determined by the local regulatory agency but more typically at a national scale, larger ratios such as are commonly applied in the US, help to mitigate for the inefficiently high level of permits specified.

Horan & Shortle (2005) outline that,

"For economic efficiency, the trading ratio should reflect the relative expected marginal environmental (damage) impacts from each source, the relative uncertainty (risk) created by each source and the relative marginal transactions costs associated with trade."

Estimation of the trading ratio is usually informed by models of the effectiveness of the management action adopted to reduce pollution that take into consideration hydrological and

topographical characteristics. Accuracy will be dependent on uncertainty caused by unpredictable weather conditions and in regard to the effectiveness of the nonpoint source pollution controls[5].

Monitoring of nonpoint source effectiveness would reduce this uncertainty and the need for a cautiously high ratio. However, monitoring nonpoint sources can be technically difficult and expensive. Generally, monitoring and enforcement requires clear and comprehensible incentives that are consistent with group goals and penalties and rewards that are considered to be fair eg. penalise only offending parties rather than groups. Such costs can erode the cost efficiency benefits associated with trading. This emphasises the need to balance the costs of effective monitoring of nonpoint source controls with setting a high ratio that accounts for uncertainty.

Whilst enforceable restrictions on point sources that require a permit to be held for each unit of discharged pollution can be imposed, nonpoint dischargers such as agricultural sources are generally considered as having a right to pollute at historical levels. Therefore, any efforts to engage agriculture in such a scheme tend to be on a voluntary basis.

Despite the practical difficulties arising from trade between point and nonpoint sources, the potential gains to trade provide a strong incentive to consider implementing trading schemes in practice. Further discussion of these potential benefits are considered below.

[5] For further information on setting point-nonpoint source trading ratios see Malik et al (1994), Horan (2001), Johansson (2002), Horan & Shortle (2005)

1.4 Benefits

The use of a trading scheme as a policy tool for water quality improvement is recommended by the US EPA (2004). They identify a number of potential benefits based on previous experiences of trading programs that incorporate economic, environmental and social benefits, summarised below:

1.4.1 Economics Benefits

Firstly, as outlined previously, the trading process can reduce the societal cost of water quality management allowing water quality targets to be achieved at a reduced price. These cost savings arise through allowing those with low abatement costs to carry out the required pollution reduction. This provides the opportunity to take advantage of economies of scale and efficiencies that exist.

Linked to this, trading circumvents the problem of asymmetric information i.e. when landholders know more about the costs associated with abating discharge and the profits gained if allowed to pollute, whilst the agency knows more about the benefits of reducing pollution. Therefore, unlike the command and control system, it is not necessary for the agency to know the costs of each individual polluter as this would be revealed through the market system.

In addition, economic growth can be facilitated in such a scheme, where expanding or new land users can choose to control pollution output themselves, offset an equivalent level of pollution through purchase of permits or both.

1.4.2 Environmental Benefits

In terms of environmental benefits, targets can be reached more quickly by those who have the means to achieve such reduction. This has the potential to include nonpoint sources of pollution, if practical issues can be overcome through the use of trading ratios.

Incentives for ‘overcontrol’ and innovation approaches to achieving control are created.

Indirect environmental benefits are likely to result from this more rapid response and incentives to reduce pollution beyond target levels. These benefits could include improvements to habitats and protection of ecosystems which in turn could provide economic benefits, such as increased tourism.

1.4.3 Social Benefits

The trading approach provides a more flexible means of achieving nutrient reduction than command and control policies. Where participants have greater control over how they comply, it is likely to be a more sustainable approach.

It is thought that the trading process also facilitates dialogues and cooperation between stakeholders eg. farmers, environmental groups and local officials that is important for a

sustainable management approach. Furthermore, such an approach engages a range of types of dischargers, unlike agri-environment schemes which focus on agricultural landholders.

1.4.4 Challenges

Whilst there are many potential gains to water quality trading programs from economic, environmental and social perspectives, a number of practical difficulties threaten to reduce the attractiveness of this scheme as a viable policy tool. The main potential difficulties are outlined below.

Firstly, Boyd et al (2003) stress that technical challenges, such as modelling water pollution transportation in the catchment can be problematic, time consuming and expensive. This is a very real challenge particularly where nonpoint sources form part of the potential market. In this case, there is no certainty regarding measurement of pollution reduction or how monitoring and enforcement can be achieved. Definition of environmentally equivalent trades will be more difficult to identify, hence reducing the political and scientific defensibility of the trading approach.

Randall and Taylor (2000) suggest that high levels of risk aversion and high levels of uncertainty associated with trading can reduce the incentive to participate. High transaction costs can also eliminate potential market participants. Where the size and/or activity of the trading market is restricted, competition for the right to discharge, necessary to ensure efficient permit pricing, will be eroded. This reduces the financial viability of the trading mechanism.

The lack of a suitable regulatory authority may be another problem (Boyd et al, 2003). The role of the authority can be significant to ensure trade is facilitated, for example: through defining the rules of trade; identifying and connecting potential trading partners; checking and approving trades; monitoring and enforcing compliance; and, communicating outcomes to government, stakeholders and the public. Where the costs incurred by the authority in order to conduct these duties are prohibitive, the gains to the trading scheme will be eroded. Furthermore, skill and experience of operating such a system will be required and may be difficult to encounter.

In addition to these challenges, the characteristics of a specific catchment, when factored together, must be amenable to water quality trading. These characteristics will include the form of the pollutant, hydrological and topographical characteristics, the number, type and location of pollution sources and their costs of controlling pollution. In other words, stringent criteria must be met to render water quality trading a feasible policy tool.

The tradable permit system presents a potentially very effective tool for achieving cost efficient water quality improvement. However, as presented in this section, implementation is not straightforward. Success will very much depend on a range of factors both known and unknown and will rely heavily on the integration of key information sources and expertise. It appears that many of the complications arise when nonpoint sources form part of the equation. The report continues to investigate another potential Market Based Instrument.

1.5 Auctions for Land Use Management

1.5.1 Definition

Auctions for land use management are used by the regulatory agency to select the landholders that will be allocated payment for implementing management practices that reduce pollution output.

Auctions are closely allied to trading as a form of Market Based Instrument. Tradable permit schemes have had proven success in cutting the costs of point source emissions. However, this type of scheme may not be feasible where environmental problems result from both point and nonpoint sources (Stoneham, 2000). Transaction costs (ie. costs arising from identification of the source, administration, monitoring and enforcement) associated with a point-nonpoint source tradable permit schemes are likely to be prohibitive.

Whilst auctions have been successfully applied to a range of markets, including the mobile phone market, they have more recently been applied to address natural resource problems. More specifically, Latacz-Lohmann and Van der Hamsvoort (1997) have demonstrated that auctions are "*an efficient mechanism for achieving land-use change for environmental goals*". For example, the Conservation Reserve Program (CRP), operated by the USDA (Riechelderfer & Boggess, 1988), adopts an auction mechanism to distribute land management contracts through a competitive bidding process. Stoneham et al (2003) reports that the auction mechanism has many potential applications in Australia where changes in land use are necessary to achieve environmental improvements, including nutrient control, salinity control and conservation of remnant vegetation. As a result, the majority of published literature that evaluates the implementation of auctions for conservation contracts is based on Australian pilot programs such as the Catchment Care Scheme for the Onkaparinga River Catchment in South Australia (Bryan et al, 2005).

1.5.2 The Auction Process

The process of conducting an auction for conservation contracts firstly requires a budget to be set. The budget represents the amount of funding that the government will allocate to achieve the environmental target. Following this, a range of management actions, which could be feasibly implemented to achieve environmental targets, should be identified by the regulatory agency. Once the budget is set and management actions are identified, the regulatory agency must adopt a bid selection approach that will assist in fulfilling the objectives of the auction.

The next step in the process is for landholders to construct their 'bids' which provide details of the proposed management actions and the compensation cost required. Landholders can be assisted by regulatory authorities in the construction of their bids through the development of individual management agreements. These plans identify the required changes from each participating landholder. The payment or compensation demanded to carry out these changes will be dependent on the land characteristics, productivity of the landholder, the level of environmental awareness,

income, size of landholding, etc. This information will help the landholder to determine the compensation they would expect to receive from the generation of pollution credits (e.g. reduced nutrients), the return they would expect from the generation of ordinary goods and services (e.g. timber, wood pulp) and the environmental benefits signaled by the agency. Where these benefits occur as a result of one land-use change, landholders could place very competitive bids (Stoneham, 2000).

When the regulatory agency receives all bids from landholders, they will assess the bids according to cost efficiency. The agency will assign relative weights to individual benefit variables to reflect those benefits that are most highly valued. Management actions proposed in individual bids will be scored accordingly. Bids will then be ranked in terms of environmental benefit per unit of cost.

Contracts will be awarded to the landholders who have submitted bids that offer most environmental benefit per unit cost, up to the point where the budget is exhausted. The landholders will then implement the management activities outlined in their bids, in return for the agreed payment.

Chan *et al* (2003) identify key features for an efficient auction. These include:

"Selected landholders should be productive and cost efficient in carrying out their management actions

Selected conservation activities are effective in generating outcomes to meet the agency's conservation goals

Selected conservation activities should have low opportunity costs

Selected landholders receive the smallest payments that are required to retain their participation in the program."

1.5.3 Auction Design

The successful implementation of any auction depends considerably on how the design corresponds with the specific circumstances. In thinking about auctions applied for conservation contracts, it is useful to refer to the characteristics of standard auctions and auction theory. These characteristics should be considered when designing an auction.

There are four main types of auction (Klemperer, 2004):

English outcry auction – where the price is successively raised until one bidder remains. Bidders participate in the auction until the price exceeds the bidder's true value of the good. If bidders remain beyond this point, their chance of winning increases but at a cost. This is known as 'winner's curse'. Therefore, the incentive is to bid one's true value because the good is sold when one bidder remains at a price just beyond the second highest bidder's true valuation.

Dutch auction (descending bid) – where the bid is lowered successively until a bidder accepts the price.

First price sealed bid auction – where bidders simultaneously submit confidential bids and the good is sold to the highest bidder.

Vickrey or second price sealed bid auction - where bidders simultaneously submit confidential bids and the good is sold to the highest bidder but at a price equal to the second highest bid. The incentive is to bid one's true valuation since bidding higher would result in winner's curse whilst bidding lower reduces the chance of winning.

Revenue Equivalence Theorem, the theory associated with standard auctions, states that all these types of auction would result in the same price on average. A number of assumptions are associated with this theorem:

- that a single item is sold
- each bidder's private value is known only to him and is independent of other's bids
- the seller believes all bids are randomly drawn from a probability distribution
- that this probability distribution is identical for all bidders
- there is no collusion
- all bidders are risk neutral

Latacz-Lohmann & Schilizzi (2005) highlight the differences between standard auctions and those used to contract conservation activities. These differences convey that the assumptions of standard auctions do not fully hold for auctions for conservation contracts. They also identify the key features for consideration when designing an auction for conservation purposes.

Auctions for conservation contracts are multi-item procurement auctions which are less well developed within existing theory largely because multi unit auctions present additional difficulties. These difficulties include: problems in matching bidders to the items; a lack of market clearing prices which results in auctions becoming a mechanism for resource allocation rather than price discovery; problems in determining optimal strategies; complexity associated with implementing a multi unit auction which may restrict the feasibility of adopting such an approach (Milgrom, 2004).

They are more complex because the items differ for each bidder ie. they are heterogeneous. Different landholders will be able to offer different environmental benefits dependent on the characteristics of their land. Heterogeneous items mean that price is not the only factor in deciding on allocation of items. This is where the benefits index (p.10) can be used to facilitate bid selection. Furthermore, 'site synergies'[6] may mean there are additional advantages when groups of bidders tender together. Site synergies occur when benefits are compounded from engaging adjacent lands in conservation contracts. Allowing submission of individual and joint bids provides flexibility which can provide a greater incentive than simply encouraging landholders with synergy potential to participate. Joint bids allow parties to apportion risks through negotiation. This option will require clearly defined contracts and the feasibility of such an approach is not fully known (Chan et al, 2003).

---

[6] For further information on designing auctions for conservation scenarios with site synergies, see Lunander & Nilsson (2004) and Kagel & Levin (2005).

Conservation auctions are typically run as repeated auctions so that there is a sequence of bidding rounds with more than one opportunity to participate. However, this creates an opportunity for ‘learning’ and collusion which can affect the cost-efficiency of the auction. When bidders ‘learn’ about the bids accepted in previous rounds, they use this information in forming their bids in the next round. Collusion describes the situation where bidders agree to demand less so that supply exceeds demand and this lowers price.

Conservation auctions can operate to meet a fixed target (‘target constrained’) or fixed budget (‘budget constrained’). A target constrained auction will award contracts to bidders who submit the most environmental benefit per unit cost up to the point where the environmental target has been reached. Conversely, a budget constrained auction will award contracts up to the point where the budget has been spent. Uncertainties arise with both forms of auction: with the former, the cost of meeting the target will be unknown, whereas the total environmental benefit will be unknown in the budget constrained auction. The choice of auction constraint will be influenced by the objectives of the auction.

Auctions can adopt different payment formats. Uniform payment issues all successful bidders with an equal payoff per unit of environmental benefit supplied. This approach is arguably more equitable but may be less efficient. Some ‘auctions’, such as the SRC Challenge Fund in Northern Ireland, have adopted fixed payments, where each land user receives the same unit payment. Uniform payment formats may be more costly because they do not take into consideration the opportunity cost of environmental provision and treat landholders as homogenous. Therefore, they can overcompensate landholders with low marginal costs of mitigation. Alternatively, discriminatory prices achieve greater efficiency by paying actual value requested in the proposed bid.

Finally, a ‘reserve price’ which reflects the maximum price that the agency will pay. This price may or may not be revealed to bidders in advance of submitting their bids to encourage participation or facilitate bid selection. This reduces the incentive to collude[7].

The above discussion highlights the importance of identifying a suitable auction mechanism that facilitates the requirements of allocating conservation contracts. The Package (also called Combinatorial or Menu) auction is a type of multi unit auction design that allows bidders to determine their own package of goods. The first price package auction is a particular form of package auction where bidders submit packages or bundles of items to be purchased (in the case of a procurement auction). These packages are proposed along with a price or bid. The buyer selects the combination of packages of items to minimise price. The bidder then receives the amount bid (ie. it is a discriminatory auction) in return for a promised performance. These auctions will have many potentially efficient solutions so that profit target strategies exist. Given full information, the outcomes of profit target equilibria ensure that prices are competitive and are bidder optimal. However, the level of information required to set profit targets accurately and be able to coordinate on one of multiple equilibria may not be practical[8] (Milgrom, 2004).

This type of auction is suited to a conservation contract because:

[7] Reserve quantities can also be imposed to prevent large landholders winning a majority of contracts.

[8] For further information on the first price package auction see Berheim & Whinston (1986), Krishna & Tranaes (2002)

The items being auctioned are not perfect substitutes i.e. whether the marginal value declines with the allocation of an additional item[9]. The requirement for goods to be substitutes is associated with other multi-unit auction types such as a Vickrey multi unit auction, rendering them inappropriate.

Practically, bidders will only be able to achieve specific, individual quantities of the items. Therefore, the bidders need to propose the 'packages' based on what is feasible rather than packages that are set by the agency. The package would describe the complete management plan detailing *all* actions the farmer would wish to undertake.

First price package auctions facilitate bid assessment with the opportunity to factor in additional criteria that may be important to the agency.

Lunander & Nilsson (2004) find that first price package auctions are more efficient for dealing with site synergies

They are relatively simple and transparent which is essential for implementation.

Having selected an appropriate auction type, it will be necessary to carefully consider the specific characteristics of the scenario and tailor the auction design to ensure an efficient outcome. Variables such as the auction constraint, the payment format, the reserve price and/or quantity and the level of information revelation will need to be determined. Economic experiments are a useful

[9] Uniform price multi unit auctions are problematic when goods are not substitutes because market clearing prices fail to exist. Uniform pricing might also result in demand reduction if bidders don't value each additional unit the same.

tool to test auction design and ensure that any complications are captured and addressed before implementation[10].

“experiments can provide valuable guidance in economic settings such as these where theoretical research cannot give clear predictions and hence is of limited use to make institutional comparisons”. (Cason & Gangadharan, 2005)

Experiments can be conducted with stakeholders. Latacz-Lohmann & Schilizzi (2005) list several potential benefits: “eliciting the opportunity costs (and heterogeneity in costs) faced by landholders; identifying likely participation rates in an auction system, across different auction *for*mats; and identifying the transaction costs associated with a tender mechanism.”

Pilot programs can provide further opportunity to refine auction design. This process of testing the policy tool is advisable given the limitations in both theory and practical application to guide implementation[11].

1.5.4 Advantages of Auctions

One of the main reasons for implementing auctions arises from problems with obtaining detailed information about the characteristics of nonpoint sources for alternative market based instruments, such as tradable permits. As previously discussed, such technical and practical difficulties associated with point-nonpoint source trading, can result in costs that make such an approach

---

[10] See, for example, Latacz-Lohmann & van der Hamsvoort (1997; 1998), Schilizzi & Latacz-Lohmann (forthcoming), Stoneham *et al*. (2003), Cason *et al*. (2003) and Cason & Gangadharan (2005).

[11] This is further discussed in a subsequent section of the report.

infeasible. Auctions can offer a more suitable alternative for nonpoint source land use management.

Bryan et al (2005) identify four key reasons that explain why auctions are a preferred policy tool for generating land use change: allocative efficiency, objectivity, transparency, and flexibility.

Allocative efficiency occurs when “the auction is won by the highest bidder and when the value of the highest bidder reflects the true social value of the resource”. In the context of conservation contracts, landholders who can achieve land use change at lowest cost and/or who value the environment highly, will offer very competitively priced conservation projects. Under conditions of perfect competition, where there are many sellers and many buyers in the market who have access to full information, auctions are likely to maximise allocative efficiency. Because auctions involve participants in a competitive bidding process, environmental targets can be reached at least cost (Stoneham, 2000).

Due to the nature of the auction process, where price is determined through the market mechanism rather than being set by government, auctions can be less subjective than other policy mechanisms. Objectivity arises because bidders compose their individual bids which are accepted or rejected relative to other submitted bids.

The auction process also tends to be more transparent as the rules associated with evaluating and selecting contracts will be revealed prior to the auction commencing (Chan *et al*. 2003). Interested landholders will typically be given information packs which describe the process and design of the auction and allocation of contracts. This instils greater confidence in the policy tool, encouraging participation.

Finally, auctions are flexible. They do not compromise policy objectives because conditions can be attached. Conditional stipulations help to manage risks incurred by the regulatory agency.

1.6 Challenges

Whilst there are significant advantages in adopting an auction scheme to manage land use changes for the purpose of environmental improvement, prior experience has identified a number of key challenges that threaten to erode these potential benefits.

Latacz Lohmann & Schilizzi (2005) present findings from the Scottish Executive pilot schemes which suggest that high administration costs and high transaction costs borne by the landholders reduce the potential gains from participation in the auction scheme. Furthermore, unsuccessful bidders reported high costs associated with preparing the bids in the face of uncertainty. This problem is likely to reduce the number of bidders participating in future schemes.

The need for a suitable regulatory infrastructure can present difficulties similar to those identified for trading mechanisms. The role of the agency will be significant, for example: designing the auction mechanism; issuing a call for bids and providing information about the procedure and rules

associated with the auction; assisting landholders to develop their individual management plans and providing information on costs to encourage realistic and feasible bids; bid evaluation, assessment and selection; administration; monitoring and enforcing. It is possible that significant costs will be incurred in meeting these requirements. If the costs are too high, the gains from the auction mechanism may be eroded.

Bryan et al (2005) identify several factors that may reduce the efficient allocation of contracts at auction. “Whilst auctions have the potential to achieve efficient outcomes, they may also perform poorly depending on market conditions, bidder behaviour and auction design”.

To a certain extent, thoughtful design of the auction mechanism can help to avoid some of these difficulties.

1.7 Review of Best Practice

1.7.1 Tradable Permit Schemes

Among the first tradable permit schemes was that brought to end the controversy over SO2 emissions by powerplants in the US (Chicago Board of Trade) under the first Bush administration in 1993. The existing command and control system was unpopular with the industry because of the cost of implementation whilst environmentalists called for more stringent control of emissions. Following this, permit trading has become much more widespread on a global scale and has been applied within a range of contexts including air pollution, recycling, fisheries, development and water quality.

For the purposes of this report, a selection of the most relevant or informative schemes will be reviewed. These examples focus on point-nonpoint source trading schemes. Point-point source trading schemes within the Melvin Catchment are unlikely to be viable given that existing point sources are relatively small waste water treatment works which are likely to face similar costs of pollution reduction negating the incentives for trade. Given the difficulties involving nonpoint-nonpoint trading (USEPA, 2004), no actual scheme has been fully implemented (Faeth, 2000). However, evaluation research investigating the potential for nonpoint-nonpoint water quality trading in the UK, will be reviewed.

1.7.2 Point-Nonpoint Water Quality Trading Schemes

Agricultural nonpoint sources have largely been by-passed by regulation which was considered impractical given the difficulties in identifying contributions to nonpoint nutrient loadings. However, the EPA in the US has more recently encouraged trading between point and nonpoint sources with farms generating pollution credits through the implementation of best management farming practices that are then traded with nonpoint sources. The EPA listed 13 existing programs[12] facilitated at the catchment level. Several levels of government are involved along with both point and nonpoint source polluters.

1.7.3 Tar Pamlico River in North Carolina

This River Basin is one the largest estuarine bodies in the United States. The point-nonpoint source trading system in place since 1990, is generally thought to be a 'national model' for cost efficient coastal water quality and illustrates a rigid form of permit trading for water quality. Like

[12] EFTEC (2005) identified 40 proposed or operating water quality schemes in the US.

Melvin, the environmental problem is eutrophication of the river caused by high nutrient loading (N and P). The trading system operates with 12 point sources who formed a collective (the Tar-Pamlico River Basin Association) and numerous nonpoint source polluters (largely farmers).

If total loadings from the 'Association' exceed the allowable limit (the cap), members are required to purchase offsetting nonpoint source abatement (estimated to cost 10% of the price of reducing 1 unit of point source pollution). Trading ratios of 3:1 for crop agriculture and 2:1 for livestock farming are utilised. Trades are arranged by the North Carolina Department of Soil and Water Conservation through the North Carolina Agricultural Cost Share Program into which funds are deposited by the Association if targets fail to be met. These funds are used for programs in the River Basin, for example, the implementation of best management practices. A minimum annual amount of money in the Cost Share Program must be maintained by the Association to ensure availability of funds should trades be necessary. Point sources do not, therefore, bear any responsibility for compliance by nonpoint sources reducing their risks of trading. Rather, the state bears the cost of monitoring and enforcement.

To date, no point-nonpoint trades have occurred because limits have not been exceeded. However, credits had been purchased for future needs and trades between point sources are active. This lack of realisation of potential benefits from trade could be due to the gains from efficiency that have resulted from a switch to performance standards for point source polluters which allowed them to abate directly. Alternatively, the design of the trading market may be too restrictive with too many bureaucratic controls that impede trade. (Huisman and Coffey, 2005; North Carolina Division of Water Quality, 2007)

1.7.4 The Lower Boise River Water Quality Trading Pilot Project

This water quality trading programme was started in 1998 to protect usage of the River from the effects of high phosphorus levels in a cost effective manner. The river in this scheme comprises 64 miles cutting rangeland, forest, agricultural and urban land. The adopted approach was to implement pre-approved trade transactions. This means that for point sources, new phosphorus loading permits are allocated that incorporate margins to allow for trade dependent variation. Trade can occur with other point sources through buying or selling permits which will result in an automatic increase or decrease in loading allowance. Alternatively, point sources can supplement their permit level with credits obtained through trade with nonpoint sources that can demonstrate they comply with pre-approved best management practices (BMPs). These BMPs, drawn up in advance of the trade, outline detailed protocols that if complied with, pre-qualify resulting reductions for sale. This pre-approved trading approach reduces risk and helps to keep cost low.

Stakeholder engagement has played an integral role in developing the trading scheme framework. An initial educational event engaged federal, state and local agencies with water quality responsibilities in addition to representatives from industry, municipalities, agricultural and environmental communities with independent support to facilitate participation and recruitment.

Participants were involved in developing the mechanisms, rules and procedures of the trading framework and models to define trade between point-point and point-nonpoint sources, equivalence ratios and other specific issues.

To manage the trading program, a private, non-profit cooperative was formed. The cooperative consists of watershed participants who handle the daily running of the trading scheme. They broker trade between buyers and sellers, the cost of which is split by market participants and the cooperative group. They ensure equivalent trades using an existing Total Maximum Daily Load (TMDL) water quality model to lower costs and ensure compliance with TMDL. Caps are applied on downstream trades to avoid hotspots. To ensure compliance with watershed level reductions, results from monitoring of water quality are collated and submitted to the EPA who initiate regulatory enforcement where limits or protocols are breached. Trading is tracked through record keeping, protocol reporting and using a database to store information. Such procedures also make public dissemination of information accessible.

An interesting characteristic of the scheme is how it manages the risk that an agreed reduction will not be achieved. Regulatory agencies have no authority over an agricultural source. Designers maintained nonpoint source regulatory independence by placing Clean Water Act liability with permit holders whilst liability for failing to produce purchased credits would be handled through private contracts between sources. The contract sets out details and assigns financial liability of regulatory non-compliance to the seller. Parties decide who pays for damages; legal involvement may be expensive (Ross & Associates, 2000; http://www.lowerboisewatershedcouncil.org/).

1.7.5 The Cherry Creek Basin Water Quality Trading Program

A trading program was started in 1985 in this reservoir in Colorado, US to manage eutrophication arising from increasing levels of phosphorus loadings in the watershed. Sources of phosphorus include both point and nonpoint entities with impacts expected to rise due to increasing pressures from accelerating economic development in the area. The main objective is to maintain the water quality status of the reservoir as a whole, rather than focus on specific rivers or tributaries. The requirement for urban nonpoint sources to cut loadings by a set amount prior to trading is yet to be achieved. However, population growth has not occurred at the predicted rate meaning that pressures are not as great.

To achieve this aim, a public authority, empowered by government, was set up to develop and administer a trading program. The approach adopted was quite different to the pre-approved trading system outlined in the Lower Boise scenario. In Cherry Creek, trades were approved on a case-by-case basis. The Authority facilitated trading of permits in two ways. Firstly, through a ‘Phosphorus Bank’, which stores phosphorus credits generated from four phosphorus reduction projects set up by the Authority. These nonpoint source projects included constructed wetlands, retention pools and stabilisation of water banks. Funds generated from the sale of credits in the Bank are used to fund additional water quality improvement projects. In addition to the Bank, the

Authority also manages a 'Reserve Pool' from which point sources can obtain credits that have been created by other watershed stakeholders who can 'overcontrol'. Overcontrol is defined as actions to reduce P loadings over and above best management practices outlined as mandatory. For example, implementation of best management practices that have been completed after the date when mandatory practices were imposed, extensions or additions to existing best management practices or other approved projects developed in line with Authority recommendations. All trades through the pool must be approved by the Authority.

The Authority plays a key role in evaluating and approving all reduction projects with input from stakeholders in terms of public notices for comment and public hearings or meetings. The Board of Directors vote on reductions and assign credit value based on the trading ratio. Applications for credits from either the pool or bank are approved or rejected by the Authority who assesses them based on past actions and need. These trades are reviewed and adjusted accordingly. Limits are then issued. Transaction costs are known. Water equivalence ratios are applied at basin level and are typically between 2:1 and 3:1 based on soluble and nonsoluble load and attenuation. Ratios for particular trades are determined by site specific monitoring, modeling or best available data. Communication between buyers and sellers is less necessary given the broking role of the Authority. Tracking and dissemination of information is easily facilitated due to centralised administration and record keeping.

Risk is largely minimised for buyers and sellers due to the responsibility born by the Authority in terms of ensuring reductions conform to market rules and in approving trades. The authority has the opportunity to substitute bank credits for pool credits where necessary to ensure compliance with water quality standard in the event of failed reduction. However, transaction risk through the pool falls on purchasers who must renegotiate another trade if initial agreement fails. (Water Environment Research Foundation, 2000; Cherry Creek Basin Water Quality Authority, 2006)

1.7.6 UK Emissions Trading Scheme

Whilst not a water quality trading scheme, the UK Emissions Trading Scheme is a point source trading scheme that aims to cut industrial greenhouse gases (GHG). Launched in 2002, participants include volunteers who cut any form of GHG emissions in return for financial compensation from the government and energy intensive industries (including the agricultural sector) who enter into an agreement to cut energy use (CO_2) in return for a tax rebate. Initial permits were issued by auction to voluntary participants and credits were issued to agreement participants for overcompliance. Trade between participants could then take place. The scheme which is implemented by DEFRA, has run reasonably successfully with very little noncompliance.

1.7.7 Evaluation of Water Quality Trading Schemes in UK

Examples of trading schemes operating in UK or Ireland are limited. There are currently no Water Quality Trading Schemes operating in either country in spite of the practice being advocated by

DEFRA in UK. However a number of investigations of the potential for trading have been conducted.

For example, the UK government has given consideration to water quality trading scheme in the Consultation on Diffuse Sources of Water Pollution from Agriculture document which was released in August 2007. In theory, this option would have the potential to reduce P loadings by a greater amount given the larger relative contribution from agricultural sources. This document identifies potential 'policy packages' for national application to catchments that would otherwise fail to comply with Water Framework Directive targets by 2015. Among those policies considered, tradable permit schemes were '*not cost effective as a stand alone measure and were therefore excluded'* (DEFRA, 2007). As mentioned, this decision is based on findings provided by research reported in EFTEC (2005) and ADAS (2007).

The EFTEC (2005) research investigated three types of trading schemes that could theoretically be conducted between agricultural sources. These included input trading, surplus (or nutrient budget) trading and farm practice trading. Input trading describes the situation where a cap is placed on P input from fertilisers and feedstuffs with an opportunity for farmers to trade their P input allowance. Surplus trading describes a similar situation but where farmers trade their allowance with regard to the net difference of P arising from outputs and inputs. Finally, farm practice trading describes the situation where a farmer would trade agricultural practices implemented to compensate for the pollution from another farmer.

After reviewing these potential schemes, it was reported that input trading was unlikely to be feasible. A number of reasons were stated, for example, agricultural P input is a poor proxy for pollution with the relationship being highly affected by a range of exogenous factors such as rainfall, farm and soil type. In addition, concern was raised with regard to the limited methods of reducing P included in this scheme which would reduce economic efficiency, the advantage it offers to those in agri-environment schemes, inequity arising from unequal potential to reduce P across farm types and the uncertainty with regard to administrative costs.

Surplus trading was thought to be the most realistic of the trading schemes examined. The advantages with this approach included that surplus P is better correlated with pollution, it encapsulates a wider range of methods for reducing P and is thought to be more economically efficient. However, problems arise from the significant difficulty in calculating surplus and the need for farmers to keep detailed records, the relative high costs incurred by those who do not trade and the lack of best practice examples on which to draw.

Finally, the farm practice trading scheme was found to be problematic due to the lack of certainty about the true impact that practices would have on water quality. Specifically, the variation of impacts on a field by field basis would likely result in high transaction costs, diminishing the appeal for farmers to participate in this scheme. The implementation of farm practices and their impacts would be difficult to monitor and measure and would result in high administrative costs. Trading

ratios would be essential to ensure equivalent trades. One advantage however, is that this approach would not impose targets on farmers which is likely to be more acceptable.

The work conducted by EFTEC was restricted by information gaps concerning water quality targets and the accuracy of data on the effectiveness of mitigating P using farm practice measures. ADAS (2007) built on this research by estimating mitigation costs of reducing to a target level given farm size and pollution load. This was used as a basis against which to compare predicted costs of alternative (trading) schemes. Initial modelling, based on theoretical costs, suggested that for large P reductions (ie. greater than 30%) across 2 hypothetical farms of equal size, a cost differential of at least 3 would be required. In other words, farm A must incur costs of reducing P that are at least three times that incurred by farm B. The model was then run using mitigation costs taken from the Diffuse Pollution Inventory omitting measures that did not reduce P, were good agricultural practice or were too 'extreme' and unlikely to be applied. No consistent benefits from operating a trading scheme were found due to the lack of cost differential. Potential trades would result in only small P reduction with operating costs which would outweigh the benefits. The greatest potential for beneficial trade exists between arable and dairy farms, where the cost differential is likely to be greatest.

Both studies conclude that the challenges of designing a trading scheme for diffuse water pollution from agriculture that is 'fair, equitable and simple' render this policy option unfeasible. Particular complications highlighted include:

- The uncertainty regarding the relationship between agricultural actions and impact on water quality, which could result in 'hotspots' or no improvement.
- "Farmers were described [in Kraemer, 2003] as reluctant to get involved because of a historic lack of regulation, an aversion to exposing themselves to risks beyond their control and difficulty in conceptualising management changes in terms of pollution reduction"
- The need to involve a third party to monitor and measure the effects on water quality and the difficulty and cost associated with this.
- The lack of differences in costs of abatement between sources which diminish the potential gains from trading.

Gaps in information include data on cost differentials between farm types and consideration of catchment specific information. However, it is thought that this missing data would not alter the conclusions. In their report, ADAS (2007) suggest that the pilot scheme proposed by EFTEC (2005) would be unnecessary in light of their findings. They do recommend that stakeholders should provide comment, that the potential for point-nonpoint source trading is further investigated and that closer inspection of US examples would be beneficial.

1.7.8 Lessons Learned

Successfully functioning water quality trading schemes appear to meet environmental objectives set with little evidence of the occurrence of hotspots. Successful schemes tend to have low transaction costs (EFTEC, 2005), are relatively simple in design and involve low levels of liability. As evident from the examples discussed, the formation of collectives can help to share the risk of individual liability and provide assistance with calculating credit values, for example.

Regulation and management of trading schemes varies but tends to involve local management initiatives which can more easily take local conditions and circumstances into account. This local control comes in the form of local authorities, independent collaborative groups or sources themselves eg. Tar Pamlico Association Government authorities, either at state or local level. These entities tend to set targets, monitor and enforce compliance though more active involvement in running the schemes can also occur. US schemes are well set up to introduce trading schemes given that TMDL targets have already been put in place.

As reported by ADAS (2007), trading between nonpoint sources is unlikely to be viable primarily due to a lack of variation in the costs of reducing pollution. Point-nonpoint trading tends to result in greater cost savings because the cost abatement differentials are greater. However, complications can arise in the difficulties of monitoring nonpoint sources. The reliance on proxies may not be accurate which increases the risk of liability. Furthermore, the complexities of many of the trading schemes suggest high levels of administration and lack of support from potential participants. Kraemer (2003) notes that a range of potential barriers to trade exist including lack of available information, uncertainty regarding the impact of existing regulations and a lack of understanding amongst the general public.

As highlighted above, it is difficult to find concrete examples of water quality trading schemes which involve a high level of trades and have been operating for any considerable length of time. This indicates the limited potential for application of a trading scheme in this context, a result also found in ADAS (2007). In addition, a lack of examples limits the information base that can be used to inform an assessment of the feasibility of implementing such a scheme within the Lough Melvin Catchment.

1.8 Conservation Auctions

The number of applications of auctions for conservation purposes is small, with most schemes operating in Australia and US. A postal survey conducted by Latacz-Lohmann & Schilizzi (2005) of agricultural ministries within EU15 countries yielded 2 responses which revealed no schemes operating in Sweden or Belgium. Given the lack of theoretical background, and complexities associated with implementation of this mechanism, it is perhaps not surprising that few examples can be identified. However, the realisation that experiments can be used to ‘test-bed’ this

approach, attention has more recently focused on auctions as a potential cost effective policy option.

1.8.1 Conservation Reserve Program, USA

The Conservation Reserve Program has been operational since 1986 and is the first known application of an auction for conservation purposes. The auction aims to reduce soil erosion and improve water quality. Farmers enter into a 10-15 year contract with the US Department of Agriculture (USDA). Land that is heavily eroded or environmentally sensitive is retired from crop production. Land cover is converted to natural vegetation through planting. In return, farmers receive annual rent from the Commodity Credit Corporation with initial costs shared. The program is administered by the Farm Service Agency with decisions regarding land, producer or practice eligibility made by the Natural Resources Conservation Service.

Initially simple, the bid design has been developed to employ an environmental benefits index (EBI) to compare bids for land retirement for conservation use. Bids are scored according to land characteristics, such as erodability, and land management practices, such as land cover, before being weighted according to environmental priorities, such as improved water quality. Bid value enters the index as a negative score. Bids that exceed a threshold score will be accepted. (Latacz-Lohmann & Schilizzi (2005).

The program is largely successful with an estimated 34 million acres of retired land achieving average rents of $45.95/acre (Latacz-Lohmann & Schilizzi, 2005; Sullivan et al, 2004). The benefits of the program, in addition to reduced soil erosion and improved water quality include reduced agricultural diffuse run-off, development of wildlife habitat, reduced sedimentation in water bodies, maintained soil productivity and provision of a source of income for farmers (Riechelderfer & Boggess, 1988; Huang et al, 1990; Young & Osborn, 1990; Kinsinger, 1991). In addition, Dunn et al (1993) reported that ecological benefits are likely to be hidden and are likely to also include reduction of landscape fragmentation and a positive impact on carbon balance.

A report conducted by Sullivan et al (2004) investigates the economic impacts of the CRP on communities within the local region and reports that initial impacts, such as low level unemployment from rural areas, are short lived. No evidence of migration from the region was found and expenditure on outdoor recreation increased. Adaptation to the CRP in the long run appears to balance any short term effects, with a small overall impact dependent on local economic conditions.

1.8.2 BushTender Trial, Australia

Australian conditions which present problems concerning nutrient and salinity control and vegetation conservation requiring some form of land-use change (eg. Stoneham et al, 2003) afford many opportunities for the application of auction based land management techniques. The need for additional cost effective management of native vegetation on private land in Victoria prompted the

Department of Sustainability and the Environment to consider the viability of auctions as a potentially efficient technique to increase biodiversity in the area. Two trials occurred during 2001-2 and 2002-3 in North Central/North East Victoria and Gippsland respectively. The first trial accepted 97 bids submitted by 73 landholders who collectively received $400,000 (Aust $). The Gippsland trial awarded predominantly 6-year contracts (with an option to extend to 10 years) to 33 successful bidders for $800,000.

The auction was initiated by requests for expressions of interest from landholders who were visited by government officers. During these visits, ecological information was collected to devise a Biodiversity Significance Index used to indicate a benefit:cost ratio of bids. The benefit component of this index comprised a conservation or biodiversity value to reflect scarcity of vegetation type multiplied by a habitat service score to reflect the quality change resulting from proposed management actions. The cost component equalled the bid value. Contracts were drawn up individually between government and landholders. A discriminatory sealed bid auction was conducted with bids ranked and allocated until the budget was spent. (Stoneham et al, 2003)

Compliance is reported at around 95% with an estimated saving of 700% compared to alternative fixed price schemes (Stoneham et al). However, this estimation is criticised as an overestimation because they do not consider that bids contain value of information rents i.e. the difference between how much has been bid and the actual cost or opportunity cost to the landholder (Latacz-Lohmann & Schilizzi, 2005)[13].

[13] Based on the Australian Auction for Landscape Recovery, White & Burton (2005) report discriminatory price auctions to generate savings of 165%-315% varying between auction rounds.

1.8.3 Catchment Care Trial, Australia

Onkaparinga catchment based auction trial aims to increase the cost effectiveness and environmental benefits of public funded schemes for private land management actions. In particular, it aims to improve biodiversity and water quality under threat from productive agricultural land use. The auction is managed by the Onkaparinga Catchment Management Board.

The auction process is similar to that adopted in the BushTender Trial, where officers visit interested landholders to assess sites and develop detailed site action plans. These plans are submitted with a bid to the Board along with the required level of cost sharing for implementation of actions. Bid assessment is very detailed in this case and incorporates risk analysis as outlined below:

Risk = Value of Land x Threat Value

Impact = Threat Reduction from proposed Actions x Risk

Environmental Benefits = Impact x Area

Environmental Benefits/$ = Environmental benefits/Cost

Bids are then ranked according to this benefits index with contracts awarded to those which offer most benefit per dollar spent for their bid price. (Bryan et al, 2005)

Computer-based simulation was used to test the bid ranking and selection techniques prior to implementation. The trial contacted 224 landholders, 42 of which participated in site visits resulting in 29 bids from 27 landholders. Seventeen bids were accepted within the trial budget of $150,000

(Aust $). Evaluation of the trial revealed that bids submitted were varied in terms of actions and bids proposed and types and conditions of land; cost effectiveness was found to decrease considerably with bid rank; and the auction approach was 24-33% more cost effective than the existing scheme. The administrative burden however, was reported to be considerable (Bryan et al, 2005)[14]

1.8.4 Challenge Funds, UK

Whilst not applied to a water quality context, the Challenge Funds provide an example of an auction approach to land management operating in the UK. In 1997, a competitive bidding system was set up to offer incentives for planting trees in addition to existing grant schemes offered by the Woodland Trust in Scotland. Landholders submitted plans detailing the location, area and type of planting to the Forestry Commission. Bids for additional funding were assessed against threshold criteria and those plans which offered most value for money, in keeping with the aims of the scheme, were accepted. Bids were scored against various criteria including cost, probability of forest establishment, habitat quality, recreation facilities, landscape and timber potential (Latacz-Lohmann & Schilizzi, 2005).

The Challenge Funds saw an increase of around 10% of woodland planting, exceeding targets in some areas. CJC Consulting (2004) conducted economic evaluation of Grampian and Central Scotland Challenge Funds and reported costs between 33-36% lower than under an alternative

[14] The Bryan et al (2005) report provides a very detailed description of the design process and practical implementation of the auction.

fixed payment scheme. However, as in the evaluation of the BushTender Scheme it is thought that this is likely to overestimate true cost savings.

The last remaining Challenge Fund completed in 2002 and currently the Woodlands In and Around Towns scheme is the only woodland auction scheme currently operating (2004-2008). The focus on this scheme is to promote sustainable management of forestry in urban areas and £3.5m has been set aside for funding the scheme in addition to the Scottish Forestry Grants Scheme.

1.8.5 Evaluation of Auctions for Land Management in UK

Latacz-Lohmann & Schilizzi (2005) conduct an assessment of the suitability of auctions as a cost efficient alternative to agri-environment schemes in Scotland through a review of theoretical and empirical literature. They consider the scheme for allocation of Land Management Contracts, which would reward farmers for implementing agricultural measures to deliver tailored economic, social and environmental benefits. They identify a number of characteristics of the local context that have the potential to restrict the advantages of applying an auction mechanism. Firstly, the compliance costs between landholders within the scheme are likely to be similar and relatively easily quantified. They argue that bidding schemes are most efficient where costs are different or unknown to the authority. In addition, in this context, land management agreements are heterogeneous with a tiered level of entry, making bid selection reasonably complex due to the requirement of multiple objectives of the scheme. Whilst this can be overcome by using a benefits index to assess bids, this will increase transaction costs and reduce transparency resulting in an increase in the number of complaints. The aim of the Land Management Contract scheme is to deliver 'tailored' benefits which will restrict the number of eligible bidders, reducing competition and hence, increasing collusion and strategic bidding. This results in diminished efficiency of the auction mechanism. Finally, as landholders are familiar with agri-environment schemes, they may anchor bids at a similar levels to these payments, also reducing efficiency.

Whilst they fail to advise adoption of auctions for the allocation of Land Management Contracts, they indicate that the limited practical application of such auctions suggests the need for testing prior to implementation of any such scheme.

1.8.6 Lessons Learned

The auctions reviewed appear to have been successful in achieving their environmental objectives, without any significant issues arising from noncompliance or broken contracts. They are reported to be a more cost efficient approach than alternative or existing schemes.

Interviews with participants of the Scottish Challenge funds were not satisfied with the tendering scheme and disliked the uncertainty of discriminatory price principle which they felt was unfair (CJC

Consulting, 2004). This suggests that investment in educating participants and involvement of stakeholders is likely to be an important factor in bringing participants on board.

Field trials also provide an opportunity to train participants and reduce uncertainty. They present an important opportunity to gain information about auction design and application prior to full scale policy implementation. However, learning can reduce the efficiency of the auction. This can potentially be overcome by altering the auction rules to prevent landholders predicting outcomes from previous results.

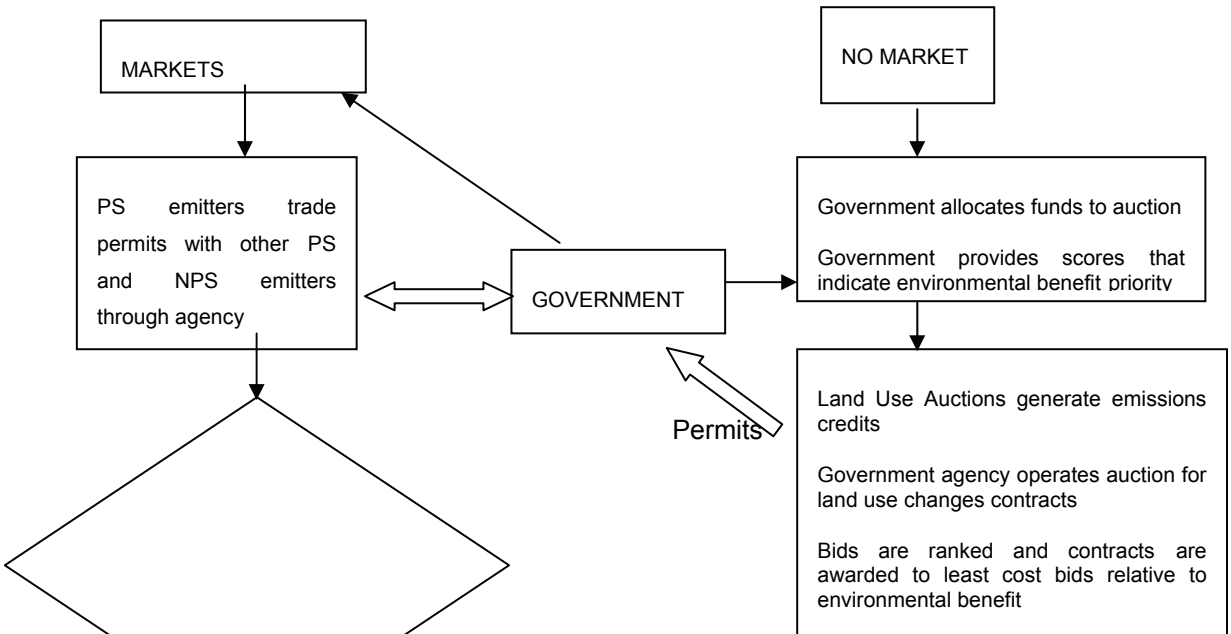
The administrative and cost burden associated with preparing bid submissions can be another off-putting feature, particularly where applicants are unsuccessful in their contract application. Participants can be helped to prepare bids by provision of information or assistance provided by field officers, as in the Onkaparinga Catchment Care Programme. Administrative costs are likely to diminish with experience.

Stoneham and Chaudhri (2000) have proposed linking tradable emission markets with auctions for conservation contracts to involve both point and non-point sources in one 'environment economy'. Point sources would operate in the market through trading permits whilst nonpoint sources engage through auctions which generate credits. The auctions would be carried out as previously described with bids ranked using an environmental benefits index and contracts awarded to those which offer most value for money. These banked credits could then be 'traded' as permits to point sources. Point sources also have the option of trading with other point sources. Transactions are represented in the diagram below.

The potential advantages of such an approach would be the reduced funding burden on the government, the involvement of both point and nonpoint sources, the ability for the government to exercise control, reduced risk for participants arising from noncompliance, flexibility to incorporate new entrants or development.

No examples of such an approach exist in reality. The potential to merge both policy instruments will firstly depend on the success of the auction.

Fig 1 (adapted from Stoneham, 2000)



PS emitters buy permits if cost of abating > cost of rmit price or sell permits if cost of abating < cost of permit price

1.9 Economic Instruments for Nutrient Management in Melvin Catchment

In order to consider which type of market based instrument would achieve a cost effective reduction in nutrient loadings, it is necessary to consider the catchment characteristics. As outlined in the US EPA Water Quality Trading Assessment Handbook, the information base required to evaluate the viability of nutrient trading schemes is quite detailed. Firstly, pollutant suitability has to be determined. This includes identifying sources of pollution and collecting information on the source location, pollution transportation, time pollution occurs, type, form and quantity of pollution discharged and required reduction in pollution levels. This information is used to ensure potential trades between sources result in equivalent impact on water quality. Where differences in source pollution characteristics occur, it may be possible to apply 'translation or trading ratios' to ensure equivalent trades. The information is also used to check that trading will adequately meet the targets set for the water catchment.

The second stage involves assessment of the financial attractiveness to consider if trading will result in sufficient economic returns to make such a scheme viable and worthwhile. To achieve this, detailed information on required reductions and abatement costs from major polluters will be required. Trade will be viable between sources with high cost differentials.

The final step is to identify an appropriate market infrastructure required to implement the trading process and to facilitate achievement of water quality targets.

Whilst this level of information is not currently available for the Melvin catchment, provisional assessment of the viability of a trading scheme can be conducted based on available information and lessons learned from best practice examples. The necessity for water quality improvement has been identified by previous research (Girvan & Foy, 2006). Within the Melvin Catchment, point sources which have been identified as contributing to P loadings in the lake include three (relatively small) sewage treatment works (STWs) which constitute around 7% of total P loadings (Girvan & Foy, 2003) and rural housing septic tanks which are thought to contribute a further 10% of total P loadings. If standards (ie. a cap) were imposed in the Lough Melvin Catchment, which required these point sources to reduce their P loadings, in a trading scheme, they could theoretically trade with nonpoint sources, if nonpoint sources could abate P relatively less expensively creating incentives for trade.

A number of complications arise in reality. Firstly, a cap would have to be set and load allocations would have to be assigned. Whilst the existence of TMDLs in the US facilitates this element of

implementing a trading system, no such standard is available for the Melvin catchment. In addition, given that water quality in the Lough meets existing legislative requirements, additional legislation would be required to uphold this more stringent standard which may be opposed by affected parties.

Secondly, potential difficulties arise from the small number of point sources. The two major sewage treatment facilities in Melvin are currently introducing more stringent treatment procedures which will reduce their nutrient loadings in the lake. Therefore, these sources are likely to comply with reduction targets set as part of a nutrient trading scheme. The remaining point sources contribute a relatively small proportion of the P concentration in the Lough. If the cap were imposed on point sources, as is typically the case[15], trading would achieve only a small P reduction. Trading ratios could be used but this increases the marginal cost of reducing pollution for the nonpoint sources, which reduces the incentive to participate in such a trade. Furthermore, the small number of trades are unlikely to justify the operation costs of a nutrient trading scheme.

If the aim were to maintain existing level of nutrients as opposed to reducing current levels, the cap could be used to control additional sources of P, for example, arising from development in the area. New sources could be required to trade with nonpoint sources. Again, consideration would have to given to the level of trading that is likely to occur that will be dependent on the level of additional pollutant loading arising from development projects to ensure that the operational costs of a trading scheme are justified.

However, in both these cases, the costs of facilitating trade are likely to outweigh the benefits. Transaction costs incurred from participating in the trade which would include the administrative costs of bargaining and setting up a trade, data collection costs to determine outcomes of trade,

[15] See examples of tradable permit schemes discussed in section 6.3.4

the cost of monitoring to ensure compliance, and the cost of developing and implementing abatement measures. "*Trading will be inefficient if too few, or too small, sources are involved in the trades*" (Jarvis & Solomon, 1998). Furthermore, the costs involved in potential trading with many nonpoint sources can be "difficult to arrange and enforce. The cost of educating and financing many small nonpoint BMPs is larger and requires more monitoring than one large nonpoint source" (Jarvis & Solomon, 1998).

Finally, as discussed previously, the viability of trading between nonpoint sources is unlikely to be feasible given lack of variation in costs of abatement. This is particularly likely to be the case within the Lough Melvin catchment, where most farms are beef and/or sheep farms. This lack of variation in farm types and hence cost differentials, is likely to restrict the gains from trade.

Given these restrictions, the costs involved with gathering the level of information required to evaluate a trading scheme for Melvin, outlined by the EPA Water Quality Handbook, is likely to be inefficient.

As an alternative, auctions are potentially a cost-effective approach where nonpoint sources exist. It is not necessary to set a 'cap' on water quality to design the auction. As illustrated in the examples of auctions for conservation contracts described previously, the ultimate level of pollution reduction can be determined by the amount of available funding and the bid proposals submitted by landholders.

The auction approach creates incentives for voluntary participation amongst farmers without the need to develop new legislation to enforce additional targets. This voluntary approach is more likely to foster support from potential participants.

However, Latacz-Lohmann & Schillizzi (2005) highlight the potential difficulties with implementation of auctions to award conservation contracts:

"Bidding schemes yield the highest benefits when the conservation agency has little information about landholders' compliance costs, the number of potential participants is large, the contracts offered are homogeneous and farms are heterogeneous in their compliance costs. The fewer of these conditions apply, the less well an auction will perform relative to a fixed-rate payment scheme."

Firstly, in Melvin, the number of potential nonpoint source bidders should be sufficient and is comparable to reviewed schemes in the US and Australia. Secondly, costs of compliance in terms of the costs of implementing nutrient reduction measures, will be largely known and relatively homogeneous. However, it is possible that opportunity costs that also inform a landholders' bid could differ. These opportunity costs will depend on the *actual* value of the land to the landholder and on personal circumstances. Finally, contracts will be heterogeneous which may create additional administrative costs arising from the assessment of benefits associated with bids. On this point, it is important to note the differences between the Melvin and Scottish contexts. In

Scotland, the Land Management Contract Scheme aims to provide whole farm support in order to reward widespread economic, environmental and social benefits. Latacz-Lohmann & Schilizzi report that designing an appropriate benefit index to rank bids would generate high transaction costs and a risk of complaints and appeals. By limiting the benefit assessment to phosphorus or nutrient reduction, as in the Australian schemes, the benefits index for assessing conservation contracts for Melvin, are likely to be more straightforward, transparent and less costly.

A further advantage to this nutrient management approach is that some of the information required for auction design will have been collated already within this Interreg Project. This includes the identification of additional best management agricultural measures that can feasibly be adopted by individual landholders to reduce the level of nutrient loadings; the costs of implementing these measures; the effectiveness in terms of average P reduction for each measure; identification of farm characteristics, including information on land characteristics, that could be used to inform assessments of land that could feed into the environmental benefits index used to assess bids. In addition, the involvement of stakeholders will have established links necessary to gain support and acceptance of an auction scheme.

If an auction approach were found to be a viable and cost efficient approach for Melvin, consideration could be given to expanding the scheme to include point sources through trading credits generated by nonpoint sources, as suggested by Stoneham & Chaudhri (2000). A land management auction held with the Lough Melvin non-point source emitters would result in a reduction in the amount of nutrients in the Lough. In addition to this, there was a further by-product, such as a reduction in water quality improvement that benefited the general community within the Melvin catchment. If a tradable permit system were held with the point source emitters alongside the land management auction, the improved water quality produced by the farmers and/or foresters would be valuable to the point source emitters. Then the farmers could sell their land management improvements to the agency. These mitigation credits could then be traded by the agency with the point source emitters. So in addition to having permits to pollute, they could alternatively have credits to pollute. Credits would be sought if they were less expensive than permits or than abating the pollution.

The absence of relevant theory, limited number of real-life examples and complex nature of conservation auctions demand caution for their implementation. Latacz-Lohmann & Schilizzi suggest that experimental testing provides an opportunity to “make at low cost all the serious and potentially expensive mistakes both in the financial and in the political sense”. This approach is also recommended by Cason & Gangadharan (2005) and has been adopted in Australia. Latacz-Lohmann & Schilizzi advise comprehensive investigations prior to introduction of a full scale scheme, which would include:

- Devising a theoretical model of bidding behaviour and potential outcomes
- Simulating bidder behaviour via computer based techniques

- Conventional Laboratory experiments typically with student subjects
- Artefactual Field experiments with landholders
- Natural Field experiments or small scale trials

Such prior testing will reveal information about suitability of design, opportunity costs faced by landholders, levels of participation and associated transaction costs. It also provides the opportunity to engage and involve stakeholders that is necessary to generate support and acceptance of a new scheme. Finally, the field experiments and trials provide training to potential participants in order to familiarise landholders with the processes encourage participation levels and ensure mutually beneficial outcomes.

1.10 Legislation

1.10.1 Consistency with Existing Policies

Trades must take place within the context of existing regulations and enforcement requirements. Nonpoint source measures must be additional to those included within existing land and/or agri-environmental management schemes

The two most important existing policies for reducing phosphorus from agricultural diffuse sources in Northern Ireland are the Nitrates Directive (Nitrates Action Programme Regulations (NI) 2006) and the Phosphorus Directive (Phosphorus (Use in Agriculture) Regulations (NI) 2006) both of which were implemented in January 2007. Similarly, the Nitrates Directive (91/676/EEC) implemented in Ireland since 1991 (which addresses eutrophic waters where phosphorus is the main contributor) along with The Water Pollution Acts of 1977 and 1990. These regulations will contribute to reducing eutrophication in NI water bodies as part of their efforts to implement the Water Framework Directive and their impact will be monitored. They primarily focus on actions relating to the application of fertiliser and storage of manure. However, the impacts on water quality to water bodies such as Lough Melvin, will not be known for years.

Any policy tool would have to be consistent with the above (and other) regulations and run alongside Nitrogen Vulnerable Zones and relevant agri-environment schemes such as REPS in ROI and the Environmentally Sensitive Area and Countryside Management Scheme in Northern Ireland. There is the potential that an additional auction scheme would introduce a heavier administrative burden to farmers which would diminish the efficiency advantage of such schemes.

In the US, water quality standards include an ‘antidegradation policy’ through a three level approach to protect water quality. "Tier 1" maintains water quality to protect existing usage of the water body. "Tier 2" protects higher quality water bodies where quality is better than that required to facilitate "fishable/swimmable" uses. "Tier 3" protects resource waters of ‘outstanding’ quality, including waters of "exceptional ecological significance”, Such an approach would facilitate

protection of Lough Melvin, however, does not appear to exist for either Ireland or UK (USEPA, 2007).

1.10.2 Legislative Framework

Schemes such as Auctions for Conservation Contracts require ultimate government involvement. In the Conservation Reserve Program, the US Department of Agriculture relies on three of its component agencies to run the auction program. The Natural Resources Conservation Service provides the technical assistance to farmers and ensures quality of compliance. The Farm Service Agency administers the contracts, sets compliance determinations and serves as the lead agency to ensure compliance with existing legislation and policies. They are responsible for consulting with other organisations and departments to determine potential impacts of action. Finally, the Commodity Credit Corporation overseas matters of financial delivery.

In Australia, the BushTender and Catchment Care programs are governed at state level by the Department of Sustainability and Environment but are managed at regional level by a Catchment Management Authorities or a Catchment Water Management Board respectively.

The potential situation for Melvin is complicated by the cross border location and shared responsibility from both governments in Northern and the Republic of Ireland. In this case, it may be prudent to establish a Melvin Catchment Water Management Board with representatives from ROI and NI government bodies including Department of Agricultural and Rural Development, Department of Agriculture, Fisheries and Food, Department of the Environment, and the Department of the Environment, Heritage and Local Government and other relevant experts. The remit of this Board would be to ensure that existing regulations on both sides are adhered to, to agree terms and conditions of the auction mechanism, to award contracts and handle funds made available by both governments. The need to manage the auctions at local level, including provision of technical assistance, monitoring and compliance could be operated through an organisation such as the Environmental Protection Agency in Ireland or the Regional Fisheries Board, who would report to the Catchment Management Board.

The management infrastructure may be affected by the call for Northern Ireland to review the status of environmental governance. This review was submitted in June 2007 and calls for a more integrated approach to environmental governance, including the enhancement of an ‘all-island approach to environmental governance at policy and operational levels’. One of the recommendations of the review is for an Independent Environmental Protection Agency to take responsibility for environmental regulation. If an EPA for Northern Ireland were to be established, this could create a mechanism for necessary cooperation.

1.11 Gaps in Knowledge

A number of uncertainties exist regarding the appropriateness of the auction mechanism. As previously stated, such prior testing will reveal information about suitability of auction design, opportunity costs faced by landholders, levels of participation, associated transaction costs, the opportunity to engage and involve stakeholders and to provide training to potential participants.

There is the need to establish an appropriate Environmental Benefits Index that would account for the desired benefits from nutrient reduction actions. This would require input from a range of experts. The index could be modelled on the formula adopted for the Australian programs, such as the Onkaparinga Catchment Care Program.

In order to inform the design of an appropriate auction mechanism and the Environmental Benefits Index, it would be necessary to collate research gathered from the results in this Report.

1.12 Recommendations

The aim of this section of the report is to,

“Examine the possibility of nutrient trading by reviewing best practice elsewhere, the information base required to operate and evaluate scheme, and the legislative framework required for application in a cross-border catchment”.

This review of theoretical and empirical studies suggests that water quality trading between point and non point sources is not currently feasible as a stand alone method for nutrient management in Lough Melvin. The key points identified are summarised below:

There are few point sources. Firstly, the two major WWTWs in the Catchment have opted to reduce their nutrient output through the introduction of more stringent pollution abatement processes. Remaining point sources contribute a relatively small proportion of P loading. The costs of conducting a nutrient trading program in these circumstances are likely to outweigh the benefits,

The viability of trade occurring between nonpoint sources has been investigated elsewhere (EFTEC, 2005; ADAS, 2007) and is unlikely to offer sufficient gains to trade for farmers due to lack of differential in compliance costs.

Reducing uncertainty would require very detailed level of information and tight monitoring which would increase the transaction and administrative costs of operating the trading scheme. This would in turn reduce the cost efficiency advantages that such a scheme offers over alternative approaches.

Auctions for conservation contracts appear to offer a potentially viable alternative to engage agricultural (and potentially forest) landholders in a voluntary capacity, who are the major contributors to phosphorus input in Melvin. Auctions would provide a mechanism to reveal the

opportunity costs held by landholders within the Catchment to provide a cost efficient nutrient management scheme. The potential gains to trade should provide an incentive to participate in the scheme. Furthermore, information required to further develop an auction for Melvin Catchment has been generated in this study, therefore, an information base and expertise on which to draw will exist.

Conservation auctions are complex mechanisms and success is heavily dependent on application context and appropriate scheme design. A lack of applicable theory and limited number of practical examples means there is little to guide auction design for specific purposes. Therefore, the next step should be to conduct experiments which will reveal potential and unforeseen problems, provide information on suitability of design, opportunity costs faced by landholders, levels of participation and associated transaction costs and to provide training to potential participants in order to familiarise landholders with the processes encourage participation levels and ensure mutually beneficial outcomes. This will provide vital information about the costs of running the scheme and indicators of success prior to implementation of a full scale land management auction.

Finally, programmes must be a collaborative project involving stakeholders and those with local knowledge with government agencies. The involvement of these groups in this development process is necessary to inform the approach, gain local support and facilitate acceptability of the mechanism.

References:

Ross & Associates Environmental Consulting Ltd. (2000) 'Lower Boise River Effluent Trading Demonstration Project: Summary of Participant Recommendations for a Trading Framework', A report prepared for Idaho Division of Environmental Quality, http://www.deq.state.id.us/water/data_reports/surface_water/tmdls/boise_river_lower/boise_river_lower_effluent_report.pdf last accessed November, 2007

Water Environment Research Foundation (2000) 'Phosphorus Credit Trading in the Cherry Creek Basin: An Innovative Approach to Achieving Water Quality Benefits'. Project 97-IRM-5A

Cherry Creek Basin Water Quality Authority (2006) 'Cherry Creek Reservoir Watershed: Trading Program Guidelines' www.cherrycreekbasin.org last accessed November, 2007

Huisman, J. and Coffey, S. (2005) 'Section 319 Nonpoint Source Program Success Story North Carolina: Tar-Pamlico Basin', http://www.epa.gov/nps/success/state/pdf/nc_tar.pdf last accessed November, 2007

North Carolina Division of Water Quality, http://h2o.enr.state.nc.us/nps/tarpam.htm last accessed November, 2007