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Local Innovations in Water Protection: Experiments with Economic Incentives

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The ineffectiveness of traditional agricultural policies to reduce nutrient-related water quality impairments has prompted some states, local environmental and conservation agencies, and some nonprofit groups, to experiment with new approaches. This article examines innovations that make use of economic incentives to engage the agricultural sector in nutrient and sediment controls. It focuses on various forms of water quality trading, but also presents some other novel uses of incentives aimed at promoting cost-efficiency.

Weighing the Performance of Water Quality Trading

Water quality trading (WQT) is a major innovation in water quality protection policy that allows exchange of pollution credits among emitters to lower the costs of achieving a pollution cap. Such programs rely on a regulatory framework that compels polluters to participate and offers the flexibility necessary to conduct cost-saving trades. Under the Clean Water Act of 1972 (CWA), point dischargers are required to have National Pollution Elimination System (NPDES) permits to discharge into the nation's waters. Initially, the permits imposed technology-based effluent limits, developed by the U.S. Environmental Protection Agency (EPA), that were independent of water quality conditions affected by the discharges. Failure to achieve water quality standards through this regulatory mechanism led to lawsuits requiring the EPA to enforce the Total Maximum Daily Load (TMDL) provisions of the CWA. These provisions require state water quality authorities to establish pollution load limits and allocations for both point and nonpoint sources consistent with desired in-water uses, and to implement plans to achieve these limits.

Point source load allocations to meet TMDLs are enforced through water quality-based effluent limits that are in addition to the technology-based standards. In one form, WQT enables regulated sources to meet these additional effluent limits by acquiring environmentally equivalent (or greater) effluent reductions from other sources. In another, WQT replaces individual requirements with a "group" permit applicable to a set of regulated sources.

The economic rationale for WQT is that it can achieve water quality standards at a lower cost than traditional, non-tradable effluent standards or technology requirements. Such cost savings can occur when load reductions can be generated at lower cost from a substitute source or sources. The expectation that trading could lower the costs of water quality protection led to various experiments and demonstration projects beginning in the 1980s. Interest in the mechanism increased substantially beginning in the mid-1990s as the successes of the SO_2 trading program used to control acid rain became clear and EPA's TMDL initiatives were increasing in number and scope. Trading programs under the TMDL are created by states or substate entities subject to the states. These initiatives have been encouraged by the EPA since the late 1990s with policy guidelines, technical assistance, and funding for demonstration projects from the EPA and the U.S. Department of Agriculture (USDA). The federal interest was prompted, in part, by studies indicating that the costs of TMDL compliance to the nation could be substantially reduced by WQT (US EPA, 2001).

In their survey, Selman et al. (2009) identified 22 WQT initiatives with established rules, 19 under consideration or in development, and 10 that were complete or inactive. Several additional initiatives have been undertaken since this survey. WQT initiatives have been both ad hoc—with the terms of trades developed and agreed upon on a case-by-case basis between specific entities—and formal—with trade rules put in place to govern market trading between multiple, unspecified entities within specific geographic areas such as watersheds. In prominent ad hoc examples, Rahr Malting Company in 1997, and Southern Minnesota Beet Sugar Cooperative in 1999, each contracted for agricultural and other nonpoint source nutrient-pollution reductions to help industrial facilities on the Minnesota River meet permit requirements.

Among the formal trading programs, some are limited to point sources, while others enable trading between point and nonpoint sources. The most prominent point-point example is the Connecticut Nitrogen Credit Exchange Program, established in 2002 to allocate reduced nitrogen loads among 79 wastewater treatment plants discharging to the Connecticut River to comply with a TMDL for Long Island Sound. Highly visible programs allowing point sources to trade with agricultural nonpoint sources for nutrients have been developed over the last decade, mainly by states in the Chesapeake Bay watershed (Maryland, Pennsylvania, and Virginia), and in Ohio for the Greater Miami watershed.

Successful Trading Within Source Sectors

The success stories in water-quality trading have been programs that promoted trading among point sources. Within-sector trading overcomes many challenges to cross-sector trading, including the technical barrier of judging the environmental equivalence between nutrients emitted directly into the impaired body of water with nutrients emitted within the watershed. This trading has, therefore, been seen as carrying a lower risk of environmental harm and been more politically acceptable.

The innovation that allows within-sector trading is a move from individual, technology-based requirements for NPDES permits to a performance-based "group cap" that is shared among a group of permit holders. This approach provides flexibility in how to comply and has driven innovation where it has been used. Two of the country's oldest trading programs highlight the potential for within-sector trading to reduce the costs of compliance of achieving nutrient caps: Tar-Pamlico Sound and Neuse River

In both North Carolina programs, the point source dischargers have been able to meet and exceed nutrient caps. Trading gave flexibility to wastewater treatment plants (WWTPs) to follow their regular upgrade schedule because plants that upgraded first were able to generate enough excess capacity and credits to those waiting to upgrade. By phasing in upgrades, costs were substantially lower than those associated with simultaneous upgrades at all plants (Shabman and Stephenson, 2007). Further, the permit flexibility provided room for experimentation that led to new approaches to reducing nutrients through changes in the production process.

Although the caps were achieved and money was saved in the North Carolina basins, the water quality outcomes cannot be judged a success. Chlorophyll *a* levels in the Tar-Pamlico estuary remain high, and gage data and models in the Neuse suggest that nutrient loads have not been reduced. An explanation for the lack of response is that the caps were not sufficiently stringent to achieve water quality outcomes. However, a wide variety of alternative hypotheses including lags in estuarine response or problems with calculations are being considered.

The lack of environmental success despite achieving cost-effective compliance reinforces the necessity of engaging all sectors in achieving environmental goals. North Carolina has, perhaps, been most innovative in this regard by experimenting with a group cap for non-point source emitters in the Neuse basin. To achieve a 30% nitrogen reduction goal from agriculture, producers are required—under threat of civil or criminal penalties—to either individually implement a set of best management practices or join an association that will develop and implement a "collective local strategy" (North Carolina Environmental Management Commission, 1998). The effectiveness of this approach is not clear at this point.

In the case of the point source group cap, the program was successful at reducing costs of compliance because, instead of regulating how to comply, plants were told what reductions were needed. However, an important caveat to the point source success story is that trading has generally not been used to forgo major investments in technological approaches to reducing nutrients. Rather, it has been used largely to improve the efficiency of upgrading multiple plants at once by providing more time for compliance by all emitters.

Greater cost savings come from avoiding cost-inefficient technological investments. For example, it is generally less efficient to install state-of-the-art technology at small WWTPs because the relatively small reduction in nutrient loads from such investments comes at a high cost. In Virginia, multiple plants with a single owner can be given one effluent limit for all owned plants to avoid unneeded technology upgrades—demonstrating that even more flexible permitting rules can enhance cost-savings.

Point-Nonpoint Trading

As suggested above, WQT between industrial and municipal point sources and agricultural nonpoint sources is interesting because it offers the potential to integrate the control of point and nonpoint sources (Shortle and Horan, 2013). Pollution policies have historically addressed the two types separately. Such a separation is at odds with the "watershed-based approach" to water quality management thought to be most efficient by water quality scientists.

Equally crucial to realizing the potential economic gains from water quality trading is effective and efficient trading between point and agricultural nonpoint sources because it helps to achieve goals at the lowest cost. Economic assessments indicate that the incremental benefits of the CWA stopped exceeding the incremental costs sometime after the late 1980s (Olmstead, 2010). Two policy choices drove this flip (Shortle and Horan, 2013). One is that water quality goals have been pursued through increasingly stringent and costly point source controls rather than through lower-cost nonpoint source controls. Further, the diminishing returns to point pollution controls are exacerbated by the use of highly inefficient, technology-based, uniform effluent standards.

The point-point trading programs implemented in Connecticut and more recently in Minnesota, North Carolina, and Virginia, suggest significant promise for water quality trading to efficiently allocate nutrient effluent reductions among point sources. However, the results, to date, for trading with agricultural nonpoint sources are generally disappointing. Most programs have shown limited participation by potential traders and a lack of trading activity. The reasons for these lackluster results include a lack of regulatory or economic conditions necessary for market development, high barriers to entry, high transactions costs, and regulatory uncertainty.

A number of unique challenges arise in developing programs that include agricultural nonpoint sources. First and foremost is that, unlike point source emissions, the movement of nutrients from farms to water resources cannot be metered. Thus, the uncertainty of agricultural best management practices (BMP) performance for controlling nutrient and sediment runoff has been a major challenge to water quality trading between point sources and the agricultural sector. This uncertainty scares off buyers who retain legal liability for the pollution reductions under trading. Further, the difficulty of verifying that reductions are occurring prompts regulators to propose trading ratios that dramatically reduce the supply of available credits and increase the costs to point sources of purchasing nonpoint reductions. For example, a 2:1 (nonpoint source:point source) trading ratio, at a minimum, halves the supply of nonpoint source credits and doubles the cost . This is sure to discourage some sellers from entering the marketplace. The contraction of supply further discourages buyers who need to secure large volumes of credits in perpetuity. Also important is that agricultural nonpoint sources are not commonly regulated, so ensuring that trading between regulated and unregulated sources results in real reductions generates the need for complicated rules that discourage farmer participation.

Administered Trading

Despite challenges, there have been outright and partial successes that indicate potential from well-designed, implemented, and administered programs. A particularly noteworthy outright success is not from the United States but Canada (Shortle, 2013). The South Nation River Total Phosphorus Management Program was established in eastern Ontario in 2000 to allow new and expanding industrial and municipal wastewater plants to meet stricter phosphorus limits by purchasing agricultural offsets at a trade ratio of 4:1 (nonpoint:point source phosphorus). Since the inception of the program, all of the point source operations have chosen to purchase offsets rather than upgrade treatment facilities. South Nation Conservation (SNC), one of 36 conservation authorities in Ontario, has leveraged an historic relationship with farmers to serve as a trading facilitator. Dischargers pay a price per credit that is intended to approximately cover the average cost of producing the credit. Payments to SNC are deposited in the Clean Water Fund, which is used, along with other funds, to finance agricultural projects that generate credits. Between 2000 and 2009, 269 phosphorus-reducing projects were established through the watershed's Clean Water Fund, and those measures reduced the amount of phosphorus discharged by an estimated 11,843 kg.

An example of a partial success is Ohio's Greater Miami Watershed Trading Pilot Program, established in 2005 as an incentive mechanism aimed at accelerating water-quality improvements. The program provides regulated point sources with the opportunity to purchase nutrient-reduction credits from agricultural sources under favorable terms, in advance of expected new regulations that would tighten in-stream nutrient criteria.

Enabling this program was an institution that was already managing water among relevant jurisdictions, namely the Water Conservation Subdistrict of the Miami Conservancy District (MCD). The MCD's original mission was flood control, but it now buys pollution-reduction credits from agricultural sources and transfers nutrient-reduction credits to point sources. They also conduct periodic reverse auctions to purchase credits and provide post-award oversight.

Several innovations may have promoted activity in this trading program. The program encourages early participation through trading ratios incentives. Point source dischargers that purchase credits before new, more stringent restrictions are imposed can, with some exceptions, do so at a ratio of 1:1. Once the new restrictions are imposed, the ratio increases to 3:1. To promote credit supply, the Soil and Water Conservation Districts (SWCDs) work with the farmers to develop projects and submit bids. Nine of the 14 SWCDs in the Greater Miami Watershed have been active in the program. The subdistrict obtains funds to purchase credits and operate the program from participating point sources and federal grants.

As of June 30, 2011, nine rounds of project submittals had been completed and 345 agricultural projects had been funded, generating more than one million credits over the life of the projects. Slightly more than $1.5 million will be paid to agricultural producers and $89,000 has been allocated to the SWCDs for assistance and oversight. The caveat that prevents declaring the Greater Miami program an outright success is that it has relied on federal grants to a significant degree to fund nutrient credit purchases. In addition, the expected tightening of water quality standards needed to sustain demand from the point sources has not occurred.

The two North Carolina watersheds that conducted point-point source trading also facilitate a type of point to nonpoint source—and nonpoint to nonpoint source—trading using an administered trading approach. This program works much like a traditional in-lieu fee system in which payments collected from regulated emitters are used to fund BMP and ecological restoration projects. The Ecosystem Enhancement Program (EEP) aims to make cost-effective investments by identifying restoration priorities and rating bids in terms of these goals.

The modest success of this program has been marred by criticism that it failed to fund projects in a timely manner and otherwise mismanaged funds. Clearly, centrally administered funds risk being inefficient due to their institutional structure. Further, the use of fixed fees within an in-lieu fee system risks creating gaps between needed and available funding as costs change. The EEP may have been particularly susceptible to institutional problems since it was largely a new institution created to administer this fund. Other programs have avoided similar problems by leveraging existing fee or payment programs to reduce administrative costs and learning time.

Paying for Performance in the Agricultural Sector

Regulators and buyers in water quality markets are concerned about environmental performance of BMPs while producers wonder how BMP adoption will affect yields or management costs. An innovative program developed by the American Farmland Trust sought to address concerns that could prevent BMP adoption. The "BMP Challenge" protected farmers from the risk of altering their practices through a yield guarantee. In this program, farmers were asked to adopt a management practice but also maintain an area of their field in their usual practices. In the mid-Atlantic region, the Challenge compensated farmers for any reduction in yield due to reducing N application to 15% below university-recommended rates.

The program succeeded in reducing N applications, but a portion of enrolled farmers were paid for yield losses. Yet, the direct program costs of $2.84/lb. N not applied (Wainger and Barber, 2012) was modest. If we apply a common rule of thumb that says that only a third of available nitrogen reaches a water body, the cost rises to a still-competitive $9.50/lb. N not delivered. These calculations are crude but suggest yield guarantee programs have the potential to be cost-effective, particularly if they are only needed initially to encourage adoption. In a follow-up survey, 59% of participants (nationally) said they would lower their nutrient application rates as a result of being involved with the Challenge. Thus, the program was successful at reducing the perception of nutrient reductions as risky in a majority of participants.

Spending in agricultural payment programs is typically backed by little to no evidence that pollution reductions are being achieved. The Florida Ranchlands Environmental Services Project (FRESP) sought to make more informed decisions and drive innovation by using the simple innovation of linking payments to measured performance. To achieve this end, it had to overcome multiple institutional, social, and technical barriers.

The payment for environmental services (PES) pilot project was initiated through a partnership between The World Wildlife Fund and a regional government agency (South Florida Water Management District) which jointly recognized that existing approaches to water quality management were not delivering desired water quality outcomes in Lake Okeechobee and downstream estuaries in Florida (Lynch and Shabman, 2011). The PES buyer was the state agency and the sellers were ranchers who were willing to modify the structure and management of existing water control devices. Modifications allowed higher water retention on fields and wetlands, and prevented phosphorus runoff.

Multiple innovations made this program possible. The program differed from similar efforts to control agricultural runoff because it provided flexibility to cattle ranchers to choose the level of action that was compatible with their site and operational goals. Most importantly, because the state was paying for outcomes rather than practices, ranchers had incentives to effectively implement the approach and to modify it to enhance performance.

From an institutional perspective, many innovations were needed. The local government shifted part of its resources to a payment program rather than continue to focus only on large, water retention structures. To minimize the transactions costs, the FRESP team created several streamlined procedures—such as development of a General Permit from the U.S. Corps of Engineers— and joint application procedures between state and federal agencies.

Moving Forward

Market-based water quality trading thus far appears to have been oversold as a way to cost-effectively manage water pollution from agricultural sources. Point source to point source trades show the potential for trading to reduce costs, but of all the successful WQT case studies that we highlight, only two have generated more than a handful of trades that involved reductions from the agricultural sector. These came about when local authorities developing the South Nation River and Greater Miami programs devoted considerable effort to develop a community of interest and acceptance for trading. They promoted acceptance by engaging traditional institutions that were trusted by farmers to facilitate trading and devised exchange mechanisms that farmers were willing to use. External funding also played a major role in one case.

Where we see the most success in lowering costs is where state programs have freed themselves from the tyranny of achieving perfect equivalence between point and nonpoint source reductions by using some form of administered trading. These programs, mostly in-lieu fee systems, offer the potential for benefits in terms of improved cost-effectiveness of payment through reverse auction approaches and verification of implementation and performance. However, centralized programs also run the risk of building in bureaucratic inefficiencies. Programs benefit from measuring performance where possible or by adopting realistic, feasible-to-administer, and "good enough" performance metrics to cost-effectively target payments, document performance, and begin to realize some of the efficiencies of engaging the agricultural sector in achieving water quality goals.

The pay-for-performance approach to agricultural nonpoint pollution control seems especially promising for innovation at state and local scales because, unlike trading with point sources, it allows program development outside of the confines of the CWA's emissions permitting structure. Emerging point-nonpoint trading programs are being developed on the basis of early forms of air emissions trading programs that required all sources to be regulated and emissions to be metered. Fitting this model to the unregulated and diffuse emissions of agriculture is like putting a round peg into a square hole. Thus, local innovators are making progress and providing lessons by creating and tailoring programs to the challenges and opportunities of agriculture.

For More Information

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