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Environmental Fees

Can Incentives Help Solve the Chesapeake's Nutrient Pollution Problems?

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RESOURCES FOR THE FUTURE

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Abstract

Nutrient pollution continues to be one of the central problems facing the Chesapeake Bay. Environmental service fees, like the sewer surcharge recently signed by Maryland Governor Erlich, can enhance the cost effectiveness of pollution control efforts as well as finance infrastructure investments. This paper looks at ways environmental fees, service charges, and taxes have been used to create incentives to reduce pollution from urban and rural sources, increase cost effectiveness of pollution control and promote innovation in pollution control strategies. We provide an overview of the economic theory of how environmental service fees should be structured. We then look at three examples of how fees have been used to improve water quality: sewer surcharges, a nutrient fee for farms in the Netherlands, and a surcharge on property taxes in the Florida Everglades. We end by discussing the lessons these experiences hold for water resource management in the Chesapeake Bay.

Key Words: Environmental taxes, environmental law, water, water pollution

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Contents

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Introduction

Nutrient pollution continues to be one of the central problems facing the Chesapeake Bay. Elevated nitrogen and phosphorus levels remain the primary cause of poor water quality and aquatic habitat loss in the bay. In 2003, the Chesapeake Bay Program set a goal of reducing nitrogen going into the bay to 175 million pounds per year and phosphorus to 12.8 million pounds per year by 2010. This is a substantial challenge given that between 1985 and 2000, nitrogen loads entering the bay were reduced only from 358 to 305 million pounds per year. With the help of a very effective ban on phosphorus detergents in the bay watershed during the late 1980s, phosphorus fell from 28.7 million pounds per year in 1985 to 20.7 million pounds per year in 2000 (Chesapeake Bay Program 2005). But similarly inexpensive and easy technological fixes for the additional reduction of phosphorus do not appear to be on the horizon.

Leading proposals for meeting these goals include upgrading the watershed's sewage treatment plants to include nutrient removal systems and a continued commitment to best management practices for non-point sources. The total estimated cost for meeting the 2010 goals is $19 billion. The cost estimate for upgrading all watershed sewage treatment plants alone is roughly $4.4 billion over a 10-year period (Chesapeake Bay Foundation 2003).

A central question on everyone's mind is how to finance this effort. The Chesapeake Bay Program Executive Committee is committed to seeking more federal funding. The Chesapeake Bay Foundation has called for an interstate compact forming a watershed authority with bonding authority. Maryland's Governor Erlich recently signed legislation that imposes $30-a-year sewer surcharge on Maryland homeowners and a volume-based sewer surcharge on businesses and multi-unit dwellings (Comptroller of Maryland 2005). Even with these actions and proposals, there remains concern that the costs of this effort are prohibitive (Blakenship 2003). A question that has to be brought to the fore of the discussion is how to make control of nutrient pollution more cost effective.

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Environmental service fees, like the sewer surcharge signed by Governor Erlich, can enhance the cost effectiveness of pollution control efforts, as well as finance infrastructure investments. But they must be designed explicitly to create incentives for individuals and businesses to adopt more cost-effective approaches to reducing the bay's nutrient loads. Fees help people recognize that the nutrient processing capacity of the bay is a scarce resource and creates reasons for them to treat it as such. There is growing recognition that the use of economic incentives in environmental management programs can help increase the cost effectiveness of pollution control. They also can help create a management system that adjusts automatically as conditions change—for example as population increases.

This paper looks at ways that environmental fees, service charges, and taxes have been used to create incentives to reduce pollution from urban and rural sources, increase the cost effectiveness of pollution control, and promote innovation in pollution control strategies. We start with an overview of what has been learned about the ways that environmental service fees function and how they should be structured. We then look at three examples of how fees have been used to improve water quality: sewer surcharges, a nutrient load fee for farms in the Netherlands, and an agricultural privilege surcharge on property taxes in the Florida Everglades. We conclude with consideration of what lessons these experiences hold for the public and water resource managers in the Chesapeake Bay.

What Are Environmental Service Fees?

Environmental service fees, pollution charges, and environmental taxes are all payments made for emitting pollution. They can be seen as a charge for the services provided by environmental resources. A sewage surcharge tied to biochemical oxygen demand (BOD) content, for example, represents a payment for use of the waterway as a disposal site for material that creates BOD. As long as the emitter is concerned about controlling costs, the prospect of having to pay such a fee can provide an incentive to search for more cost effective control options. As long as the fee is higher than the cost of controlling emissions, the fee also creates an incentive to prevent release of polluting emissions. The emitter would most likely control those emissions and pay tax on the remaining units of emission released into the environment.

Why Use Fees to Enhance Cost-Effectiveness?

From an economic perspective, an ideal, or socially optimal, tax or standard is one that reduces pollution to the level where the social benefits from reducing pollution further (including ecological benefits) just equals the added cost of doing so. This reflects technological and biological limits to what can be done and the fact that taking care of the environment has to compete for society's resources with other activities such as schools, roads, and housing. In this ideal world, every polluter would have an individually tailored tax (or standard) set at the point where the polluter's cost of further control just equals the social benefits of their reducing one more unit of pollution. This tax (or standard) would be unique for each polluter because available and appropriate technologies, management capabilities, environmental impact of effluent, and other factors' cost effectiveness differs in important respects from firm to firm. As a result, costs and benefits of control are unique to each facility. With knowledge of the costs and benefits of pollution control, a regulator can simply require firms to engage in the efficient level of control. The efficient level of control can be directly mandated, such as via a permit that prohibits effluents exceeding specific firm-level standards. Alternatively, an effluent tax can be applied, with increases in the rate if control is inadequate and reductions if it is excessive. In theory, both taxes and standards can generate this "first-best" outcome.

Unfortunately, the equivalence of the two instruments and their ability to generate the efficient outcome break down in the face of real-world constraints (Boyd 2003). Perhaps the most important of these constraints is that regulators have limited information regarding both firm-specific control costs and the benefits arising from a firm's effluent reductions. In practice, we cannot expect a regulator to easily determine these differences. For example, it is very difficult for a regulatory agency to measure or even infer firms' control costs. It is also difficult to determine the social benefits of controls, since the benefits often are diffuse and typically are not easily observable, much less easily measured in monetary terms. When this informational constraint is taken into account, the goals of policy change.

A more pragmatic question motivates most analysis of water quality policy: namely, what is the best way to achieve a given level of ambient water quality in a water body? This is a "second-best" policy question because it abandons the goal of finding the most socially efficient outcome. States must establish, with federal oversight, surface water quality standards. Achieving ambient standards is a more limited and realistic goal. Taking these standards as given, and ignoring the question of whether the standards themselves are efficient, we now turn to ways in which environmental quality goals can be met at minimum cost.

Ideally, a regulator would still tailor taxes or quantity standards on the basis of facilities' control costs, so that facilities reduce pollution by different amounts. But usually this is impractical. In the words of Kneese and Schultze:

> In practice, the need to tailor limits to each firm, and to consider for each the cost and effectiveness of all of the available alternatives for reducing

> pollution, would be an impossible task. There are up to 55,000 major sources of industrial water pollution alone. A regulatory agency cannot know the technological opportunities, the alternative raw materials, and the kinds of products available for every firm in every industry. (1975, p. 88)

Targeted fees or control standards tailored to the control costs and benefits of individual facilities—while efficient—are impractical from a real-world regulatory standpoint.

If taxes and standards cannot be targeted, what is the alternative? The alternative is uniform taxes and standards that apply to a range of facilities. Under the charges approach, a uniform tax is applied to a set of polluters, the tax level being set high enough to induce aggregate effluent reductions adequate to meet an ambient water quality standard.[1] Under the uniform treatment approach, all firms are required to reduce emissions by an equal percentage or amount, sufficient to meet an ambient standard. The uniform treatment policy roughly corresponds to the water quality permit system currently in place in the United States. When these two more practical policies are compared, taxes appear to be significantly preferable.

Taxes are preferable because they are flexible in a way that mandated reductions are not. With a tax system, not all facilities have to reduce pollution by the same amount. Because facilities differ in their control costs, this flexibility is important. Under a tax, high-control-cost firms abate less and low-control-cost firms abate more. In aggregate, this means that a given level of ambient water quality can be achieved more cheaply than if all firms abate the same amount.

As an example, assume that two facilities contribute to water pollution in a lake and that for the lake's water quality to meet state standards, six units of pollution need to be eliminated. If the facilities' control costs are as described in Table 1, we can easily compare the tax and uniform treatment policies. A uniform treatment policy requires each firm to abate three units of pollution. The aggregate cost of complying with the uniform treatment policy is therefore $180: $60 for firm 1 and $120 for firm 2. Now consider an effluent tax equal to $45. With the tax, the two firms do not make the same abatement decisions. At that price, firm 1 abates four units (because the marginal abatement cost of those units is less than the pollution price) and firm 2 abates two units (for the same reason). In total, six units are abated, which meets the ambient

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[1] A detailed description of this approach is provided in Baumol and Oates (1975).

goal. But note that the total cost of abatement, $160, is now lower.[2] This savings is the benefit of a tax mechanism. Also note that the regulator need know nothing about the firms' respective control costs to achieve this result. The tax can simply be iteratively raised (or lowered) until the water quality goal is met. It is in this sense that "effluent fees ... tend to elicit the proper responses even in the absence of an omniscient regulatory agency" (Kneese and Schultze 1975, p. 88).

Table 1. Tax Versus Uniform Treatment Policies

Units of pollution eliminated	Facility 1's marginal control cost	Facility 1's total control cost	Facility 2's marginal control cost	Facility 2's total control cost
1	10	10	20	20
2	20	30	40	60
3	30	60	60	120
4	40	100	80	200
5	50	150	100	300
6	60	210	120	420

Taxes are particularly desirable when pollution control costs vary across sources and are difficult for regulators to measure. One of the reasons that water effluent taxes are embraced by economists is that pollution control costs vary by polluter, sources of water pollution are varied, and are difficult to assess at the individual polluter level. In principle, taxes overcome this problem. With a tax or fee, high-control-cost firms abate less and low-control-cost firms abate more. Often firms with high-control costs for the next unit of pollution reduction are those who are already doing a lot to clean up pollution. Those with lower-control costs are often those who have done less. There is often talk in environmental policy circles about going after the low-hanging fruit. Low-control-cost polluters are "low hanging fruit," and properly designed environmental service fees go after them first.

[2] Firm 1 abates 4 units at a total cost of $100 and firm 2 abates 2 units at a total cost of $60.

In the long run, economic incentive and command-and-control approaches to pollution abatement are likely to achieve different results. In theory, economic incentives should produce greater dynamic efficiency; that is, they should encourage more technological and managerial innovation than command-and-control regulation. Firms can avoid paying the fee by preventing effluent. This gives them an incentive to try to find or develop technology or management practices that control pollution at a lower cost than the fee. This would be true of both tax and cap-and-trade market systems now used to control air pollution. However, unlike cap-and-trade markets, taxes do not have a built-in incentive for the system to adjust to growth. Under cap-and-trade, permits become more expensive as they become scarcer with growth. This creates incentives for load reduction that maintain environmental quality in the face of growth. Taxes can be raised to reflect additional treatment or environmental damage costs but do not automatically adjust to economic growth.

Given the advantages of taxes, it is noteworthy that effluent taxes have not been widely adopted. The reasons lie both in politics and in economics. Taxes have distributional characteristics that are far different from command-and-control regulations. Taxes shift the cost of pollution to polluters. With standards, polluters pay only the cost of meeting the standard, not the cost to the environment and society of the remaining pollution. Taxes require polluters to both pay control costs and taxes on emissions that are not controlled. This is a significant distributional difference that may explain the political demise of effluent tax policies. With either standards or taxes, businesses may be able to pass the burden on to their customers. With taxes, consumers would face something closer to the full social and environmental cost of their consumption than they would with standards. As socially desirable as this may be, it is not necessarily politically popular. Standards also can deter the entry of new firms and facilities if there are large fixed capital or overhead costs associated with meeting the standards or if new sources are held to higher standards than old sources, as they often are. From the standpoint of existing firms, this is an advantage.

Environmentalists have resisted the use of charges. The most frequently heard criticism is that use of fees allows firms to buy their way out of reducing pollution. In fact, as just discussed, fees force firms and consumers to face more of the full environmental cost of their actions than do standards. There is also a somewhat misplaced ethical concern that fees are not fair because not all firms have to abate the same amount. But uniform taxes are fair in the sense that all firms have to pay the same amount per unit of effluent not controlled. Financially, they are facing the same burden per unit of pollution.

Types of Fees, Charges, and Taxes in Environmental Policy

There are several basic questions that should be considered in designing the fee system. Table 2 details various types of environmental fees. Fees work best if they account for natural variation in environmental impact and cost of control. Does the impact on the environment vary by region or by industry? If so, then consideration should be given to varying the structure of the fee on that basis. For example, if non-point sources are a larger contributor to nutrient load than point sources, the environmental fee system should focus on the non-point sources. Similarly, if nutrients discharged from certain geographic areas have a greater environmental impact than those discharged in other areas, environmental fees could be structured to reflect this fact. For example, a non-point source fee that varied by agricultural conservancy district could capture this geographical variation in the contribution of sources to environmental damage. Costs of control also may vary by the type of source. For example, if it was less expensive to reduce a pound of phosphorus from urban landscape applications than from agricultural applications, a fee system could be designed that takes this into account.

One basic question that must be considered in designing an environmental tax system is what is going to be taxed. A basic principle is that it is best to tax something as closely tied to the environmental damage as is administratively feasible. Fees can be based on environmental damages, on pollution discharge, on fixed or variable inputs to production, or on consumer products or household activities.

Ideally the fee would be based on the amount of damage caused to the environment. As discussed above, this generally is not possible because the damage caused by any individual or firm usually is not observable or only at very high administrative costs. Two basic alternatives have been suggested. The first basic approach is to base a tax (or subsidy) on something closely correlated to the actual damage caused by the individual polluter. One way this can be done is to tax the amount of effluent an individual polluter discharges to the waterway. An example follows looking at such a tax system in the Florida Everglades Agricultural Area. With point sources, the cost of monitoring and observing effluent discharge may be low enough to make it feasible. Sewer discharge fees are an example of this approach. In general, however enforcement costs will be too high to make this approach feasible for non-point sources. In a similar vein, a proxy for actual observed discharge can be taxed. For example, a fee might be based on expected discharge calculated using standard approaches like the universal soil loss equation. Moving further from the actual damage, a tax could be levied on the polluting input, for example nitrogen. The cases below look at a sophisticated use of nutrient taxes to address non-point source pollution in the Netherlands. Moving even further from actual damage, a fee (or alternatively a subsidy) could be based on management practices.

The second basic approach is to base the tax on ambient quality rather than individual pollution. Cooter and Porat (2007) propose such a tax. In this tax structure, each discharger in a water basin would be taxed for the amount by which damage to the water resource exceeds a socially desirable level of damage. They show that this structure, as opposed to a tax based on the full damage to the water resource, results in corrective incentives for both the intensity and level of polluting activity. For example in the case of farming, the structure of the tax creates the right incentive both for number of acres farmed and pollution control effort per acre farmed to achieve the socially desirable water quality goals. The basin-wide tax credit in Florida's Agricultural Privilege Tax is similar to this theoretical proposal.

Table 2. Types of Environmental Fees

Instrument	Description	Examples
Pollution fee	Charge based on the quantity of pollutants released into the environment	• Air emissions permit fees in California, Maine, other states • Effluent permit fees in Louisiana, California, Wisconsin, other states • Solid waste disposal fees
User fee	Fee for the use of resources	• Water use fees • Congestion or time-based highway tolls • Sewer surcharges • Grazing fees • State advance disposal fees on tires, motor oil, packaging, other goods
Product charge	Charge on a product believed to have environmentally harmful effects	• Gas guzzler tax • CFC tax • Carbon tax • State taxes on fertilizers • Pesticide tax • Virgin material tax
Other fees on environmentally damaging activities	Various mechanisms	• Wetland development fees • Stormwater runoff fees

Source: Based on U.S. EPA, The United States Experience with Economic Incentives for Protecting the Environment (Table 4-1) (January 2001, EPA-240-R-01-001).

Using Environmental Fees and Taxes to Manage Water Quality

In practice, pollution charges, fees, and taxes often do not fit neatly into theoretical categories. They often are used in conjunction with other instruments and are designed primarily for revenue generation rather than for their capacity to improve the effectiveness of pollution control measures. Often it is difficult to tease out the contribution of the fee or tax from other factors affecting polluters' behavior. In many cases, this has not been done. Nevertheless, it is instructive to look at a few examples of how fees or taxes actually have been used in water quality management. In this section, I look at three such cases: the use of sewer surcharges, like those recommended by Governor Erlich, to control nutrient pollution from animal waste; the use of an innovative property tax tied to phosphorus discharges in the Everglades Agricultural Area in Florida; and the use of an input tax in conjunction with a nutrient balance accounting system to reduce nitrogen run-off from farms in the Netherlands.

Sewer Surcharges and Water Rates

Publicly owned treatment works (POTWs) in the Chesapeake Bay watershed typically receive wastewater both from households and industrial sources. Although agricultural non-point sources contribute the lions' share of nutrients to the bay, POTWs also are a major source of nitrogen in the bay. Governor Erlich's office estimates that when fully implemented, enhanced nutrient-removal processes in Maryland's POTWs could reduce nitrogen loads in the bay by 7.5 million pounds per year, or nearly one-third of Maryland's commitment to nutrient reduction under the 2000 multi-state Chesapeake Bay agreement (Environment Reporter 2004). Under a new Maryland law enacted in the spring of 2004, households will pay an extra $2.50 per month on their sewer bills (Comptroller of Maryland 2005). Businesses will pay a surcharge of $2.50 per 250 gallons per day of wastewater discharged.

The sole purpose of this surcharge is to finance POTW upgrades (Environment Reporter 2004). This is not uncommon. In general, sewer discharge fees are imposed to raise revenue to cover the costs of providing sewer treatment services rather than to create an incentive for pollution reduction or to allocate a scarce good, treatment services, among competing interests (EPA 2001). There is evidence, however, that properly structured, sewage surcharges do provide incentives for discharges to reduce their waste streams.

During the 1970s and 1980s, POTWs built extensive capacity in response to federal capital subsidies (CBO 1985). POTWs in the Chesapeake watershed were among these. For example, the Washington Suburban Sanitary Commission (which serves Montgomery County and Prince George's County, Maryland) doubled its capacity in the late 1970s using grants from the federal program. Twenty-five years later, it still has excess capacity that dates to this period.

As new effluent guidelines tighten required controls on direct discharge by point sources, the excess capacity in POTWs resulting from this early grant program provides an attractive alternative for industrial sources to treating their own waste. This has been particularly true for plants, such as dairy or poultry processing plants, that generate organic wastes that are easily handled by POTWs (Harrington 2003). Excess capacity also makes it attractive for POTWs to take industrial wastes, since even low fees are generally higher than short-run marginal operating costs (Harrington 2003). For example, in the late 1980s, Virginia issued new regulations limiting phosphorus discharges into the bay from point sources to 2.0 mg/l. Smithfield Foods found it very difficult to meet this standard in two plants it was operating in Isle of Wight County. Through a litigation settlement, Smithfield agreed to pipe wastewater from these plants 20 miles to a POTW operated by Hampton Roads Sanitary District, which had excess capacity. New industrial plants also have been increasingly choosing indirect discharge over direct discharge over the past 25 years (Harrington 2003).

There are multiple reasons for industrial sources to prefer indirect to direct discharge. Permit requirements for direct dischargers frequently are more stringent than for indirect dischargers. Direct discharge also is more visible and more subject to public scrutiny and publicity than indirect discharge (and has greater potential to lead to legal liability). In 1995, the Environmental Protection Agency reported that nationwide fewer than 3,500 major dischargers held National Pollution Discharge Elimination System (NPDES) permits and discharged directly into receiving waters, while more than 35,000 "significant industrial users" discharged to POTWs (U.S. EPA 1995, cited in Harrington 2003).

To set local limits for pollutant discharge from industries, POTWs have to estimate, pollutant by pollutant, the waste load the plant can receive safely from non-household sectors. The NPDES permit generally will set allowable effluent discharge for the POTW by pollutant. Using knowledge of the plants' removal efficiency, the POTW can estimate the total waste stream it can accept by pollutant. The POTW can allocate to industrial users this stream net of discharges from household and "uncontrollable" sources, such as septic tank cleaners or waste haulers. Generally, POTWs allocate this waste stream uniformly among industrial sources. EPA guidance and regulations do not require this and do not rule out more efficient methods of allocation such as a cap-and-trade approach. Such an approach is used by the POTW in Passaic, New Jersey (Harrington 2003).

Harrington (2003) found evidence suggesting that sewer surcharges may be having some impact on nutrient discharge. Discussions with dairy plant operators “suggest that pretreatment of dairy wastes is rarely cost effective when compared to sending the untreated waste to the POTW and paying the sewer surcharge” (Harrington 2003, p. 28). However, reduction of the waste load does appear to be affected by the sewer surcharges. “Dairy operators report that the presence of waste surcharges has caused them to take a closer look at plant operations, and, as a result, they have found numerous opportunities for reducing waste loads by making changes to product specification, production process, product sequencing in multi-product operation, and production run lengths (Harrington 2003).” As with any cost savings associated with a change in production process or technological adoption, there is a learning curve. Accompanying the imposition of a sewer surcharge with educational outreach or the creation of discussion forums for producers to exchange information on waste management could be expected to increase the industries’ responsiveness to sewer discharges.

What needs to be done? First, research. There is a marked absence of empirical research on the responsiveness of industries to sewer surcharges. To begin to use sewer surcharges as a means of reducing waste load or increasing the cost effectiveness of treatment, there is need for a better understanding of treatment costs and load reduction options in affected industries. Second, more research. Harrington (2003) argues that there may be an incompatibility between the use of sewer surcharges on indirect dischargers by the POTW and the POTW facing a non-transferable discharge limit. For example, a natural use of a fee would be to efficiently restrict load from indirect dischargers when a POTW is faced with increased demand from residential development. Harrington suggests that uncertainty over response might lead the POTW away from heavy reliance on fees to prevent their discharge limits from being exceeded.

The use of water rate structures in drought-prone areas provides some insight into how water rate structures might be used to reduce nutrient run-off. Urban water use, particularly for landscaping, is closely related to discharge load. Experience with the use of rate structures to induce more cost effective conservation in water service provision might hold some lessons for their use to induce more cost effective compliance with discharge limits.

Unlike industrial sewer rates, residential rates typically are based solely on volume of water used. Therefore, they provide a less direct incentive for pollution reduction. However, it may be possible to take advantage of differences in summer and winter water use to create incentives for reduction of nutrient loads from residential sources. The ability of any tax to affect behavior depends on the responsiveness of demand to changes in price. Residential demand follows different patterns of responsiveness than industrial demand. Typically, winter residential demand is relatively unresponsive to price in the short run. This is because winter water use reflects basic sanitation needs and is most influenced by plumbing and appliances. Over a longer period of time, sustained rate differentials can affect household-level adoption of appliances and fixtures that use less water. In contrast, summer demand reflects a wider range of uses, such as sanitation, lawn and garden maintenance, car washing, and swimming pools. Some of these uses contribute to bay nutrient loads, and some do not. To the extent that summer water use is more responsive to changes in price, a graduated water/sewer tariff that increases with volume of water used could provide some impact on use of water on lawns and gardens, which indirectly could reduce nutrient loads to the bay. This is a very blunt instrument, however, since it is water discharge into storm sewers, not actual water use, that creates the added nutrient load in the summer.

Florida Everglades Agricultural Privilege Fee

The South Florida Water Management District has used its property tax system to create something akin to a sewer discharge surcharge in the Everglades Agricultural Area. This effort is part of a comprehensive program to reduce phosphorus loads flowing into the Florida Everglades. The Everglades Agricultural Area (EAA) is a 500,000-acre area of rich organic soils located between Lake Okeechobee and the Everglades National Park. The EAA basin is one of Florida's most important agricultural regions. Three-quarters of the EAA basin is cropland. Primary crops include cane sugar and vegetable and sod production. The area supplies 40 percent of the U.S. winter vegetable crop and 25 percent of U.S. sugar consumption.

Like the Chesapeake Bay, the Everglades are threatened by elevated phosphorus levels. In the late 1980s, the federal government sued the South Florida Water Management District and the State of Florida for allegedly not enforcing Florida water standards intended to protect ecosystems in Everglades National Park. In 1998, the Florida Legislature passed the Everglades Forever Act, mandating an integrated program of regulation, taxation, education, and research to implement a settlement agreement to reduce phosphorus loads by 25 percent (Florida Senate 1994). Under the act, the first line of defense was mandated adoption of best management practices by farmers in the EAA. The second line of defense was construction of Storm Water Treatment Areas (SWTAs), large artificial wetlands designed to remove discharged phosphorus before it reaches the Everglades. Construction of the SWTAs was financed through an "Agricultural Privilege Tax" surcharge on EAA farm property taxes. But the tax is structured to provide incentives for pollution reduction as well as financing SWTAs.

The hydrology of the EAA facilitates use of incentives to reduce agricultural pollution. The EAA was created from wetlands in the 1950s when the Army Corps of Engineers (ACE) built a series of levies to separate the EAA from the Everglades. Roughly 100 miles of primary canals were built between Lake Okeechobee and the Everglades that enhance both drainage and provide irrigation. Farmland was developed in the EAA by farmers constructing a system of 6,000 miles of interior secondary and tertiary canals to “reclaim” land. All water draining from the EAA passes through five pumping stations that pump water from the EAA into the Everglades. Two pumping stations pump irrigation water from Lake Okeechobee into the EAA during dry periods. Each of the roughly 300 farms in the EAA has a point discharge where water is pumped into the larger canal system. As a result, both the farmer and the SFWMD can monitor discharge from each farm essentially as one would monitor point sources.

The 1994 Everglades Forever Act mandated two types of monitoring: EAA basin-level monitoring by the district and individual sub-basin or farm-level monitoring by the owner/operator of private water control structures discharging within the EAA basin (South Florida Water Management District 2003). Total phosphorus load samples are collected at 27 locations from district structures. Water passing through the district’s basin-level structures comes from both agricultural and urban runoff. Total phosphorus loads attributable to agricultural lands in the EAA have shown a declining trend since implementation of best management practices in 1992. The EAA basin has achieved the annual 25 percent reduction goal in all years since compliance was first required in 1996 (Everglades BMP Program Annual Report 2003).

Under the Everglades Forever Act, farms cannot discharge water into the canals without a wastewater discharge permit. To obtain and maintain a permit, a farm must develop and implement a best management practices plan to reduce phosphorus discharge. These plans most commonly focus on reduction of soil erosion, precision application of phosphorus fertilizer, and refined water management practices to manage discharge during storm events. The permits are written to ensure that the basin meets the phosphorus reduction standard. If the basin as a whole fails to meet the standard, the permits allow the SFWMD to target farms that discharge more than average phosphorus loads. This has never been necessary. Since implementation, the basin has averaged an almost 50 percent load reduction, well in excess of the required 25 percent.

While we are aware of no research directly examining the impact of the tax’s incentive, SFWMD managers believe that part of the reason for the success of the program has been the incentive provided by the Agricultural Privilege Tax. The Agricultural Privilege Tax, is a per acre tax on farmland for conducting agricultural trade in the EAA; that is, a tax on fixed capital inputs. Like Maryland's sewer surcharge fees, the tax revenue is used to finance construction of the SWTAs, a wastewater treatment facility. But unlike the sewer surcharges, the Agricultural Privilege Tax is designed explicitly to provide incentives to reduce phosphorus discharges. Farms can reduce the tax substantially by implementing effective best management practices. The tax rate schedule for the Agricultural Privilege Tax was designed to increase over time, as noted in Table 3.

Table 3. Agricultural Privilege Tax Rate Schedule

Period	Per Acre Tax
1994–1997	$24.89
1998–2001	$27.00
2002–2005	$31.00
2006–2013	$35.00
2014 and thereafter	$10.00

EAA agricultural landowners can reduce their tax rate to the original $24.89 per acre rate by earning credits through effective implementation of best management practices for phosphorus controls. Both area-wide and individual incentive credits can be earned. Credits cannot be used to reduce the tax below a floor of $24.89 per acre. Excess credits can be carried forward and applied in future years. All credits expire in 2013. Individual credits can be earned for reductions in phosphorus discharges from structures that serve the individual's property. The area-wide credit is earned only if phosphorus load reduction exceeds 25 percent for the whole EAA. Irregardless of basin performance, landowners who maintain annual phosphorus concentration levels of 50 ppb in water discharged from their land pay the minimum rate of $24.89 per acre. This does not create a credit that can be carried forward but if maintained on a continuing basis, ensures the landowner of a minimum tax rate irregardless of the actions of other landholders in the basin. Potentially, EAA farmers could save $10 per acre per year or basin-wide a total of $5 million per year. Current annual aggregate gross agricultural revenue in the EAA is roughly $1 billion annually. So the tax savings potentially are in the neighborhood of .5 percent of aggregate gross revenue.[3]

Since the program was implemented in 1994, there has been a total decrease in phosphorus load of 1,100 tons. Annual phosphorus loads entering the everglades from the EAA have decreased from 300 tons per year before 1994 to less than 100 tons per year in 2003. It is worth noting that in the Florida Everglades Agricultural Area program, no one mechanism was relied on alone. Best management practices were mandatory. Agricultural wastewater treatment is used. Tax incentives were used to create an incentive for cost-effective compliance with best management practices. And research and extension education efforts were funded as an integral part of the management plan. An ongoing research program has helped refine best management practices and verify their effectiveness in achieving water quality goals (Everglades BMP Program Annual Report 2003).

Probably no one factor is fully responsible for the change. The program met great resistance when it was first adopted. Strong support for research into improving both the environmental and cost effectiveness of best management practices has been a major part of the effort and has helped. Education efforts about the impact of phosphorus on the Everglades and management alternatives has helped foster and reinforce a strong culture of pride in good environmental management. Some of the improved management practices, like precision fertilizer application, have shown cost savings. The potential for regulatory action under the permits has provided a stick. And the economic incentive of being able to reduce the discharge tax rate, the carrot, has reported made a difference as well.

Dutch Agricultural Minerals Tax

The Netherlands directly taxes nutrient effluent as a way of creating a strong incentive for intensive nutrient management. The Netherlands has the highest density of livestock population in Europe, with an average national livestock density of 3.9 livestock units per hectare (Dutch Ministry of Agriculture 2001). Like the Chesapeake Bay watershed, the Netherlands is a net importer of feed (and therefore nitrogen and phosphorus). The resulting waste contributes to

[3] We are aware of no cases challenging the tax in a way that would affect its viability. The only case we are aware of sought to limit the geographical extent of applicability of the tax. In the late 1990s, the Florida Supreme Court upheld a ruling against two ranch owners who claimed that they shouldn't be required to pay the agricultural privilege tax because their land doesn't drain into the Everglades (Barley v. So. Florida Water Management District, No. SC00-1998 (Sup. Ct. Fla. Apr. 11, 2002)).

high nitrate levels in Dutch groundwater, as well as nutrient pollution in the North Sea. Agriculture is responsible for more than 40 percent of phosphate and 70 percent of nitrogen load in Dutch waters (Dutch Ministry of Agriculture 2001).

As with the Chesapeake Bay states, nutrient management policy in the Netherlands is driven in part by external forces. A 1991 European Union nitrate directive sets a nitrate standard for groundwater of 50 mg of nitrate per liter of groundwater. In 1985, the Netherlands entered a 1985 North Sea treaty under which it agreed to reduce nitrogen and phosphate discharges into the North Sea by 50 percent.

The centerpiece of the current Dutch nutrient pollution policy is a farm-level nutrient accounting system enforced by a tax on annual net balance of nutrients in excess of a levy-free minimum that went into affect in 1998. This is accompanied by a cap on manure application per hectare coupled with a system of manure trading started in 2002 (Dutch Ministry of Agriculture 2001). The principle behind the Dutch Mineral Accounting System (MINAS) is that farmers record the amount of nitrogen and phosphorus that comes onto the farm and the amount that leaves it. Nitrogen and phosphorus may come onto the farm in many forms, including feed, livestock, fodder, manure, and chemical fertilizer. It leaves the farm in the form of things such as livestock, forage, manure, grain, milk, and eggs. The difference is the farm's mineral loss or surplus. The MINAS program sets a loss standard that represents uncontrollable nutrient loss (Dutch Ministry of Agriculture 2001). The farmer is charged a levy on nitrogen and phosphorus surplus in excess of this loss standard. The farmer must account for the nitrogen and phosphorus content of the inputs and outputs. The MINAS phosphorus tax currently is set at 9 Euros per kilogram of excess phosphate. Excess nitrogen is taxed at a rate of 2.3 Euros per kilogram (Dutch Ministry of Agriculture 2001). The taxes are viewed as substantial enough to motivate changed behavior.

Like the U.S. income tax system, the Dutch mineral tax relies on self-reporting supported by reporting of basic data from off-farm sources. In the case of the U.S. income tax, employers, banks, and brokerage firms are required to file reports of income with the Internal Revenue Service. In the Netherlands, feed suppliers are required to send annual feed and feed supplement purchase reports to the Tax Office of the Dutch Ministry of Agriculture. MINAS returns must be accompanied by documentation, such as receipts for livestock and manure shipments. Farmers must supply laboratory tests of nutrient content in manure. This seems rather burdensome, although one could imagine a system in which a farmer had the option of adopting either default assumptions about nutrient content of feed, forage, or manure or providing laboratory testing of samples. This would again provide flexibility and incentives for cost effectiveness in management decisions. The Ministry of Agriculture carries out audits of farms and other agricultural establishments with reporting requirements.

Representatives of Dutch farm organizations maintain that the preparation of the annual mineral account is difficult and that most farmers hire a consultant to assist them in preparing the report. The burden appears to be comparable to that of filing the farm income tax and preparing careful feed rations and nutrient management plans. The Dutch extension service is providing assistance and training on working with the accounting system. It is too soon to report to what extent and how quickly this process can be streamlined through computerized aids.

The MINAS accounting system is more than a tax reporting system. It is fundamentally an intensive nutrient management system. The goal is to provide farmers with the information they need to have a detailed picture of nutrient flows on their farm and the flexibility to reduce them cost effectively. A fundamental question is whether the administrative cost of maintaining such detailed record keeping will be justified by the combination of improvements in water quality and cost savings to farmers from more careful management. Given the density of population and agriculture in the Netherlands and its high water table, it is likely that a higher administrative cost may be justifiable than in the Chesapeake Bay. Despite challenges to the earlier restrictions on livestock numbers, the Netherlands is also typically more accepting of environmental and land use restrictions than the United States.

The European Union (EU) Commission challenged MINAS in the European Court of Justice on the grounds that it was inconsistent with the 1991 EU Nitrates Directive, of which the Netherlands is a party. The EU Nitrates Directive takes a regulatory rather than an incentive-based approached to nutrient pollution control. The EU Commission criticized MINAS for lack of application limits for animal manure and fertilizer. The European Court of Justice ruled that MINAS was an inappropriate mechanism for implementing the EU Nitrates Directive. In 2006, MINAS was replaced by a complex system of limits on the use of animal manure and fertilizers. Even without the opposition of the EU Commission and the Court of Justice ruling, it is not clear that MINAS would have remained in effect (OECD 2005).

Evaluations of MINAS show that it was useful in decreasing nitrogen and phosphorus surpluses in dairy farming, but not in hog, poultry, or row crop farming. Dairy farms account for more than 60 percent of the agricultural land area of the Netherlands. This land base provided a broader range of technical options for manure management than available to Dutch hog and poultry producers, who have much more land-intensive operations. Much of the opposition to MINAS within Dutch agriculture came from hog and poultry producers. Most row crop farming had nitrogen and phosphorus surplus levels that were below the levy-free surplus level and therefore MINAS generally did not bind these activities. The European Court found that the complexity of the accounting system, in particular the difficulty in measuring nutrient content in manures, produced high administrative costs and opportunities for fraud (OECD 2005).

Conclusion

Environmental fees can help achieve desired environmental goals more cost effectively than standards. First, they focus clean-up efforts where they are least costly. Second, they provide built-in incentives for searching for, adopting, or developing less costly ways of preventing pollution over time. There are a few guiding principles for designing effective fee systems. To the extent possible, environmental fees should vary with environmental impact and the cost of pollution control. Fees should be tied as closely as possible to actual environmental damages. The ability to do this will depend on the costs of monitoring ambient quality, the feasibility of linking observable activities to changes in ambient quality, enforcement costs, and the administrative costs of fee systems. To state the obvious, the greater the environmental or public health impact, the greater the costs that are justified. The Florida Everglades Agricultural Privilege Tax surcharge can be based on actual water quality because the structure of agricultural drainage in the area makes it easy and inexpensive to monitor discharges as well as instream water quality. The Netherlands' nutrient tax system creates a very strong incentive for careful nutrient management by affected farmers. But this level of administrative effort and expense only is justified by high levels of environmental damage. Finally, as with any tax or fee, careful attention needs to be paid to the final incidence of the tax and its non-environmental impact on firms and consumers.

The political acceptability of any particular fee system is likely to turn on some familiar factors and some unexpected factors. In general, familiarity will increase political acceptability—sewer surcharges are familiar tax instruments in the United States. Nutrient taxes like that used in the Netherlands are not. Public understanding of the environmental harm needs to be addressed, as well as belief in the usefulness of the particular fee system in mitigating that harm. A case still needs to be made to environmentalists that fees are a way of holding polluters responsible for their actions, not a way of giving them a license to pollute. The initial and final incidence of the fee system will raise concerns about fairness and unintended non-environmental financial effects. These are all familiar factors that come up with any tax or fee system. But less familiar are the ways that both environmental fees and standards affect competitive incentives for industry and therefore their political acceptability to industry. Standards are generally more costly for small firms than for large firms. It should not be surprising to see large firms opposing fees more than small firms. Fees on discharges by commercial sources also shift some of the initial incidence of costs from the environment and/or consumers to producers. So on this basis, one should also expect to see resistance to fees from commercial interests. So is there a political argument for fees over standards. Yes, fees can lower the costs of meeting environmental quality goals. They provide states and local governments with a lower cost way of meeting federal mandates.

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