# An international review of environmental markets and trading programs

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### *Abstract*

Over the past year or so, the concept of developing markets for environmental services has attracted unprecedented attention in Australia. For example, environmental credit trading is gaining currency as a potential mechanism for managing dryland salinity, biodiversity, and preserving native vegetation in agricultural regions. The prospect of commercialising environmental services such as carbon sequestration, water filtration, and aquifer recharge is exciting because it would overcome the current situation where public demand for improved environmental quality fails to be communicated to private firms via a market mechanism. However, the creation and trade of property rights in environmental services is still in its infancy and numerous obstacles stand in the way of implementing market programs. This paper reviews the current status of environmental markets in the US and UK and highlights the lessons that can be gleaned from the success and failure of programs in these countries.

**Key words:** Environmental markets, trading programs, property rights.

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## *Introduction*

Over the past year or so, market-based instruments have attracted unprecedented attention in Australia as potential tools for addressing environmental problems such as dryland salinity, water pollution and native vegetation decline. The concept of harnessing market forces to reduce pollution or increase the supply of environmental services has captured the attention of governments, both at federal and state levels, and non-government organisations. A diverse range of economic instruments have been implemented in Australia over the last five years - and further applications are being proposed (Table 1).

Operationally, the use of market forces involves the establishment of a mechanism that provides firms with a financial incentive to change their behaviour. This approach is distinctly different to traditional environmental policies that involve inflexible regulations (eg the command and control approach), or voluntary mechanisms that lack the 'regulatory teeth' to bring about sufficient change. Examples of market-based mechanisms include environmental taxes and subsidies, permit trading, environmental accreditation, eco-labelling, and performance bonds. The growing acceptance of these mechanisms as a valuable tool for environmental management represents a quantum change in mindset among policy makers because, until recently, market based instruments were perceived to be too difficult or too costly to implement.

**Table 1: Australian applications of economic instruments**

| *Instrument* | *Example schemes* | *Implementation stage* |
|---|---|---|
| Environmental taxes and offset payments | Load based licensing program for water effluent (NSW EPA). | Commenced 1999 |
| | Offset payments for aquatic habitat damages (NSW Fisheries) | Commenced 2000 |
| | Offset payments for vegetation clearing (NSW DLWC) | Proposed 2001 |
| Environmental subsidies and tax concessions. | Auctions for environmental services (Victorian DNRE, WWF) | Pilot phase, 2001 |
| | Landcare tax rebates | Commenced 1997 |
| Credit or permit trading programs | Hunter River salinity trading program (NSW EPA) | Commenced 1995 |
| | Renewable energy tradeable certificates (AGO) | Commenced 2001 |
| | Intra-firm carbon emissions trading (Shell, BP) | Commenced 1999 |
| | Native vegetation and salinity offsets (NSW DLWC) | Proposed 2001 |
| Eco-labelling | Banrock Station winery wetland restoration program | Commenced 1997 |
| Certification and environmental management systems | ISO 14000 certification. | Commenced 1996 |
| | Green slips for salinity management practices (NSW Salinity Strategy) | Proposed 2000 |
| Deposit-refund systems and performance bonds | Great Barrier Reef Marine Park Authority performance bonds | Commenced 1987 |

Trade in environmental permits or credits is one mechanism that has received considerable attention lately, both in Australia and overseas. While permit trading programs have been used extensively in the context of air pollution (for example the

US Acid Rain Program) and fisheries (tradeable individual quotas), the concept of trading salinity credits or biodiversity credits is relatively new. A number of factors appear to be responsible for this development. These are summarised as follows:

- The failure of existing policies to deliver satisfactory outcomes has prompted policy makers to consider alternative mechanisms. There is a belief that the decade of Landcare, while valuable in terms of awareness raising and capacity building, has under-performed in terms of delivering tangible environmental outcomes. The federal government has come to the view that existing agri-environmental policies are failing to provide a satisfactory return on public investment (Industry Commission, 1997).

- Water reforms instigated by the Council of Australian Governments have demonstrated that efficiency gains are possible from water entitlement trading and have given governments greater confidence to apply market-based approaches to other forms of natural resource problems. Similarly, the success of the US Acid Rain Program has raised significantly the profile of trading instruments as a cost effective way of reducing pollution.

- Technological improvements, such as remote sensing and the internet communications, are reducing the transaction costs associated with environmental trading programs.

- There is a growing body of quantitative information about the state of Australia's land and water resources, the causes and effects of degradation, and the economic trade-offs of alternative resource use options. Major studies include the National Land and Water Resources Audit, the Murray-Darling Basin Audit, and State of the Environment Reports. This new information is prompting resource management agencies to set environmental quality targets, which is a preliminary step towards designing a trading program in environmental permits or credits[2].

- Environmental trading schemes are seen by government as a means of stimulating private investment in the delivery of environmental public goods. For example, a carbon credit market could encourage industrial firms to invest in the rural sector in return for emission credits generated by tree plantations. The attractiveness of this trade is further enhanced if trees yield multiple public benefits that are surplus to the emission credits.

## This paper

Despite the recent bout of enthusiasm for environmental trading programs, the application of market instruments to the agricultural sector poses a number of challenges. One complicating factor is the heterogenous and diffuse nature of environmental impacts associated with land use practices that are generated over

[2] Examples are the statutory cap on water abstractions from the Murray River, which has facilitated a market in tradeable water entitlements, the proposal to establish 'end-of-valley' salinity targets for catchments within the Murray Darling Basin (MDBMC, 2000) and the NSW Government's intention to set statewide targets for protecting and re-establishing native vegetation (DLWC, 2001).

different geographic areas. This causes measurement and accounting difficulties and increases considerably the cost of monitoring and verification of credits. Another complication is the poorly understood relationships between 'on the ground actions' and environmental outcomes across space and time. The corresponding uncertainty about 'cause and effect' relationships gives rise to risk and who is legally responsible for underwriting environmental improvements. Compared to industrial emissions trading, much less has been documented on the practicalities of overcoming these obstacles when designing markets for agri-environmental outcomes.

This paper reviews several environmental trading programs and early prototypes that have been established in the United States and the United Kingdom. The objective of the review is to come to a better understanding of the potential opportunities and limitations of environmental markets. The paper begins with a brief examination of theoretical aspects of permit trading, the types of market systems that have evolved to date, and the potential advantages of pursuing a market-based approach to controlling environmental externalities. This is followed by a critique of overseas programs that have been applied to water quality management, biodiversity and habitat protection, and carbon sequestration. The paper concludes with a summary of the lessons that can be gleaned from overseas experience with environmental markets.

## *A case for establishing environmental markets*

The basic underlying cause of environmental services being under-supplied (or the quantity of pollution being over-supplied) is a case of markets failing to send signals to private firms who are having an impact on the environment. To be more precise, it is not so much a case of markets 'failing', but rather the situation where markets do not exist because property rights are not defined for public goods such as clean air and water. Well defined property rights are fundamental prerequisites for a market to function as they provide the necessary elements of access security, defensibility of ownership, and transferability. Property rights are well defined if they are adequately configured in three dimensions. The rights must be:

- defined clearly so as to reside with a specific person or entity;
- defended easily against non-owners who might wish to use or 'steal' the entitlement; and,
- fully transferable by the owner to others on whatever terms are mutually satisfactory to buyer and seller.

When property rights are absent, private firms have no incentive to reduce their impact on the environment beyond what is commercially profitable because the public good benefits of their actions cannot be secured. Consequently, when a firm lowers the quality of the environment, it does so without taking account of the costs it imposes on other firms or the greater community. This situation produces a problem known as an 'externality', which means that the financial implications of a private firm's actions are external to its decision making process. The goal of market-based schemes is to 'internalise' these externalities by putting a mechanism in place that forces firms to account for the full costs of their actions. The mechanism involves defining and issuing property rights in the environment, alternatively known as the

'securitization' environmental services. For instance, property rights in the atmosphere convey a right to emit a unit of pollutant into the atmosphere. Similarly, property rights in sequestered carbon convey a right to the benefits from selling a unit of sequestered carbon.

Paradoxically, the traditional response by governments to externalities has been one of 'command and control' which weakens rather than strengthens property rights in the environment. Rights to pollute are divested to the community and 'socialised' rather than privatised. Centralised approaches, which are divorced from a market mechanism, can lead to considerable inefficiencies. The setting of minimum performance standards with penalties for non compliance, or the stipulation of 'best practice' technologies for cleaner production, only provides firms with a financial incentive to adhere to the stipulated limits. It fails to encourage firms to make quality improvements beyond the minimum requirement. The standards may even act as a perverse disincentive for firms to adopt cleaner technologies if businesses perceive that they will be held to a higher standard of performance as a consequence of their actions. Furthermore, there is no opportunity for firms who find it costly to meet the performance standard to 'off-load' their obligation to firms who can provide equivalent quality improvements at lower cost.

These inefficiencies do not arise in market-based system because inter-firm trade in pollution rights or offset credits allocates the burden of meeting an industry performance standard to those firms that are able to reduce emissions at least cost. In addition, firms have an economic incentive to reduce emissions below the minimum requirement because there is an opportunity cost associated with continuing to pollute. That is, firms that continue to pollute forego the opportunity to sell credits or surplus emission permits. The same principle provides firms with an incentive to innovate and develop low-cost ways of reducing emissions. These features of a market system provide a strong *prima facie* case for greater use of trading mechanisms as a means of managing environmental externalities. However, the potential benefits of establishing a trading program need to be weighed up against the costs and practical feasibility of implementing the program. In some cases, the costs of administration, enforcement, monitoring, and other transaction costs may be prohibitively high.

### *Operationalising environmental markets*

A variety of different types of trading schemes have evolved since the United States first started experimenting with rights-based policies for industrial emissions in the 1970s. Perhaps the best known scheme is the **'cap and trade'** system, whereby an aggregate emissions target (or cap) is set for an industry and individual firms are allocated tradeable permits that entitle each firm to emit a specified share of the cap. Examples of this type of scheme include the United State's Acid Rain Program, which controls sulphur dioxide, and California's Regional Clean Air Incentives Market (RECLAIM), which controls both sulphur dioxide and nitrogen oxides.

Another type of trading system is **'baseline and credit'**, whereby a baseline level of environmental performance is enforced rather than assigning permits to an aggregate cap. Baselines may be set according to a firm's historic level of environmental performance or be set at a more stringent level, requiring the firm to reduce its

emissions over time[3]. Firms that wish to make quality improvements beyond the baseline generate credits. A firm with a surplus of credits can either sell the credits to other firms who cannot meet the baseline, or the firm can retain the credits for later use should it need them in future periods to offset excess emissions (a mechanism known as credit 'banking'). Depending on the pollutant, firms can generate credits by adopting cleaner production methods or by investing in technology that offsets emissions (eg. carbon sequestration). Baseline and credit systems are now used in a wide range of contexts, including water quality control, wetland protection, recycling of waste packaging, and meeting renewable electricity targets.

## Origins of environmental markets

Baseline and credit systems originate from a number of schemes that were developed in the United States during the 1970's and 80's. These schemes do not involve a formalised market but they do allow firms to make 'trades' within their own operations and, in the case of offset schemes, some limited trades between firms. The schemes are intended to give firms greater flexibility in meeting emission standards. The main types of policies are as follows:

**Offset schemes**. This policy dates back to 1976. It was formulated to ensure that new facilities or industries do not increase the total level of gas emissions in a specified geographic region. When a new facility is to be set up in an area that is subject to a cap on total emissions, the firm must obtain emission credits from existing sources in a proportion determined by the offset rate applying to the particular area.

**Bubble programs**. The United State's bubble policy was introduced in 1979. An emission bubble allows an individual firm to increase its emissions in some production centres, provided these increases are offset with emission reductions other centres. The term 'bubble' is used to connote an imaginary bubble over a source such as a refinery or steel mill that has several emission points, each with its own emission limit. Firms are judged to be in compliance if the sum of individual emissions does not exceed the limit set for the bubble.

**Netting.** This mechanism was first introduced in the United States in 1980. It provided firms with greater flexibility in meeting an existing ruling which stipulated that firms must meet more stringent emission levels if they plan to modernise and expand existing facilities. The netting program exempted firms from this ruling on the proviso that any additional emissions from the modernised facilities are offset by reductions at existing sources.

**Emissions averaging**. This mechanism was first used in the mid 1980s. It allows individual firms to average emissions across their product range. For example, the automobile manufacturers in the United States must build engines that meet a specified emissions rate. However, firms are given the flexibility to produce some

[3] Baselines for pollution are either specified in terms of pollutant concentration (eg. grams per megalitre of discharge) or in terms of the total amount of allowable emissions. The former is known as an 'open system' because total emissions are not capped, while the latter is known as a 'closed system' because the pollution limit is binding.

engines that exceed the limit provided they can offset these ‘overshoots’ with other models that have cleaner engines.

## Are caps and baselines essential?

For markets to function effectively there must be sufficient demand for pollution rights or offset credits. In the situation where the environmental problem is characterised by **public externalities**, enforceable caps or baselines on resource use are almost always required to create sufficient scarcity, and hence value, in pollution rights or credits. This is because the benefits from removing a public externality accrue to the whole community and are not excludable. It follows that under these circumstances there is no incentive for private individuals or interest groups to invest in environmental services, unless the production of these services is compatible with private goals.

One alternative to setting mandatory targets is for the government to step in and purchase environmental services, which could involve the purchase and retirement of credits from a trading program. This represents a one-off subsidy to polluting firms for a permanent reduction in emissions. The use of subsidies as an incentive for reducing pollution is generally less efficient than a market in tradeable credits because firms do not have an incentive to abate below the amount stipulated by the contract. Furthermore, if firms do not have to competitively bid for the subsidy there is no incentive for firms to seek out the most cost-effective method for reducing pollution or providing the environmental service.

Another approach is to set mandatory targets but provide firms with the option of paying a predetermined sum of money into a conservation trust fund if they do not meet their obligations. This policy is essentially an environmental tax and the 'price' of pollution is set by a centralised authority rather than a market. Some trading schemes utilise a hybrid approach and combine a tax instrument with credits (for example the Mandatory Renewable Electricity Targets Scheme recently introduced in Australia). In these schemes, firms have the option of staying in compliance by improving their environmental performance or by purchasing credits 'on the market' or from government. The price of credits issued by government puts a ceiling on credit prices for the trading program.

Other mechanisms that could stimulate demand for credits in an environmental market are:

- Credits could be linked to a certification scheme. If there were sufficient economic rewards from certification (eg. from market price premium or market access), then firms may have an incentive to purchase or generate credits.

- Government could reward firms who purchase or generate credits with extra services such as technical information and advice. This equates to an indirect subsidy.

- The implementation of enforceable caps on one sector could create a demand for credits from another unregulated sector. For instance, an emissions trading policy

that is targeted at an industrial sector could generate a demand for offset credits from the agricultural sector.

If the environmental problem is mainly characterised by **private externalities**, for example where farmers upstream are reducing water quality for irrigators downstream, it may not be necessary to impose an enforceable cap to stimulate market demand. This is because in the case of private externalities, the removal of the externality produces an excludable benefit to 'downstream' firms. Under these circumstances it may be sufficient to define property rights in the form of environmental credits, then leave the rest to the market. If benefits are truly excludable, then 'downstream' firms may form a cooperative and purchase credits from 'upstream' firms[4]. However, the potential for these localised markets to develop is limited by high transaction costs, including the initial cost of setting up a trading system and the ongoing cost of verification and monitoring.

Furthermore, localised markets are, by definition, 'thin' markets meaning that the volume of credits traded is low. This hinders the price discovery process. Another limiting factor is the high risk associated with the production of environmental outcomes. Private firms would be reluctant to buy credits if the rights do not provide them with a guaranteed improvement in environmental quality. Given these constraints, government involvement is usually required to stimulate markets by setting up a trading program with a regulatory cap or baseline.

## Other key design variables

There are a number of key variables that influence the shape and form of a trading program. Five important design factors are the specification of the tradeable rights, the scope of the market for trade, the trading rules, the organisational structure used to facilitate and broker trades, and the mechanisms used to monitor compliance, verify credits and enforce regulations.

### Specification of rights

There are three main elements to specifying rights. Firstly, depending on the nature of the environmental problem, the commodity being traded may take the form of an emissions permit, an offset credit or an abstraction right[5]. Secondly, a physical basis for measuring the action or ouput underpinning the right must be specified. For example, an emissions permit may have a 'performance basis' defined in terms of the annual quantity of allowable emissions. Alternatively, the basis may be specified in terms of a pollution process (eg. expected recharge of a groundwater aquifer). In some cases an 'input basis', such as the permissible rate of fertiliser application, may be appropriate if there is a clear quantifiable link to outcomes. A third element to

[4] An example of this type of trade is a Memorandum of Understanding that was signed in 1999 by NSW State Forests and Macquarie River Food and Fibre (a farmer cooperative comprising over 600 irrigation farmers). Under this arrangement, the cooperative has agreed to purchase salinity control credits generated by new forests planted in the salt prone Macquarie River catchment.

[5] Abstraction rights are relevant to water markets and other extractive activities such as fishing, mining, and logging. These markets are not discussed in this report.

specifying rights is the stipulation of a duration time over which the rights are valid. Emission permits or reduction credits may be valid for a finite period or given number of periods (in which case they are comparable to a rental contract) or they may be valid indefinitely (in which case they are comparable to property rights).

#### Scope of the market

Simulations have demonstrated that at least eight participants are required for a market to operate efficiently (US EPA, 2001). The price discovery process fails in markets with too few participants. Thus it is generally beneficial to develop markets that have a wide scope. The scope of a market is defined by the geographical area over which trades can take place, the entities allowed to participate in the market, and the 'level' at which trading can occur (eg individual firms, groups of firms operating within bubbles, inter-country trade).

The geographic scope of a program partly dictated by the dimensions of the environmental problem. Markets that operate over a large geographical area have greater potential for delivering efficiency gains because they involve a larger number of participants with differing marginal costs of pollution abatement or environmental service provision. However, with increasing spatial scope there is a greater chance that pollution at different locations will produce unequal damages, implying that credits generated at different locations will have unequal impacts. The problem of non-equivalence can be addressed with trading ratios (see discussion under trading rules). Another potential problem associated with markets that operate over large areas is the development of pollution ‘hotspots’ caused by a localised concentration of pollution permits.

In some circumstances the scope of the market is limited by restrictions on who can trade. For example, it may be necessary to place restrictions on transfers of rights to prevent a concentration of ownership or to disallow the transfer of emission rights to organisations that plan to retire the rights (eg. conservation groups). Other rulings might be necessary to manage the level of involvement of brokers and speculators.

#### Trading rules

Trading rules constitute the framework within which trades can take place. Some examples of trading rules include:

- trading ratios that stipulate the exchange rate between offset credits and emissions permits. Ratios that differ from ‘one-to-one’ are required if credits and permits have different bases (for example, a credit based on recharge and a permit based on discharge). Trading ratios can also be used to adjust for non-equivalence when exchanges take place between different geographic locations. A third potential use for trading ratios is to reduce aggregate emissions by requiring new sources to purchase multiple credits to offset one unit increase in emissions;

- banking (saving) and borrowing of credits, which adds temporal flexibility to the trading program;

- cross pollutant trading, which allows emission permits for one pollutant to be exchanged with permits for a different pollutant.

#### Organisation of transfers

The establishment of an environmental market requires institutions to be put in place to administer trading. Large trading programs such as the US Acid Rain Program have increased efficiencies by establishing a centralised permit exchange. Brokerage services have also become a feature in these large markets.

#### Monitoring, verification and enforcement

The elements of a trading program are essential to maintain the integrity of the rights. Monitoring involves a range of tasks, including checks on the performance of permit holders, verification and certification of credits, and the recording of transfers. Reliable information systems are required to record performance and transfers so that compliance with emission requirements can readily be checked. Monitoring tasks are performed by government, by authorised third parties, or by market participants themselves if adequate mechanisms are in place to encourage self-regulation.

There is a wide range of possible sanctions that can be applied to firms that do not comply. Some examples include: fines, forbidding future participation in transfers, reduction in the firm's permit holdings, obligation to fund compensatory activities aimed at enhancing the environment, or legal action. In some situations, monitoring and enforcement may be too costly for the establishment of the market to be a practical proposition. In other circumstances, it may be possible to establish self-enforcing schemes through internal incentives. To a certain degree, trading programs have ‘in-built’ mechanism for self-regulation because market participants have a vested interest in ensuring that the value of their permit or credit rights are not undermined by fraudulent actions.

## *International case studies*

Several countries are experimenting with various programs for commercialising environmental services and controlling pollution externalities. The United States is at the forefront in this endeavour, and the United Kingdom is beginning to investigate alternative mechanisms. The following case studies provide a 'cooks tour' of the current state of play in the development of environmental trading programs.

### Water quality markets

The United Sates is at the forefront in developing water effluent trading programs. The main water quality issue in the US is nutrient discharge but other pollutants such as sediments, salt, and pesticides are also evident in some States. Effluent is discharged from both point and non-point sources. The point sources include sewage treatment plants and industrial facilities, while run-off from agricultural land constitutes a non-point source that cannot be observed or measured. Until recently, the US Environmental Protection Agency (US EPA) has focused primarily on controlling point sources of pollution. Under the National Pollutant Discharge Elimination System, point sources require a permit to operate and limits are set on the quantity of

each type of effluent that can be discharged. While these measures have brought about significant improvements in water quality, the effluent contributions from non-point sources remain an outstanding obstacle to achieving water quality objectives. To date, subsidies and voluntary programs have been used to encourage farmers to adopt best management practices but these programs have generally not delivered satisfactory reductions in run-off (Ribaudo et al 1999).

Over the last two years, there has been a strong push by US State and Federal governments to develop formal management plans for watersheds where pollution exceeds acceptable standards. These management plans specify a total maximum daily load (TMDL) limit for a watershed, and take into account all sources of discharge. The limit is set at a level that ensures water quality standards are met. The plans also establish load allocations for each point source and for non-point sources. At this stage, only the point source allocations are to be enforced, but under the Clean Water Act of 1972 there are provisions that would allow the EPA to make discharge limits on the agricultural sector enforceable (via the implementation of best management practices).

The TMDL plans have provided the necessary impetus for water trading programs to develop because in many watersheds, point sources are facing costly reductions in discharge to meet the new quality standards. By contrast, nutrient discharge from agricultural sectors can be reduced at considerably lower cost. Therefore, the US EPA is supporting the development of several demonstration trading programs that allow point sources to purchase credits from non-point sources as a means of meeting their discharge reduction obligations. Point-to-point trades are also encouraged to enable treatment plants with high abatement costs to purchase credits from plants with lower costs of abatement. There are now approximately thirty five trading programs in various stages of development and implementation (US EPA, 2001).

The Lower Boise River Trading Program is one such prototype, which has been developed for the Boise River in southwest Idaho. In 1997 the US Environmental Protection Agency (EPA), in partnership with stakeholders in the watershed, began to examine the potential for setting up a trading program as a means of reducing the costs of meeting new water quality standards to be introduced in 2001. Sewage treatment plants, factories, and agricultural producers all discharge phosphorous into the Boise River. It was decided to develop a demonstration program for trading phosphorous reduction credits. Initial investigations suggested that trading would yield net economic benefits because the costs for nutrient reductions range widely among sources. At present, development of the trading framework is nearing finalisation and the program is expected to be operational by 2002.

The program is a 'baseline and credit' system involving point-to-point trades and point-to-non-point trades. The existing National Pollutant Discharge Elimination System (NPDES) enforces point sources to comply with an individually-specified discharge limit. Once the TDML plan is implemented, it is expected that these limits will become more stringent. Point sources must meet their discharge limits by either reducing their discharge or purchasing offset credits. The credits may be purchased from other point sources (point-to-point trading) or from the agricultural sector (point-to-nonpoint trading). The agricultural sector is not subject to an enforceable baseline

level of discharge, but farmers can generate credits for sale to point sources by adopting approved 'best management practices' (BMPs). Example BMPs include buffer strips, wetland construction, irrigation control systems, and tillage systems. Credits will only be issued in circumstances where a farmer has changed his management practices in adopting a BMP. That is, credits will not be issued retrospectively.

For some BMPs it is technically infeasible or too costly to measure and monitor discharge reductions, so credits are to be estimated using a model. The number of calculated credits from a BMP will be adjusted by an 'uncertainty discount' which accounts for the variability in effectiveness of the practice. Both type of credits will be specified in terms of the quantity of phosphorous reduced per unit time in a given month. Once the credits have been verified, a Reduction Credit Certificate specifying the number of credits created will be lodged with a Trading Association. It is proposed that the buyer of credits will be responsible for verifying that the credits are bona fide (it is envisaged that the verification and monitoring tasks would be undertaken by an accredited third party). Furthermore, the buyer will be held liable for failure of the BMP to deliver nutrient reductions. The EPA will retain the authority to perform spot audits and to apply appropriate penalties for non-compliance.

The objective of the TDML plan is to meet a water quality target which is measured at the mouth of the Boise River. However, the sources of pollution are distributed unevenly through the catchment and therefore marginal increases or reductions in discharge by a particular source will have a differential impact on the target depending on where that source is located. To take account of these spatial differences, several trading ratios have been devised. The trading ratios are used as conversion factors to determine the amount of transferable credit that arises when a point source or non-point source reduces its nutrient discharge at a particular location in the river system. In addition, a trading ratio exceeding 1 is used for nonpoint-to-point trades. That is, when a farmer enters into a contract to supply and sell credits to a treatment plant, the plant will be required to retire a proportion of the credits from the system. This is known as a 'water quality contribution' and its objective is to reduce the total amount of phosphorous discharge from the agricultural sector.

The proposed establishment of a private Trading Association is an innovative feature of this program. It will help connect buyers with sellers, develop and maintain the trade-tracking database, prepare monthly watershed-wide summary of trades, and provide support to the trading system as requested and agreed to by its members. In a related project, the World Resources Institute (a non-government organisation based in Washington DC) is currently developing an internet-based trading exchange called Nutrientnet[6]. It is proposed that this on-line exchange will be a 'one-stop-shop' for buyers and sellers wishing to partake in the nutrient trading market. For instance, non-point sources planning to sell credits will be able to quickly estimate the current level of discharge from their properties, the quantity of credits that could be generated from alternative BMPs, and the approximate cost of generating the credits. There is also a section that provides tools for posting offers to buy or sell reduction credits, and registration of completed trades. The World Resources Institute predicts that brokers

[6] See www.nutrientnet.org

will play an important role in bundling up parcels of credits from numerous non-point sources and offering them for sale to point sources. Nutrientnet is soon to be used by an effluent trading program in Michigan.

Several other water effluent trading programs have been in operation for some years now, and it is useful to look at these programs for insights to potential problems. For example, the Dillon and Cherry Creek Reservoirs in Colorado have had a trading program in place since 1985. Trade in discharge allowances is allowed between point sources and industrial firms can purchase credits from non-point sources. However, very few trades have been recorded to date. Discussions with the US EPA and Department of Agriculture revealed that the lack in trade is attributed to a number of factors:

- population growth in the watershed has been low in recent years, so the emission limits imposed on point sources have, to date, not been a real constraint to point sources;

- many point sources who did experience binding constraints on their emissions were able to install abatement technology at a relatively low cost, so firms took this option rather than trade;

- in the absence of an enforceable cap on non-point source emissions, point sources who purchase credits from non-point sources bear all the risk of abatement failure, which has discouraged point/non-point trading;

- non-point sources are unwilling to generate credits in case they get labelled as polluters and become subject to an enforceable cap; and,

- the Clean Water Act demands that existing, expanding, and new point sources meet specific technology-based requirements. This feature of the Act has tended to stifle innovation and thus discourage point/point trading.

## Markets for habitats and biodiversity

There are three main directions in which markets for environmental services from biodiversity preservation are emerging. Firstly, there is a trend towards the commercialisation or privatisation of some types of services. For instance, pharmaceutical companies are taking out patents and intellectual property rights for specific genes and knowledge derived from bioprospecting, while ecotourism companies such as Earth Sanctuaries Limited in Australia are preserving native species by establishing commercial wildlife sanctuaries. The second direction in which markets are emerging is via public purchases of environmental services from farmers (eg the US Conservation Reserve Program and the Countryside Stewardship Program in the UK).

This paper focuses on a third mechanism that is gaining momentum as a useful tool for stimulating markets in biodiversity and habitat protection. This mechanism is the establishment of mitigation banks and subsequent trade in credits. Mitigation banking is the term given to the generation and storage of environmental credits for subsequent use or sale. Mitigation banking is being used in the US as a means of providing firms

with the flexibility to meet wetland protection regulations and endangered species laws. The US now has legislation in place which outlaws any net loss of wetlands (the Clean Water Act) and prohibits actions which could jeopardise the safety of endangered species (the Endangered Species Act). Both of these Acts make provision for mitigation banking to offset unavoidable damage to wetlands or endangered species, respectively.

An example of endangered species mitigation banking is an agreement reached between International Paper and the US Fish and Wildlife Service concerning the red-cockaded woodpecker (Heal, 2000). This company owns forests which harbour the endangered woodpecker. The agreement allows International Paper to harvest the forest at will, provided that it maintains sufficient habitat to support a target number of breeding pairs, as stipulated by the Fish and Wildlife Service. Further, if the company exceeds the minimum target of breeding pairs, the agreement allows the company to generate credits which can be 'banked' and used to offset the firm's activities in other forests which are subject to ESA restrictions with respect to the red-cockaded woodpecker. There may also be a future possibility of granting International Paper the right to sell the 'woodpecker credits' to other landowners who are subject to ESA restrictions.

Wetland mitigation banks are now a common feature in many States of the US. The principle of compensatory mitigation (or offset credits) has been applied to wetlands since the early 1980's but it is only recently that credit banking has been officially recognised and promoted as a valid means of meeting the CWA's requirement of 'no-net loss' in wetland function (Federal Register, 1995). The current scheme operates as follows: Firms that want to develop a wetland site (eg for agriculture or real estate) can obtain permission to do so provided they create an equivalent amount of new wetland elsewhere or if they purchase wetland credits from a mitigation bank. Mitigation banks are created through a memorandum of understanding among federal and state officials and a bank administrator. The sources of land for a mitigation bank commonly include existing natural wetland areas, pits created by the removal of landfill material, and lands that have previously been drained for agricultural use. Conservation groups, non-government organisations, and private commercial firms have also set up banks that offer mitigation credits for sale. About 100 banks in at least 34 states are currently in operation and more are in advanced stages of planning.

Credits are defined in terms of a unit attainment of wetland function, where function is typically indexed to the number of wetland acres restored, created, or enhanced (in exceptional circumstances, the preservation of existing wetlands in perpetuity may be authorised as a legitimate way of generating credits). Similarly, debits are measured in terms of a unit loss in wetland function at a project site. In most cases, a bank can only sell credits once a satisfactory level of wetland functions are attained. That is, advance sales of credits are generally not permitted. However, there are cases where banks with adequate financial backing and a strong reputation for delivering sound environmental outcomes have been permitted to sell credits in advance of the wetland becoming fully functional. The wetlands in a bank are usually protected in perpetuity with appropriate real estate arrangements (eg. conservation easements). The bank operator is responsible for securing adequate funds for the operation and long term maintenance of the bank.

Before a mitigation bank can be used, firms must first satisfy the government that all appropriate and practical steps have been undertaken to avoid and-or minimise adverse impacts to wetlands. On-site mitigation is preferred, and the use of mitigation banks is only permitted if there is no practical alternative or if the use of off-site credits will lead to a better environmental outcome.

Mitigation banking offers numerous advantages over the situation in the early 1980's where offsets were restricted mainly to on-site mitigation activities:

- environmental values are better protected in large scale developments rather than the fragmented wetlands which often result from on-site rehabilitation efforts;
- economies of scale can be achieved by creating, protecting and enhancing large parcels of wetland;
- the cost of wetland mitigation actions can be made known to developers very early in the development process;
- mitigation banking offers greater assurance of long term management of the protected area; and
- allowing firms to purchase credits overcomes a problem of 'slippage' which was experienced prior to the advent of mitigation banking. Slippage refers to the cumulative effects of many small individual losses in wetland functions which, on their own, were deemed to be impractical to offset (King, pers comm 2001).

## Carbon markets

The Kyoto Protocol has catalysed the development of several early markets for carbon sequestration credits. Despite the fact that the Protocol's emission reduction targets, and the mechanisms to achieve those targets, have not yet been ratified, a significant number of large firms have committed to voluntary reductions in greenhouse gasses. For instance, the Royal Dutch Shell Group has launched an internal cap and trade system that aims to make a 10 per cent cut in emissions by 2002 relative to its 1990 levels. Similarly, BP Amoco has pledged to reduce its emissions by 10 per cent from a 1990 baseline over the period to 2010 and have adopted an internal trading scheme. These companies have already invested in forestry projects for the purpose of obtaining carbon sequestration rights. There are a number of reasons why firms are taking these voluntary steps to reduce greenhouse gas:

- intra-firm trading has the potential to improve production efficiencies across a firm’s production centres;
- firms are willing to invest time and resources into learning about trading mechanisms so that they will be better prepared if and when greenhouse gas limits become mandatory;
- early movers may gain an advantage over competitors in terms of more favourable treatment by the regulator or may have an opportunity to shape the design of the trading program in its favour;

- the public-relations benefit associated with having a clean, green image. These benefits could materialise in the form of access to new markets or higher product prices; and,

- the threat of future regulatory constraints on emissions poses a significant financial risk to large industrial firms. If equity markets identify that a company is exposed to this risk, it may increase the firm's cost of obtaining finance. Furthermore, companies with higher risk profiles generally incur higher insurance premiums and higher interest rates on borrowed capital.

In the United States there is no mandatory requirement for companies to reduce their greenhouse gas emissions. Nevertheless, some companies are partaking in voluntary abatement programs. One of the most recent developments in the US is a proposal by the Chicago Board of Trade (CBOT) and Environmental Financial Products (a Chicago-based consulting company) to establish a Climate Exchange for trading greenhouse gas emissions. A pilot 'cap and trade' program is currently being designed for seven Midwestern States of the US. The program aims to:

- encourage firms to sign on to voluntary emission reductions; the goal is to reduce participants' emissions by five percent below 1999 levels over five years;

- establish mechanisms for monitoring, verification, tracking, and reporting; and,

- allow credits to be created for targeted domestic and foreign emissions offset projects, including methane destruction, solar and wind energy projects, and certain carbon sinks.

At the time of writing this paper, 25 companies and non-profit organisations have agreed to participate in the market design phase, including manufacturers, electric utilities, agricultural cooperatives, and conservation groups. The utility companies involved in the design phase represent almost 20 percent of greenhouse gas emissions in the Midwest region. If the pilot program succeeds it will provide an opportunity to discover the price of carbon, something that to date has been the subject of speculation.

The UK has taken a relatively aggressive approach to reducing greenhouse gas emissions and has recently introduced a hybrid policy instrument that consists of an energy tax linked to an emissions trading scheme. In April 2001 the UK introduced an industrial energy tax called the Climate Change Levy. All industrial firms are required to pay the levy, but firms belonging to the energy intensive sector are eligible for an 80 per cent discount on the levy provided that they enter into negotiated agreements with government that set 'challenging targets' for abatement. These agreements, known as 'Climate Change Levy Agreements', allow companies to choose between an absolute reduction in carbon dioxide emissions or a target defined in relative terms (ie. a reduction in energy consumption per unit of output).

Running in parallel with this energy tax and Levy Agreements is a national trading scheme for emissions permits and reduction credits. This scheme originated largely as a result of lobbying pressure from the group of industries who were not given an opportunity to obtain a discount on the levy via the Climate Change Levy Agreement

(CCLA) mechanism. As of January 2002, companies belonging to both sectors are able to participate in a 'cap and trade' scheme. Participation is voluntary, and participants will still have to pay the full Climate Change Levy (unless they have entered into a CCLA). Those companies that have taken on absolute targets under the CCLA will be able to obtain credits from their abatement. Companies who have taken on a unit reduction target will be able to purchase credits to offset their energy reduction targets (subject to a predetermined exchange rate) but cannot generate credits for sale.

The UK government has agreed to establish an incentive fund that will be used to provide incentive payments to companies that agree to take part in the trading scheme. The incentive fund will only be available to those companies that are not covered by a CCLA (ie. companies will not be able to receive both the tax discount and an incentive payment). It is anticipated that the payments will be allocated using an auction mechanism whereby companies will be asked to submit bids in terms of emission reductions. The extent to which the trading scheme will increase the demand for sequestered carbon is unknown at this stage. However, the scheme has established a framework within which UK companies can potentially partake in an international market for carbon credits- including credits from forest sinks- if and when a market comes into being.

## *Conclusions*

This review of international trading programs highlights a number of recurring themes and lessons that are instructive for Australia as we begin to explore alternatives for developing environmental markets. Six main points stand out:

### 1. Enforceable caps are the key

An enforceable cap or baseline level of environmental quality is the most effective way of stimulating demand for environmental services. In circumstances where the externality has public good characteristics, a regulatory stimulus is essential. However, the imposition of enforceable targets must be justified by a preliminary economic assessment that demonstrates the policy will lead to a net welfare gain after accounting for all costs and benefits. Alarmingly, this basic point is often overlooked in Australian strategies that seek to reallocate resources. Policy makers also need to be cognisant of the equity implications of imposing targets. Mechanisms for cost-sharing between government and landholders may be appropriate. One such mechanism could be a percentage rebate on the cost of credit purchases made by landholders.

### 2. Start from scratch

A clear message from consultations with numerous people who have been involved with designing trading programs is the need to commence the design process from scratch rather than make piecemeal changes to existing programs. This is not to say that existing regulations should not be given due consideration. Instead, the emphasis should be on developing a program that is simple to understand by all stakeholders and puts in place the correct incentives to address the externality problems.

## 3. Understand the market potential

The US approach to designing water effluent markets highlights the value of gaining an initial appreciation of market potential. Program designers in the US firstly make an assessment of whether the potential economic benefits to be gained from trading outweigh the transaction costs of establishing a trading program. To a large extent, the potential efficiency gains will hinge on whether there are an adequate number of firms in the watershed who would be interested in participating in a market and whether these firms are sufficiently heterogeneous in terms of their abatement costs. The design process does not proceed past stage one unless these basic prerequisites are fulfilled. If there is sufficient evidence to suggest that a trading program will yield efficiency gains over an alternative instrument, then the process continues to phase two, which involves framework development, and then to a third phase of implementation.

## 4. Involve stakeholders

It is evident that the success of a trading program relies heavily on the extent to which interested parties are involved in the planning and design phase. Furthermore, there is a strong case for government to decentralise the day-to-day management of a trading scheme by passing this responsibility onto a community-based association. US water effluent programs such as the Lower Boise River Trading Program will involve market participants in self-monitoring, with the EPA taking a background role of auditing and enforcement.

## 5. Keep trading rules simple

Experience shows that unnecessarily complicated trading rules is one of the primary factors responsible for causing trading programs to fail. There must be sufficient transparency in the trading process and a minimum of bureaucratic intervention. Furthermore, restrictions on trade should be kept to a minimum.

## 6. Get the science right

This review has demonstrated that it is critical to define a physical basis for the emission permits or offset credits which is measurable, able to be monitored readily, and is defensible against legal challenge. In Australia this may involve refining the methods and criteria used to measure biodiversity and habitat function. An empirically sound method for measuring the physical basis is required for establishing confidence in the market. In the case of non-point sources of pollutants such as salinity and nutrients, robust models are required to define the impacts of land use practices on subsequent discharge. These models need to be calibrated for different spatial locations, which will allow program designers to formulate appropriate trading ratios for the purpose of maintaining equivalence in trades.

Environmental systems are inherently variable and indeterminant. Therefore it must be accepted that we will never be able to model the relationships with complete accuracy. However, the US water effluent trading programs demonstrate that a highly accurate model is not required: What is needed is a model that adequately describes the relationships within a known margin of error. Trading ratios can then be used to

buffer against uncertain outcomes. If trading instruments are to be applied to dryland salinity in Australia, a key step forward would be to develop a broad understanding of the relationship between recharge and discharge for different parts of the landscape, the relationship between land uses and recharge, and the time lags involved. It will also be necessary to establish the margin of error associated with the predicted outcomes.

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