Incentive Based Conservation Policy and the Changing Role of Government

Brent Sohngen, *The Ohio State University*

Introduction

With the Clean Water Act of 1972, the United States began setting goals for improving water quality in lakes, streams and rivers. This Act has two key components. First, it sets goals for water quality by directing the U.S. Environmental Protection Agency to designate particular uses of stream segments and other water bodies. Second, it calls for the elimination of all discharges of pollution (Freeman, 1993). In order to meet these goals, the EPA has concentrated efforts on regulating point sources of pollution, mainly industrial facilities and municipal sewage treatment plants.

While it is difficult to determine the exact extent of water quality improvements over the last 26 years, most believe that water quality has improved considerably (Rankin, et al, 1996). However, even though the National Pollution Discharge Elimination System requires permits for over 200,000 point sources of pollution nationwide, the goals of fishable and swimmable waters (in all streams and rivers) and zero discharge have not been met. In 1996, 56 percent of streams surveyed met their water quality designations, 8 percent were threatened and 36 percent were in fair or poor conditions (U.S. EPA, 1998).

As government agencies think about how to improve water quality in the 36 percent of streams, lakes or estuaries that are not meeting their goals, it is becoming more apparent that pollution from nonpoint sources must somehow be addressed. The EPA's National Water Quality Inventory (U.S. EPA, 1998) suggests that nonpoint source pollution is primarily responsible for the approximately 40 percent of surveyed rivers, lakes and estuaries that are not meeting their goals. Several problems with nonpoint source pollution, however, have so far prevented direct regulation. These include their diffuse nature, difficulties in measuring and monitoring pollutants from nonpoint sources, and the relationship between nonpoint source pollution and unpredictable events like weather. Traditional command−and−control regulation is difficult in these circumstances, but there are few well−accepted alternatives in use at this time.

To begin to address nonpoint source pollution, federal and state agencies have focused on voluntary participation programs, particularly with agricultural nonpoint sources. In particular, cost−share programs became the policy institution of choice in the 1980s and they continue to dominate today. Cost−share programs essentially transfer funds from public agencies to agricultural practitioners who install conservation practices or new waste management structures on their farms. As with the best available control technologies of command−and−control regulations, payments are tied to the installation of specific practices or structures that are expected to reduce off−site effects of land management. In recent years, these practices have been termed "Best Management Practices," or BMPs.

The financial scale of cost−share programs is quite large. Section 319 of the 1986 reauthorization of the Clean Water Act, for example, authorizes the EPA to spend approximately $130 million annually on nonpoint source pollution programs. Between 1996 and 2002, the U.S. Department of Agriculture will distribute over $1.6 billion to farmers through the Environmental Quality Incentive Program and the Wildlife Habitat Incentive Program. In addition to these new programs, the USDA was authorized to maintain 36 million acres of land under contract in the Conservation Reserve Program, and the Wetland Reserve Program was authorized to enroll up to 975,000 acres. Cost−share funding does not stop at the federal level; many states are now allocating large sums of money as well. The Natureworks program in Ohio, for example, provides $1.5 million per year for different watershed projects that install BMPs, particularly for riparian zone enhancement.

While cost−share programs provide important financial resources for land based conservation, and federal and state resources for these programs have "bucked" the trend by continuing to grow, it is not clear that they alone will be sufficient to meet the goals of the Clean Water Act. Instead of requiring specific levels of pollution reduction associated with installation of new practices, cost−share payments require only the installation of BMPs. Programmatic success is determined by the number of different practices that were installed rather than actual gains in water quality. Even if cost−share programs help improve water quality in certain watersheds, programs that focus on inputs rather than outputs are not likely to be the cheapest way to improve environmental quality (Tietenberg, 1985).

The government potentially has a more important role to play in promoting conservation practices in farming. In particular, this paper focuses on the creation of regulatory institutions that allow for various forms of pollution trading. These programs, some of which are already underway, provide an exciting opportunity for government to achieve water quality goals while at the same time minimizing costs to society, industrial point sources and farmers. To develop these institutions, however, requires substantial changes in the typical way that government addresses nonpoint source pollution control for agriculture.

While pollution trading systems are often touted by economists, they are more often misunderstood by the public and regulators. This paper seeks to clear up some of these misconceptions by providing a basic background on how concepts from pollution trading systems may be applied to agricultural issues. It begins with a discussion of performance versus technology standards. Economists generally agree that performance standards are more cost−effective than traditional technology standards, and it is important for conservation practitioners, government agencies and industry to understand the differences when exploring the possibility for new institutions or systems. The paper then discusses how tradable pollution permit markets might be applied to agricultural nonpoint source pollution issues. This section concentrates on identifying some of the important components of trading systems and some of the issues yet to be resolved. The paper then describes several instances where trading mechanisms have been implemented for nonpoint source pollution. This is an exciting development in recent years, and it suggests that the role of government is already changing to consider performance standards. Our final section provides some discussion of potential next steps, in research and policy.

Technology Standards vs. Performance Standards

Most environmental regulations since the early 1970s have relied on command−and−control regulations. Because command−and−control regulations dictate not only the level of abatement that must be met, but also the technology that must be used to achieve such abatement levels, they are called technology standards. One of the most widely cited examples of this type of regulation is the "best available control technologies" required in the Clean Water Act of 1972 (and most subsequent amendments). While regulating technology may provide some assurance that firms are complying with regulations, these benefits can impose excess costs on both individual firms and society. Because there may be a more efficient method for the firm to use to achieve the same results, such as re−engineering the entire process, technology standards are not likely to minimize pollution abatement costs (Tietenberg, 1985).

Most existing cost−share programs mimic this technology−based approach because they dictate specific BMPs, and they often use particular technical guidelines. From the agencies' perspective, BMPs are desirable because regulators generally understand the practices. However, this fails to address whether or not the practice is effective and for how many years it will remain effective. Further, the important question to ask is not whether the regulators understand the practices, but whether the farmers implementing them do. Performance standards rely on the notion that farmers are in a better position to understand the effectiveness of different practices on their farms than regulators. In fact, it is likely that farmers could devise better alternatives if given the correct incentives.

Unlike technology standards, performance standards applied to cost−share programs would dictate the level of pollution abatement required by farmers signing up, but not the methods used. Farmers then have the option to adopt whichever practices are most economical for them to meet the standard. Because production systems vary widely from farm−to−farm, there are likely to be many different ways to meet cost−share requirements which stipulate pollution reduction goals rather than mandated technology. Given the opportunity, farmers would choose the technology that minimizes their costs for reducing the specified amount of pollution.

In theory, performance standards can be applied in different ways, either on a farm−by−farm basis, or at the watershed level. Watershed level regulations would hold both point sources and nonpoint sources in the watershed collectively responsible for their aggregate pollution emissions. If any one source pollutes too much, and ambient water quality goals are not met, all firms would be held liable. Several different schemes have been suggested to enforce such regulations, including the full marginal damage scheme of Segerson (1988), the random fine mechanism of Xepapadaes (1991), the nonpoint source tournament of Gouvindasamy et al. (1994) and environmental bonding. While several alternative liability mechanisms have been suggested, it remains a rich area of research in economics to develop a scheme that is both economically and politically feasible.

An example of a performance standard that is applied to a group of polluters is the sulfur dioxide trading program initiated by Title IV of the Clean Air Act Amendments of 1990. Economic theory suggests that firms with high costs of abating their own emissions of sulfur dioxide will purchase additional allowances from firms with low costs of abatement. These purchases will reduce the overall costs of complying with regulations intended to reduce the damages caused by acid rain.

The role of performance standards is well illustrated with the first phase of trading in this program (trading started in 1994). Burtraw (1996) argued that moving from a technology standard, which required each source of sulfur dioxide to install scrubbers, to a performance standard, may have been the most important component of the dramatic cost savings seen in the sulfur dioxide permit trading market in the early 1990s. While predictions of the marginal cost of sulfur dioxide reduction with scrubbers was over $1,000 per ton of sulfur dioxide in the 1980s, the price of a permit for sulfur dioxide in the 1990s has been approximately $130 to $150 per ton. With the implementation of the trading market came the performance standard: firms no longer had to install technology to "scrub" sulfur from emissions. They instead could substitute other forms of abatement, which included importing low sulfur coal from western states. To be fair, these low prices were aided by deregulation in the rail industry which reduced the price of coal transportation. Without a performance standard, however, these benefits may never have been realized.

Agriculture and Pollution Trading

While pollution trading appears to be successful with sulfur dioxide, could systems be designed for nonpoint sources as well? What should these systems look like? Is there any potential for trading between point and nonpoint sources of pollution? How would agencies deal with the inherent uncertainty involved with nonpoint source pollution? These and other questions must be addressed before trading markets for nonpoint source pollution become more prevalent.

There is no single recipe for developing a trading scheme that would involve agriculture. In fact, as the examples below suggest, rather than installing a widespread, formal trading structure like sulfur dioxide trading, it instead may be entirely possible to develop institutional arrangements that are less formal. These arrangements would nevertheless include concepts from trading programs that foster private incentive payments to farmers for conservation. Perhaps the most important aspect of any potential program is that it must embrace the notion of a performance standard.

In this paper, we discuss mechanisms in terms of formal and informal. A *formal* mechanism would involve bringing nonpoint sources under the same regulatory umbrella as point sources. In this case, the nonpoint sources would be assigned limited property rights to pollute. They would be required to hold enough discharge permits to cover the effluents discharged in their runoff. Nonpoint sources would then be treated in the same manner as point sources. Although it may be costly and difficult to monitor pollution for all permit holders, it may be entirely possible to include certain agricultural sources in these markets, particularly concentrated livestock operations. However, given that the size of the institution necessary for keeping track of the over 200,000 NPDES permits now is already burdensome for the EPA, it is unlikely that formal arrangements such as this would be introduced in the near future.

Even if nonpoint source pollution is not permitted as NPDES, there are opportunities to institute trading arrangements. A *less* formal arrangement would allow nonpoint sources to be invited into the trading regime on a voluntary basis. The incentives for nonpoint source participation rest on the assumption that agricultural practices that reduce pollution are less expensive than additional direct point source control. In the less formal arrangement, nonpoint sources are an additional supplier of pollution abatement. Participants would not hold the actual discharge permits, but they would enter into contractual arrangements with point sources to provide reductions in pollution discharges. It is this less formal arrangement that is currently employed within the U.S. environmental policy, and discussed below.

Whether a formal or informal arrangement is developed for trading, several key steps must occur before trading can occur. The first step is that the goals of the program must be clearly defined. Often, goal setting may begin by developing pollution load analysis for a watershed. Such analysis would allow regulators and stakeholders to learn how much each source is contributing to pollution in the basin. This will provide the baseline information from which goals for improving water quality can be developed, and improvements in water quality can be measured. With this information, standards can be set for different sources of pollution, perhaps through the Total Maximum Daily Load process.

The second step is to allocate the rights to pollute. This means that the loads for different sources must be constrained to ensure that total pollution in the watershed remains below the constraint. These rights might be called permits to pollute. Under the formal arrangement above, both point and nonpoint sources would be allocated a given number of permits, while under the informal arrangement, permits would be given only to the point sources. Allocating permits involves not only determining the overall quantities of pollution that will be allowed by point and nonpoint sources, but also distributing these permits to the individual sources in the watershed. Thus, each polluter would obtain the permit to pollute X kg of nitrogen. Initially, these permits can either be given away for free, as occurs in the sulfur dioxide market, or auctioned to raise revenue.

The third step is to allow the permits to be divided so that polluters can trade individual pieces of their permits. For example, polluter A might find that it is too costly to pollute less than their initial permit allows, but that polluter −− will sell them part of their permit. After the trade, the polluter A would have a large enough permit so that they are within the law, but polluter −− has a smaller permit and must abate the given level of pollution. The fourth step is to develop an institution that allows individuals to trade these rights. This may involve licensing a set of brokers to facilitate trading, or it may involve developing an annual (or even more frequent) auction where buyers and sellers meet. Individual firms must be allowed to trade their allocated rights freely. Since the total number of permits remains the same, the overall constraint placed on pollution will not be violated. It is important to realize that trading such as this does not mean that firms shirk their responsibility, but it instead means that firms switch the responsibility of pollution abatement to someone else, using a market arrangement to facilitate this transition.

The question of whether or not there is scope for trading systems to provide funding for land conservation can be considered from several different angles. Between 1972 and 1992, the costs of water pollution control in the United States are estimated to have been $735 billion (1992 dollars), and in 1992 alone, they were $57 billion (Jaffe et al. 1995). If trading systems were implemented and industry was allowed to purchase pollution control on farms, they may re−allocate some of these expenditures to farms. If only 1 percent of these compliance costs were re−allocated in this fashion, it would provide an additional $570 million per year in ***private*** incentive payments for farmers. In reality, the value of trades may be more or less than this, but the scale of financial resources currently devoted to pollution control suggests that there are potentially large sums of money available for private incentives.

The motivating argument for pollution trading rests not on the total sum of pollution expenditures, but instead on the fact that farmers may be able to reduce pollution at a lower cost per additional ton than regulated industries. Along a given stream segment, or within watersheds, this means that the costs for point sources to reduce an additional ton of effluent need only be higher than the costs for agricultural sources to reduce the same ton. Early economic studies suggest that potential cost savings for water pollution trading programs between point sources relative to command−and−control lie between 12 percent and more than 100 percent (Tietenberg, 1985). Although these savings represent an upper bound (Teitenberg, 1985), they provide evidence to support the idea that point sources have some scope for trade.

One way to see if there is scope for trading between point and nonpoint sources is to consider the marginal costs of pollution abatement. If these costs differ dramatically, then there is likely to be some scope for trade. Henschel (1995) suggests that the marginal cost of pollution abatement in pulp plants in the Great Lakes ranges between $18 and $100 per kilogram, depending on the level of abatement. In contrast, Hopkins et al. (1996) estimate that the marginal costs of pollution abatement on two Ohio farms ranges from $2 to $4.50 per kg of nitrogen. A recent study by Nakao (1998) suggests that the cost of reducing a kilogram of soil erosion in the Maumee river basin of Ohio is less than $1 per kg of gross erosion. These data on cost differences, although not complete, suggest that there is likely to be considerable scope for trading between point and nonpoint source pollution.

The most contentious issue associated with the prospect of point−nonpoint source trading involves the issue of uncertainty: what happens if the nonpoint source pollution reductions are ineffective? Since regulators are already uncertain how much pollution abatement results from the implementation of these practices, pollution levels may then rise above existing levels, and therefore cause backsliding. This issue has been raised by many environmental organizations who have commented on the EPA's "Draft Framework for Watershed−Based Trading" (U.S. EPA, 1996).

Existing technology standards are preferred by many because they provide some measure of certainty that point sources are reducing their pollution. Allowing these same firms to purchase BMPs that are subject to considerable uncertainty, can raise red flags for regulators, firms and environmentalists. For trading systems to satisfy societal demand for improved water quality, they must somehow find ways to reduce this uncertainty.

The method most employed in practice for reducing uncertainty in trading programs is the trading rule. The trading rule follows from the theory of safe minimum standards (Ciriacy−Wantrup, 1968). The regulator wants to ensure that after all trading has occurred, pollution is at least as low as before. However, if conservation practices are uncertain, and regulators do not monitor the reduction in pollution loading from the practices, regulators cannot be certain that total loadings will be reduced. The trading rule is a relatively simple way to safeguard against these uncertainties. Firms are required to offset more pollution by purchasing conservation practices in case the conservation practices are not as effective as predicted. A trading rule may state that a firm must purchase five tons of pollution reduction from farms in lieu of reducing one ton of its own pollution.

The problem with a trading rule is that it may discourage trading altogether. If it is set too high, it will discourage trading because it may no longer be cost−effective for firms to purchase conservation practices, and if it is set too low, the environmental goals may not be met. The trading rule must be carefully set to encourage trading and to ensure compliance with environmental standards. Dealing with uncertainty such as this remains one of the biggest obstacles to successfully implementing programs on a wider basis in the United States.

Uncertainty may not be as large a problem as it seems. There are two reasons. First, farmers are the individuals who have the greatest ability to deal effectively with it. They understand better than others how their farms operate and what can be done to reduce pollution to the levels desired. Second, uncertainty will not be constant over time as more information is revealed about the effectiveness of different technologies (i.e., through research at Land Grant Universities). This information can be more effectively introduced into trading programs because farmers have the ability to choose from a wide range of alternatives rather than the alternatives used in technical guidebooks.

This second issue suggests another important aspect of trading programs. They are potentially better suited to allow markets to adjust freely over time without undue constraints from government. For example, economic conditions may change in the watershed as firms and farmers enter and exit. As the mix of firms changes, the mix of pollution will change, as will the overall quantity. Trading systems give those involved in the market the best opportunity to adapt to these changing conditions.

The Changing Role of Government: Examples

The role of government in agricultural pollution trading is dramatically different than its role in cost−share programs. Rather than providing direct financial assistance to farmers, the government provides the institutional framework for the private firms to purchase pollution abatement from others in lieu of more costly pollution reductions within their own plants. State and federal agencies still must develop water quality standards to meet goals set forth by legislation. However, rather than regulating particular technologies used by point sources, or purchasing particular BMPs from farmers, regulators focus on designing systems that give incentives for point sources and farmers in watersheds to choose effective technologies in the most efficient manner. In the case of water pollution trading programs, private entities are free to choose the particular set of methods that will allow them to mitigate or offset pollution most cheaply.

While pollution trading may provide a feasible alternative to public cost−share programs, they have only recently begun to attract attention. Nevertheless, the "Draft Framework for Watershed−Based Trading" (U.S. EPA, 1996) suggests that the institutional support for these programs is gaining momentum. To date, there have been no formal watershed based trading programs (i.e., programs that involve both point and nonpoint sources through the permitting process). However, several informal arrangements have been developed. Two of them, the Dillon Reservoir program in Colorado and the Tar−Pamlico program in North Carolina, involve point−nonpoint source pollution trading. Although minimal trading has occurred in either market, they do provide an opportunity to examine alternative institutional frameworks for permit trading markets. Another interesting arrangement to consider is wetlands mitigation banking, which is occurring in several different states. Two additional programs are discussed that show how government agencies have begun to adopt informal arrangements by trading among themselves.

Dillon Reservoir, Colorado

The Dillon Reservoir trading program for the control of phosphorous from point and nonpoint sources began in Colorado in 1984. Lake Dillon faces various competing uses including recreational activities, drinking water supply and waste assimilation. Anticipated increases in phosphorous loading from development and growth within the Lake Dillon watershed led to the development of a permit trading market. The trading market is composed of four publicly owned waste water treatment works and all surrounding point sources (EPA, 1996). Only nonpoint sources that were established within the watershed prior to July of 1984 can generate phosphorous credits for point sources (Apogee Research, 1992). More recent nonpoint sources are subject to new command−and−control phosphorous control regulations.

Point sources can purchase nonpoint source pollution abatement according to a 2−1 trading ratio (Apogee Research, 1992). This means that the point source must arrange for two units of nonpoint source phosphorous reduction for each unit of phosphorous it discharges above its allocated limit. The trading ratio was chosen based on the modeling of projected nonpoint source phosphorous loadings (Zander, 1997).

Trades are monitored and enforced through linkages to the NPDES permits of the point sources required by the Clean Water Act. While all trades are arranged by the parties involved, they must be approved by both the State Water Quality Control Commission, as well as the federal EPA regional office (Zander, 1997). Because nonpoint sources do not typically come under the restrictions of the Clean Water Act, point sources are held responsible for the compliance of all trades. Thus, if a nonpoint source is not in compliance, the point source is held in violation of its NPDES permit, and it falls under the penalty structure of the Clean Water Act (Zander, 1997). To date, there have been very few trades in the Dillon Reservoir system. Perhaps the main reason for this is the switch to the performance standard, inherent in trading programs. This led to the unexpected discovery of low cost direct control methods for point sources, and it allowed the use of these methods. Even with the buildout of the watershed basin, the point sources are not expected to reach their allocations (Apogee Research, 1992).

Since point sources of phosphorous are no longer considered to be a major threat to the watershed, the attention of regulators has switched to nonpoint sources. Local officials developed a phosphorous mitigation policy that requires new nonpoint sources to offset their expected phosphorous impact. This is done by reducing the impacts of existing nonpoint sources, in addition to meeting the existing command−and−control requirements for new nonpoint source control.

Three trades have occurred to date. The first trade was between a point and nonpoint source, and it was initiated solely to test the administration of the project. A local publicly owned treatment work in the Breckenridge Sanitation District replaced the septic systems of a local subdivision with a connection to the sewer system. In return, the point source received 11 pounds of additional phosphorous credit (Apogee Research, 1992).

The other two trades were between nonpoint sources. The city of Frisco experienced storm water drainage problems that resulted in phosphorous runoff. Concrete manholes were constructed to increase drainage and trap sediments, thus reducing phosphorous loadings (EPA, 1996). The earned credits were applied to mitigate the construction of a new town golf course (Zander, 1997).

In the second nonpoint−nonpoint trade, the Snake River wastewater treatment facility built a discharge structure to reduce the nonpoint source phosphorous loading from a stream entering Lake Dillon. Although the trade was initiated by the point source, it did not need the additional discharge credits. The earned credits were then applied to offset an increase in phosphorous loadings anticipated by a stream diversion proposed by the Denver Water Board (Zander, 1997).

Tar−Pamlico River Basin

High nitrogen and phosphorous levels within the Tar−Pamlico river basin led to eutrophication and fish kills. As a result, a permit trading system was created to reduce nitrogen and phosphorous loadings at low cost. The participants in the trading markets consisted of both point (12 Publicly Operated Treatment Works and a single private firm), and numerous nonpoint sources within the watershed (primarily cropland and livestock). The point sources were organized into a single group, referred to as the Association. The Association places all individual point sources under a single "bubble." If the total loadings of the Association exceed the allowable nutrient load, then they must purchase offsetting nonpoint source abatement.

As opposed to the Dillon Reservoir market, the regulatory agency, in this example, plays a more active role in the trading process. The first step was to conduct a total maximum daily load analysis to determine the allowable levels of nitrogen and phosphorous discharge in the basin. A t−ratio of 3−to−1 for cropland BMPs and 2−to−1 for livestock BMPs was set in the market (Apogee Research, 1992). Based on a computer simulation of potential trades, the price of a tradable permit was set for the market at a weighted average of $29 per kg. This price includes the projected per kg costs of both livestock and crop nutrient abatement, including the required t−ratio. Trades are not negotiated by the participants in the market directly. Instead, if the Association's total loadings exceed the allowable aggregate level of the point sources, they are required to purchase offsetting nonpoint source abatement at the set price of $29 per kg. (Gannon, 1997). The trade is arranged by The North Carolina Department of Soil and Water Conservation through the Agricultural Cost−share Program in the Tar−Pamlico Basin. The Association is required to maintain a $500,000 annual reserve in the Agricultural Cost−share Program. This ensures the availability of funds for the implementation of any potentially required trades. Since the Association is not involved in the implementation of trades they do not carry the responsibility of ensuring compliance of the nonpoint source trading partner (Gannon, 1997). Instead, the state, through Soil and Water Conservation District officials, bears the cost of inspection and enforcement of compliance. This arrangement is thought to relieve the point sources of bearing excessive risk through trading.

To date, no trades have occurred within the Tar−Pamlico market. During Phase I of the market's formation, each point source was required to perform an engineering analysis of their management and operation practices for pollution abatement (EPA, 1996). As a result of these analyses, many new low cost methods of pollution abatement were discovered. In response to the flexibility derived from the switch to a performance standard the point sources were able to abate nitrogen and phosphorous discharge directly, and trading was not required. Association members still remain well below their allowances. Therefore, trades are not anticipated for a few years (Gannon, 1997).

Wetlands Mitigation

The preservation of wetlands has gained attention in recent years, as the acreage of natural wetlands has declined. There are essentially two types of wetland policies in the United States. The Wetland Reserve Program serves the traditional role as a federal incentive system that attempts to increase the area of wetlands. Section 404 of the Clean Water Act provides legislation that limits the loss of remaining natural wetlands. However, Section 404 contains an interesting provision that allows individuals who wish to remove wetlands in one region, to mitigate these wetlands in another region. Wetland mitigation banking provides another example of innovative government policy based on performance rather than technology standards. It also can be applied directly to land conservation policy.

Land developers must apply for a permit to alter any existing wetland. The Army Corps of Engineers evaluates the physical qualities of the wetland and determines whether the applicant must minimize the impact of development, or avoid impact altogether. Mitigation banking provides an off−site compensatory option in minimizing impact.

Ohio Wetlands Foundation

In response to concerns regarding the loss of wetland habitat, the Ohio EPA has actively pursued a "no net loss" policy for wetlands. This policy requires that development does not result in a loss of total wetland acreage. Any land development project which may impact wetlands quality must first obtain a permit. When a permit is granted for land development, it may include restrictions on the project to offset or minimize negative impacts on wetlands. Onsite offsets include setbacks and filter strips designed to minimize degradation of the directly impacted wetlands. However, it can often be more effective to require offsets to be carried through offsite. One form of off−site offsets is mitigation banking, where the developer will pay to create new wetlands, or improve an existing wetland in some other area. Such banking programs allow developers to impact certain wetlands in exchange for developing or improving existing wetlands elsewhere. An informal performance standard exists in this trading scheme. In order for a developer to qualify for wetland mitigation banking, the impacted wetland must be offset by a wetland of higher ecological quality. In most cases, the offsetting wetlands are larger in size and are of better ecological quality.

The effectiveness of constructed wetlands are uncertain. Therefore, a mitigation ratio is used. This ratio is determined by the regulatory agency (i.e., EPA and Army Corps of Engineers), and dictates that more than one acre of constructed wetlands be created to offset a single acre loss of existing wetlands. The most common mitigation ratio is 5:1 in Ohio. However, this ratio can be even greater if the impacted wetlands are of a higher quality. The mitigation ratio is determined on a case−by−case basis during the permit process.

The Ohio Wetlands Foundation is a nonprofit organization which creates constructed wetlands banks and sells acreage to land developers for offsetting purposes. Since 1993, the foundation has sold out three separate banks ranging in size from 33 acres to 330 acres (Sutliff, 1998). The incentive of a low cost offsite alternative allows marginal wetlands to be put to more valuable uses, while maintaining, and in some cases increasing, the amount of high quality wetlands in existence.

Other Trading Systems

Various less formal trading schemes have been introduced throughout the United States to deal with diverse pollution problems. These trading systems are less formal in the sense that they are more case specific in arrangement, and are directed to a narrower class of trading partners. The city of Providence, Rhode Island has instituted a trading arrangement between the city's Department of Water and the Department of Transportation. The Department of Water was required to meet specific sodium standards within the supply source recharge area (EPA, 1996). Faced with costly in−plant treatment, the Department of Water agreed to subsidize the use of non−sodium based road deicing chemicals by the Department of Transportation. This allows the Department of Water to meet its sodium standard at minimum cost.

Laguna de Santa Rosa, California, is the site of another informal trading arrangement. The City of Santa Rosa faced difficulties in meeting water quality standards during the summer months. Instead of increased abatement efforts, the city shipped treated wastewater to area golf courses, as well as dairies and farms for application to pasture and some food crops (Smith, 1997). No overall trading mechanism exists, and trades are not reflected within the City of Santa Rosa's NPDES, but they are accounted for within the TMDL (Smith, 1997). The city initially paid dairies to take the water, but payments are no longer made due to the desirability of the nutrient content (EPA, 1993). Noncompliance problems are enforced against the farmer or rancher who applies the wastewater to fields by local governments (Smith, 1997).

Conclusion

Regulatory institutions for the provision of private incentives hold the potential for improving land based conservation management. Rather than the traditional public provision of cost−share assistance, innovative pollution trading programs may allow point sources of pollution to provide private incentives for pollution abatement on farms. This shift in regulatory focus, however, would first require a change from technology−based standards to performance standards. The institution for pollution trading can vary greatly to fit the problem at hand, as illustrated by the brief overview of ongoing pollution trading programs. These programs suggest that trading regimes are not only possible, but that they have been implemented successfully over the past several years.

Although existing cost−share programs can change farmer practices, they rely heavily on traditional technology approaches. Rather than focusing on the performance of BMPs in reducing the quantity of pollution that moves off−site, cost−share programs focus most heavily on the technological presence of BMPs. One distinguishing feature of tradable pollution permit programs is that they require regulatory agencies to focus more attention on performance rather than the installation of abatement technology.

Performance standards shift the burden of uncertainty from regulators to farmers. Under the current regime, where cost−share incentives are based on technological inputs, the regulators face all of the uncertainty of BMPs. If they spend a given amount of money in a certain watershed and the resulting practices are not effective, the blame is placed on the regulator, not the farmers. Under a tradable pollution permit system, however, the individual parties involved in the trade would be held liable for non−compliance with water quality standards. This places the burden of uncertainty on the parties involved to ensure that they use the most effective BMPs given the problem at hand.

While farmers do not currently face this type of uncertainty, a central premise of the trading regime is that they are most suited to accepting it, given that they have the best ability to respond. In the economic literature and within the examples of nonpoint source trading programs discussed above, regulators have provided an additional measure of certainty by incorporating trading ratios. Trading ratios are introduced to ensure that minimum standards are met when pollution trading occurs.

As seen in the examples above, trading regimes do not necessarily have to be developed in the traditional sense discussed by economists, or as set up under Title IV of the Clean Air Act Amendments of 1990. There are opportunities for trading to occur at many different levels and scales. For example, point sources may trade with other point sources or with nonpoint sources, nonpoint sources may trade with nonpoint sources, or government agencies may trade with other government agencies. Trading is therefore seen to be a means to an end, not an end in and of itself.

There may be other ancillary benefits of tradable pollution permit programs that have not been discussed above. Perhaps the most interesting of these is that trading markets may provide incentives for innovation in pollution abatement technology. For example, if a farmer contracts for a given level of pollution reduction, he/she has the incentive to provide this pollution abatement in the cheapest manner possible. The traditional cost−share program provides little incentive for farmers to find cheaper methods because they are highly prescriptive. Although there is some disagreement among economists about the extent of this "induced" innovation (see Porter and van der Linde, 1995, and Jaffe and Palmer, 1994), trading markets provide the proper framework to encourage these new innovations.

Tradable pollution permit programs suggest a very different role for government in encouraging alternative land management practices to reduce pollution than the cost−share programs currently used. Rather than directly providing financial incentives, the government would facilitate new trading institutions that allow private incentives to promote conservation. While several trading programs, or at least informal programs that contain aspects of trading, have begun in the past few years, it appears that there is substantial scope for them to flourish in the future.

[1] While the views expressed in this paper are those of the authors alone, they would like to thank Alan Randall for comments made during discussions on this topic.

References

Appogee Research, Inc. *Incentive Analysis for Clean Water Act Reauthorization: Point Source/Nonpoint Source Trading for Nutrient Reductions*. EPA Contract 68−CO−0083 April, 1992.

Ciriacy−Wantrup, S. von. *Resource Conservation: Economics and Policies*. 3rd Edition. Berkeley, CA: University of California Division of Agricultural Sciences. 1968.

Batie, Sandra and Ervin, David E. "Flexible Incentives for Environmental Management in Agriculture: A Typology. Unpublished Manuscript. 1997.

Burtraw, Dallas. "The SO2 Emissions Trading Program: Cost Savings without Allowance Trades" *Contemporary Economic Policy*. Vol. 14 (April, 1996): 79−94.

Freeman, A. Myrick. "Water Pollution Policy" Chapter 3 in *Public Policies for Environmental Protection*. Edited by Paul R. Portney. Washington, D.C.: Resources For the Future. 1993.

Gouvindasamy, Ramu; Herriges, Joseph A.; and Shogren, Jason F. "Nonpoint Tournaments" Chapter 4 in Dosi, Cesare and Tomasi, Theodore. *Nonpoint source pollution regulation: Issues and analysis*. eds. Fondazione Eni Enrico Mattei Series on Economics, Energy and Environment. Dordrecht and Boston: Kluwer Academic. 1994.

Gannon, Rich. Personal Telephone Conversation. North Carolina Water Quality Commission. May 13, 1997.

Henshel, Eva. *Enforcing Pollution Control Regulation*. Unpublished Ph.D. Dissertation. The Ohio State University. 1995.

Hopkins, Jeffrey; Schnitkey, Gary; and Tweeten, Luther. "Impacts of Nitrogen Control Policies on Crop and Livestock Farms at Two Ohio Farm Sites." *Review of Agricultural Economics*. Vol. 18 (1996): 311−324.

Jaffe, Adam B; Peterson, Steven R.; Portney, Paul R.; and Stavins, Robert N. "Environmental Regulation and the Competitiveness of U.S. Manufacturing: What does the Evidence Tell Us?" *Journal of Economic Literature*. 33: 132−163.

Jaffe, Adam B. and Karen Palmer. "Environmental Regulation and Innovation: A Panel Data Study." *Resources for the Future Discussion Paper 95−03*. October, 1994.

Malik, Arun S., David Letson, and Stephen R. Crutchfield. "Point/Nonpoint Source Trading of Pollution Abatement: Choosing The Right Trading Ratio." *American Journal of Agricultural Economics*. Vol. 75 (November, 1993): 959−967.

Nakao, Megumi. 1998. Costs of Using Riparian Forest Buffers for Soil Erosion Control. Unpublished Master's Thesis. The Ohio State University. 1998

Oates, Wallace E., Karen Palmer, and Paul R. Portney. "Environmental Regulation and International Competitiveness: Thinking About the Porter Hypothesis." *Resources for the Future Discussion Paper 94−02*. November, 1993.

Porter, Michael E. and Claas van der Linde. "Toward a New Conception of the Environment−Competitiveness Relationship." *Journal of Economic Perspectives*. Vol. 9 No. 4 (Fall, 1995): 97−118.

Purvis, Amy, William G. Boggess, Charles B. Moss, and John Holt. Technology Adoption Decisions Under Irreversibility and Uncertainty: An Ex Ante Approach. *American Journal of Agricultural Economics*. Vol. 77 (August, 1995): 541−551.

Rankin, Edward T., Chris O. Yoder, and Dennis Mishne. "1996 Ohio Water Resource Inventory Volume I: Summary, Status, and Trends." *Ohio Environmental Protection Agency Technical Bulletin*. April 22, 1997.

Segerson, K. "Uncertainty and Incentives for Nonpoint source Pollution Control." *Journal of Environmental Economics and Management*. Vol. 15 (1988): 87−98.

Smith, Dave. Personal Telephone Conversation. Region 9 U.S. Environmental Protection Agency. May 19, 1997.

Suttliff, Jim. Personal Telephone Conversation. Ohio Wetlands Foundation. June 19, 1998.

Tietenberg, T.H. *Emissions Trading: an exercise in reforming pollution policy*. Resources for the Future, Inc. Washington, DC. 1985.

United States Environmental Protection Agency. Draft Framework for Watershed−Based Trading. EPA−800−R−96−001. May 1996.

United States Environmental Protection Agency. *National Water Quality Inventory: Report to Congress*. EPA−841−F−97−003. April 1998.

Xepapadaes, A. "Environmental Policy under Imperfect−Information: Incentives and Moral Hazard." *Journal of Environmental Economics and Management*. Vol. 20 (1991): 113−126.

Zander, Bruce. Personal Telephone Conversation. Region 8 U.S. Environmental Protection Agency. April 18, 1997.

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CONTACT INFORMATION:

American Farmland Trust
Center for Agriculture in the Environment
148 N. 3rd St.
P.O. Box 987
DeKalb, Ill. 60115
Phone: (815) 753−9347
Fax: (815) 753−9348
E−mail: Ann Sorensen (asorensen@niu.edu), Director.

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