Market-Based Incentives and Water Quality[1]

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Introduction

Since 1972, when the Clean Water Act was passed, the United States has made great effort to improve water quality. The nation has invested heavily in the control and treatment of industrial and municipal wastes, as well as a wide variety of voluntary programs to reduce runoff from agricultural sources. The days of burning rivers are gone, and many waters, such as the Potomac, that were once deemed health hazards, are now fishable and swimmable.

In spite of these efforts, the United States is not only failing to restore its water resource base, it is not even managing to maintain it. Surveys of the physical environment indicate improvement in some areas of the country, but also show that a large and growing proportion of the nation's waters are impaired and do not meet their intended uses. The principal cause of water quality impairment is nutrient loading from agricultural land use and municipal and industrial dischargers.

One option to address these that appears to have great potential is nutrient trading. This approach is an adjunct to regulation that uses markets to achieve improved environmental quality at least cost. When tighter standards are put in place, trading increases flexibility and reduces costs by allowing dischargers with new obligations the option of adapting their own facilities or financing comparable reductions by others. Trading makes it profitable for sources with low treatment costs to reduce their own effluents beyond legal requirements, generating a credit, and sell these credits to dischargers with higher treatment costs. This flexibility produces a less expensive outcome overall while achieving, and even going beyond, the mandated environmental target. Trading is used to produce a net decrease in discharges and improvements in water quality in the same watershed.

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[1] This material was drawn from a forthcoming report by WRI, *Trading as an Option: Market Based Incentives and Water Quality* by Paul Faeth.

Policy Issues

It is clear that the nation's existing water quality policy framework is inadequate. Not only is the nation failing to meet the goals set out by Congress, but forward progress seems to be slow and difficult. The central policy problem, is that water quality policy formulation in the U.S. has not kept up with the need. Policy is fractured, expensive, and the approaches taken for point and nonpoint sources are inconsistent.

The bulk of the nation's spending for clean water is for point source control. Between 1974 and 1994, about $96 billion was spent through the Federal Construction Grants Program for new municipal construction and upgrades. Local governments have added another $117 billion. For the next 20 years EPA estimates that almost $140 billion in capital costs will be needed for municipal treatment works and related needs. The Association of Metropolitan Sewerage Agencies (AMSA) and the Water Environment Federation say that another $190 billion will be needed by local governments to replace aging facilities and collection systems, not including operation and maintenance costs (AMSA/WEF, 1999).

The approach taken for nonpoint sources stands in stark contrast to that for point sources. Abatement programs for nonpoint source pollution, to the extent that it is controlled, occur mainly through subsidy programs provided by the USDA and the USEPA, with the lion's share of the funds coming through agricultural legislation to farmers for land retirement and cost-share programs, primarily for erosion control. In recent years the USDA has spent around $3.5 billion per year on conservation programs, extension, administration, and research. The EPA spends about another $800 million on its voluntary nonpoint programs (USDA, 1997). Approximately half of the USDA's money goes to the Conservation Reserve Program (CRP) which was conceived primarily as a means to keep land out of production to support crop prices.

Most of the contention regarding clean water policy revolves around water bodies that are impaired. Section 303(d) of the CWA requires states to identify waters that are not fishable or swimmable and to develop Total Maximum Daily Loads (TMDLs) to address the problems. TMDLs are plans to establish and allocate loading targets. This typically means additional requirements for point sources and more subsidies for nonpoint sources.

The list of impaired waterways is extensive. Nationwide, there are 3,456 waterways that listed as impaired by nutrients and another 141 that are impaired by algal blooms, typically caused by excess nutrients (Table 1). Because the TMDL process sets a cap on the load and allocates that across sources contributing to the problem, the process is a natural one for the establishment of nutrient trading schemes. On a strictly physical basis, therefore, there appears to be enormous opportunity for nutrient trading to be applied in the U.S.

Table 1. The top 10 states by number of waterways impaired by nutrients.

Illinois	634
Florida	539
Mississippi	469
Oklahoma	218
Pennsylvania	217
Ohio	204
Montana	156
Maryland	145
Delaware	138
Massachusetts	135
Subtotal	**2,855**
Total 50 States	**3,456**

Source: USEPA, 1999.

The Economic Potential for Nutrient Trading

Even though nutrient trading has been promoted and attempted because of its potential to reduce the costs of improving water quality, there has been very little economic analysis comparing trading with other policy approaches. The work that has been done has been fairly simplistic, most often comparing average costs of various forms of nutrient reduction for point and nonpoint sources.

WRI recently completed a study to develop a comprehensive analytical framework to compare and contrast the economic and environmental performance of alternative policy strategies to reduce nutrient loads. We worked with state agencies and local stakeholders to explore opportunities to reduce loads of phosphorus in three watersheds of the Upper Midwest: the Saginaw Bay in Michigan, the Rock River in Wisconsin, and the Minnesota River Valley.

The intent of the analysis was to develop and implement a policy tool to explore the cost-effectiveness and environmental performance of various strategies to improve water quality in specific watersheds. In doing this, we hoped to illuminate the economic issues, to facilitate the development of successful pilot nutrient trading programs, and to better understand the opportunities and barriers to improving water quality under each of the policy approaches considered.

The three watersheds considered have a number of things in common, and a few very important differences. Three key differences are the number of point sources in each watershed, the variation in their size distribution, and their level of treatment. In Minnesota there are 211 facilities and the vast majority are very small. The Rock River and Saginaw Bay watersheds have fewer facilities, at 60 and 69, but in the Wisconsin case, small facilities, comprising 25 of the 60 are exempt from treatment requirements. In these three watersheds only the Saginaw has a prior requirement for phosphorus treatment because it drains to the Great Lakes.

We tested several scenarios that could be considered for situations like those presented by the three case studies. These were intended to contribute to the discussion on trading and were not endorsed by any state agencies. These tests include:

- *A point source performance requirement (Scenario 1).* Point source controls have been the first avenue of attack to correct water quality problems. This scenario asks: "What if we do more of the same?" It helps to set a policy baseline for comparative purposes. We assumed in this scenario that all point sources would be forced to adopt a new standard for phosphorus, except in the case of Wisconsin, where the smallest dischargers would be exempted as a cost-saving measure. In Minnesota and Wisconsin the standard would be 1 ppm. Michigan already has a standard of 1 ppm and would go to 0.5 ppm.
- *A conventional subsidy program for agricultural conservation, "best management practices" – BMPs (Scenario 2).* Instead of regulatory controls on agriculture, most of the policy effort in the U.S. has focused on providing subsidies to farmers to help reduce the costs of implementing ○best management practices○ (BMPs). In this vein, this scenario provides a subsidy for mulch tillage, no-till and nutrient management. We adjusted the subsidy level until it induced an agricultural load reduction for the watershed equal to that for the point source performance requirement.
- *A point source performance requirement coupled with trading (Scenario 3).* What if point sources could trade with other point and nonpoint sources to meet the new standard? This scenario adds point and nonpoint trading flexibility to the first scenario.
- *A trading program coupled with performance-based conservation subsidies (Scenario 4).* This scenario combines elements of the second and third scenarios, where the burden of reductions is shared between point source and nonpoint sources. A key difference however, would be that the conservation subsidies would be based upon the attainment of

least-cost load reductions however achieved, not the adoption of any particular BMP. For nonpoint source reductions that are applied to nonpoint source obligations, there is no trading ratio applied.

- *The Least-Cost Solution (Scenario 5).* For comparison purposes we ran a scenario that removes all policy restrictions and finds the load reduction target while minimizing the cost to do so.

A summary of the cost results for all the case studies is found in Table 2. In each case, the strategy of tightening point source performance requirements is the most expensive option. Costs across the studies vary considerably, however. Saginaw Bay results are the highest because there is an existing requirement of 1 ppm in place and the requirement simulated here is for 0.5 ppm instead of 1 ppm as in the other studies. Minnesota River results are also relatively high because there are so many small sources. In contrast, in the Rock River the smallest sources are exempt and the costs are quite a bit lower for the same level of control.

Scenario 1 would provide a cut in the point source load of 70, 71, and 49 percent, respectively for Minnesota River, the Rock River, and Saginaw Bay. These reductions work out to cuts in the total load of 20, 30, and 16 percent. Again, less potential is available from point source reductions in Saginaw Bay because phosphorus is already controlled.

The second scenario is somewhat better at achieving the same result, but is still relatively expensive except in the Saginaw Bay where wind erosion is such a problem. The costs of achieving the same amount of load reduction through untargeted agricultural subsidies for conservation tillage practices is lower than the point source regulation approach, but still more expensive than other options. Costs are comparatively greater in the Minnesota River because there is more adoption of conservation tillage in this watershed and wind erosion, unlike Saginaw, is less of a problem. There is also greater use of the moldboard plow, the most erosive practice, in the Rock River. These characteristics provide less expensive remediation opportunities.

If agriculture achieved the same absolute cuts as new point source performance requirements, the percentage load reduction would be less because the agricultural load in each case comprises a larger share of the total. We compared the cost per acre required in the model to bring in more conservation tillage with the costs actually paid under existing government programs. In each case the results were very close to the actual.

Table 2: Cost for phosphorus control under different polices (US$ per pound of phosphorus removed).

	Scenario 1 Point Source Performance Requirement	*Scenario 2* Conventional Subsidies for Agricultural Conservation Practices (BMPs)	*Scenario 3* Point Source Performance Requirement w/ Trading	*Scenario 4* Trading Program w/ Performance -based Conservation Subsidies	*Scenario 5* Least-cost Solution
Minnesota River	19.57	16.29	6.84	4.45	4.36
Saginaw Bay	23.89	5.76	4.04	2.90	1.75
Rock River	10.38	9.53	5.95	3.82	3.22

Note: The levels of phosphorus reduction from the base are different for each watershed.

Compared to the least-cost solution, Scenario 5, both of these approaches are expensive. The least-cost solution relies on performance objectives to achieve the desired result and is otherwise unconstrained. The first two policy tests are obviously quite far from the most cost-effective result. In the case of new point source requirements, the reason is that there are many small point sources with diseconomies of scale and therefore expensive remediation costs compared to the agricultural side. Scenario 2 favors certain practices without regard to performance and is therefore inefficient. Scenario 5 represents the equivalent of a highly targeted performance-based subsidy program. The cost here range from 69 to 93 percent lower compared to Scenario 1 and from 66 to 73 percent lower than Scenario 2.

In contrast, in Scenario 3 the costs are considerably lower. In this case, the performance requirement acts as the “cap” in a “cap and trade” system. This would not represent a “fully closed” cap and trade program because not all sources are covered under the cap. Nevertheless, this scenario gets much closer to the least-cost solution because it allows the point sources to take advantage of the least expensive remediation opportunities, wherever they may be found. This scenario assumes that only one-third of the load reduction from nonpoint sources could be applied against point source requirements, a 3:1 trading ratio. The rest of the load reduction produced is essentially an “environmental credit” to assure the achievement of water quality goals and account for the greater uncertainty inherent in nonpoint source loads. The trading ratio produces a greater total load reduction than any other policy, an additional 10 percent for each case. Even with the environmental credit for the uncertainty of the nonpoint source load applied to the point source obligations, there is still a significant savings to be had over the strict regulatory case. For Saginaw Bay, the costs drop by nearly $20 per pound – 82 percent for the point sources. The other case show similar costs reductions, though less dramatic, primarily because of the phosphorus requirement already in place in Michigan.

This trading scenario assumes that existing point sources would pick up the bill to help clean up threatened rivers, lakes, and estuaries, raising the question of equity. Is it fair to ask point sources to pay for remediation simply because that is where regulatory control is the strongest and politically easiest? Should broader social or sectoral responsibility be sought?

To reflect this concern we constructed a scenario that mimics burden sharing. Scenario 4 assumes that the burden for reductions would be borne evenly by point and nonpoint sources. In this case, point sources would be responsible for half of the reduction level imposed in the other tests. The remaining reduction is assigned to the agricultural sector. We assumed for this scenario that the cost for agricultural reductions would come from conservation subsidy program funds. However, the subsidies would be performance-based so that those farmers able to produce the cheapest load reductions would receive the available funds. This would mean that those closest to streams, those with the most highly-erodible soils, and who had not yet adopted conservation practices would be the first to receive program funds. Further, we assumed that point sources could still purchase nonpoint source reductions. Because agriculture has its own obligation, however, and would not trade away its cheapest reductions, the results show very little point-nonpoint source trading but quite a bit of point-point source trading. This scenario effectively provides a cap for all sources and so is closer to "fully closed" trading system.

Here, both point and nonpoint sources contribute evenly to the reduction of phosphorus loads. While most of the total costs would still be paid for by point sources, their costs would be cut considerably compared to the previous trading scenario and even more compared to a regulatory standard. For example, in the Rock River, the cost would be just $3.82 per pound. The total annual cost estimate to produce this reduction is about $2.2 million per year, less than half of the point source trading program by itself. Of this total cost, about $600,000 would be borne by farmers or by public subsidy programs. The total cut in the phosphorus load is less because the trading ratio is not applied to reductions made by agriculture on its own behalf, as in the case of the trading program with caps on point sources only. This scenario is the closest to achieving the economically ideal least-cost solution. Point sources still bear the majority of the costs, but these are the lowest of any scenario.

Conclusions and Recommendations

It is clear water-quality programs are designed more efficiently, significant water quality gains can be had at relatively low cost. Policy scenario analysis for alternative programs show that there is a wide range in the cost-effectiveness of different approaches, with conventional strategies showing the least benefit per dollar spent. More flexible approaches can potentially provide greater improvements in water quality, over a larger range of reductions, and at much lower cost.

This is not to say that conventional regulatory approaches have been a failure in achieving improvements in water quality -- things would certainly be worse without them. But our analysis points out that pushing on point sources alone would be a relatively expensive approach when other sources contribute more to the problem. Conversely, in the agricultural sector the opportunities for inexpensive gains are great if conservation subsidies were to be based upon performance, to the extent that we are able to estimate it. Further, point sources are not the largest contributor to the problem in the watersheds we looked at, or on a national basis. This means that any strategy to reduce the level of loads to restore surface waters must include agriculture, not only because of economic efficiency arguments, but also for the sake of fairness. This may not be true in every watershed, but it appears to be a dominant situation in many rural and urbanizing U.S. watersheds.

Because there is a large differential between remediation costs for conventional approaches and programs that involve trading of some form, trading has potential in the watersheds we considered. One would also expect that the potential for trading would be extant in many other watersheds as well, because the same reasons for cost-effectiveness would apply.

While a regulatory mandate on point sources coupled with a flexible trading program appears to have merit, an even better program would couple these elements with a strategy directly involving agriculture. In such a program, point-point and point-nonpoint trading would be allowed, but nonpoint sources would have a shared responsibility to undertake remediation actions not coupled to point source regulatory requirements. Further, regulations controlling nonpoint sources need to be strengthened and evenly enforced.

While trading has economic potential, there are some uncertainties associated with trading that need to be acknowledged and accounted for. The first and perhaps most important aspect of trading that would involve nonpoint sources is that there is a great deal of uncertainty involved because the loads are tied to weather events. While point sources produce fairly regular flows across seasons and even years, nonpoint sources do not. Therefore, it is important that water quality is monitored to make sure that expected improvements are realized and water quality goals are met.

Issues regarding liability must also be carefully considered. When a point source fails to meet a legal requirement, the responsible regulatory agency has the ability to force the offender to comply. Any water quality program that employs trading must similarly provide a legal remedy for those instances when someone sells or applies a credit that has no environmental value.

Another consideration is that trading programs can be expensive to put in place and operate if poorly designed. Regulatory paperwork, information gathering and the process of identifying partners to trade with, can create transaction costs that are prohibitive and make a trading program ineffectual. Administrative oversight needs to be sufficient to ensure good performance, but not so burdensome as to inhibit trading. Registration of trades should be efficient so that partners can easily hook up, report their trades, and get approval. When numerous nonpoint sources are involved, some sort of broker, for example a cooperative, needs to be organized to coordinate the sale of credits and to verify them using standard techniques.

Probably the most important barrier to more extensive adoption of trading is that regulatory agencies are of many minds on the utility of trading and the opportunities to apply the tool. Not only within offices at state agencies, but also within the EPA, the interpretation of regulations varies. The regions are inconsistent in their encouragement of trading as an option. This is large part flows from the fact that regulations and the law are unclear.

References

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