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Markets for the Environment

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Articles in this Theme:

Markets are increasingly being used and proposed as a way to address environmental problems and manage natural resources. Functioning markets exist for water rights and sulfur dioxide credits can even be purchased via the Internet. Markets are being developed for trading water quality credits, greenhouse gas emissions, and many other environmental services. In this paper, I examine why such markets are being widely proposed, give some background on their history, and speculate on their future. The other papers in this *Choices* theme provide an overview of what is really happening "on the ground," discussing how well the promise of these new markets has been met in reality.

Background

Most economists are quite enthusiastic about markets; they make buyers and sellers better off and create incentives for innovation. These benefits can also be achieved when applied to the environment. Markets can help reduce the cost of achieving environmental goals and move resource usage permits to those that value them most. However, Adam Smith's invisible hand does not magically materialize to provide clean air, protect endangered species, or even ensure the best use of fresh water. If markets are to be used to address these issues, then the rights to be transacted must be intentionally defined.

The advantages of markets have led economists to look for ways to harness market forces for the management of the environment and our natural resources. After being promoted for decades by economists, this policy tool is beginning to have some notable successes. Costs of controlling sulfur dioxide have fallen dramatically, and water quantity trading is now routine in some regions. It might even be argued that the development and implementation of environmental markets constitutes the single most valuable contribution of environmental economists to date, having saved billions of dollars in the SO_2 program alone. Today markets are being promoted as part of the solution to an ever-increasing range of environmental problems, including overfishing, urban sprawl, and global climate change.

What are the Economic Benefits of Environmental Markets?

The theory behind market-based approaches to deal with pollution problems arose in the late 1960s in work by Dales (1968) and Crocker (1966). In such a system, rights to emit pollutants or use natural resources would be distributed to stakeholders but could then be sold. Market negotiations between potential permit buyers and sellers would occur and result in the reallocation of these permits across the stakeholders. In the textbook version of such a program, a cap is first placed on total pollution emissions. Second, permits equal to the cap are distributed to the polluters. Finally, a market develops in which the sellers are those firms with relatively low abatement costs who end up reducing emissions by more than initially required; buyers are those with relatively high abatement costs who end up reducing emissions by less than initially required. Regardless of the aspect of the environment being considered, the market-based approach requires that transferable rights be defined and protected (typically by government), an initial allocation is set, and trade in these permits is allowed. The textbook result is an efficient market equilibrium in which a pollution target is achieved at lowest cost or a resource is used in a way that yields the most value to society.

At least, that is how it is supposed to work—the simplest theoretical models never quite work in practice. For example, Dales' original proposal was to use transferable rights to improve water quality. Coincidentally, one of the earliest applications involved markets for water pollution on the Fox River in Wisconsin. However, significant barriers to market trades arose because the difficulty in obtaining regulatory authority for trades and the persistent concerns about "hot spots"—locally high concentrations of the pollutants. In the end, the Fox River program, established in 1981, did not give rise to a single trade during the first 14 years of its existence.

Challenges to Market Design

As the Fox River example makes clear, the design of environmental markets is not without challenges. Numerous decisions must be made when such markets are put in place. The nature of the rights must be carefully defined so that environmental goals are met but market flexibility remains. The initial allocation of rights must be established, sometimes being handed out based on historical precedents and other times being auctioned by the government. These decisions, and many others, can be politically contentious and can affect the success of the market.

Whether they are used to address pollution problems or fisheries management, all transferable rights programs require that an institution (typically the government) certify the validity and transferability of the property right. In addition to defining the rights and obligations associated with the permit, the oversight agency must monitor compliance. This is more difficult than in standard markets. When someone purchases an apple at the supermarket, they know the purchase is complete when they walk out of the store; if the apple is rotten they can usually return it for a refund. When someone purchases a pollution permit, they know that it is legitimate when the government informs them that they are allowed to increase their pollution, but they usually have no way to know (or reason to care) if the seller of the permit actually reduced its pollution to generate the offsetting environmental benefit. Compliance must be enforced by the government. Monitoring and enforcement is also needed to create demand for the rights to be transacted. Permits will be valued only if polluters know that they are required by the government. As Dennis King puts it in his paper in this series, "the 'invisible hand' will not work without the 'visible foot' of a regulator insuring compliance."

Further inhibiting the performance of environmental markets is the fact that they usually grow out of more traditional regulatory programs and often carry excess baggage as a result. As Robert Hahn (1990) noted, "In the real world, regulatory systems are rarely discarded and replaced wholesale. Rather, reform of regulatory systems proceeds in an incremental fashion." Hence, the earliest transferable rights programs in pollution are hardly identifiable as market-based systems at all. In some cases flexibility arises over time, but such evolution is not automatic. As Leonard Shabman and Paul Scodari argue in their paper in this series, the level of flexibility that has been introduced in the management of our nation's wetlands is so limited that the program can not even qualify as truly market based.

A Brief History of Environmental Markets

The development of the institutions needed to support transferable rights is more natural in some instances than in others. The buying and selling of water rights, which is centuries old, is a natural improvement over fights that inevitably arise over this scarce resource. As governments became more involved in resource management, however, they often created barriers to trades that made transactions more difficult. Government control of water, environmental regulations, and restrictions on the rights to use water often made water trading quite difficult. However, as Richard Howitt notes in his paper in this series, in recent years there have been efforts to encourage markets by modifying laws to facilitate trading. Fierce battles are still being fought, but pressed by rising scarcity, there has been substantial growth in water markets.

For pollution and environmental services, there is no natural tendency for markets to arise; the initiation had to come from the regulatory branch. In the 1970s, the US Environmental Protection Agency started down the path toward market-based instruments when it began introducing some flexibility into its air quality programs. The 1980s saw an expansion in the use of this tool: Trading was allowed as part of the rules that removed lead from refined gasoline and as part of the US approach to controlling chlorofluorocarbons. That decade also saw the development of a number of small-scale market-based programs to address water-quality: the Fox River program noted above, programs in Lake Dillon and Cherry Creek Reservoir in Colorado, and on the Tar Pamlico River in North Carolina. By the 1990s, the number and scope of market-based programs was expanding rapidly. The national SO_2 program, started in 1990, has proven that a program can work in textbook-like fashion. California introduced an ambitious trading program in air pollutants, and water pollution programs have sprouted up around the nation.

In addition, it appears that interest in market-based mechanisms is as strong as ever. In fact, it often appears today that when environmental policy is discussed in the US, market-based approaches are assumed desirable unless proven otherwise.

Why this Issue?

Today there are many proposed markets, and we can observe a number of successful and unsuccessful efforts. It is a good time to take stock of where we are. In this collection of articles, *Choices* explores the reality of environmental markets in the United States today. In this package of papers:

- Robert Stavins reviews the market for permits to emit sulfur dioxide, which is widely viewed as an enormous success;
- Richard Howitt and Kristiana Hansen look at the emerging markets for water in the West, where markets remain quite limited despite the fact that there seems to be great potential for gains from trade;
- Leonard Shabman and Paul Scodari look at wetlands mitigation banking, which, they argue, is so restricted that it is like any other offset program and cannot legitimately be called a market-based program; and
- Dennis King looks at the problem of water quality markets and finds that the potential in this arena has yet to materialize; and it may never do so unless government plays a stronger role.

What Do the Papers Tell Us?

A constant theme repeated throughout these papers is that *details matter* and the creation of markets for natural resources and environmental services is no small task. As we look to the future, it may be prudent to avoid exuberant predictions of huge economic benefits from trading. Although it is clear that these instruments will continue to be part of the policy landscape for years to come, they will also face challenges and setbacks, and markets may not be appropriate in every setting. Over time, market-based instruments may take a less prominent place in the policy mix, to be seen as one tool among many that can be used for improved management of the environment and natural resources.

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Lessons Learned from SO_2 Allowance Trading

Robert N. Stavins

The most ambitious application yet undertaken of a market-based instrument for environmental protection has been for the control of sulfur dioxide (SO_2) emissions in the context of acid rain reduction under Title IV of the Clean Air Act amendments of 1990. That Act established an allowance trading program to cut SO_2 emissions by 10 million tons from 1980 levels—a 50% reduction. In this article, I identify lessons that can be learned from this grand experiment in economically oriented environmental policy.

The System and Its Performance

In Phase I of the allowance trading program, emissions allowances were assigned to the 263 most SO_2-emissions-intensive generating units at 110 power plants operated by 61 electric utilities, located largely at coal-fired power plants east of the Mississippi River. After January 1, 1995, these utilities could emit SO_2 only if they had adequate allowances to cover their emissions. The US Environmental Protection Agency (EPA) allocated each affected unit, on an annual basis, a specified number of allowances related to its share of heat input during the baseline period (1985-87) plus bonus allowances available under a variety of special provisions. Cost-effectiveness was promoted by permitting allowance holders to transfer their permits among one another and bank them for later use. Under Phase II of the program, which began on January 1, 2000, almost all electric power generating units were brought within the system. Certain units are exempted to compensate for potential restrictions on growth and to reward units that were already unusually clean.

The SO_2 allowance trading program has performed successfully. Targeted emissions reductions have been achieved and exceeded, and total abatement costs have been significantly less than what they would have been in the absence of the trading provisions. Trading volume has increased over the life of the program (Figure 1), and the robust market has resulted in an estimated cost savings of up to $1 billion annually, compared with the cost of command-and-control regulatory alternatives that were considered by Congress in prior years, representing a 30–50% cost savings.

The allowance trading program has had exceptionally positive welfare effects, with estimated benefits being as much as ten times greater than costs. It is notable that the majority of the benefits of the program are due mainly to the positive human health impacts of decreased local SO_2 and particulate concentrations, not to the ecological impacts of reduced long-distance transport of acid deposition. This contrasts with what was assumed at the time of the program's enactment in 1990.

Lessons for Design and Implementation of Tradable Permit Systems

The performance of the SO_2 allowance trading system provides valuable evidence for environmentalists and others who have been resistant to these innovations. It shows that market-based instruments can achieve major cost savings while accomplishing environmental objectives. The system's performance also offers lessons about the importance of flexibility and simplicity, the role of monitoring and enforcement, and the capabilities of the private sector to make markets of this sort work.

In regard to flexibility, tradable permit experience indicates that systems should be designed to allow for a broad set of compliance alternatives, in terms of both timing and technological options. Allowing flexible timing and intertemporal trading of the allowances—that is, "banking" allowances for future use—has played a very important role, much as it did in EPA's lead rights trading program a

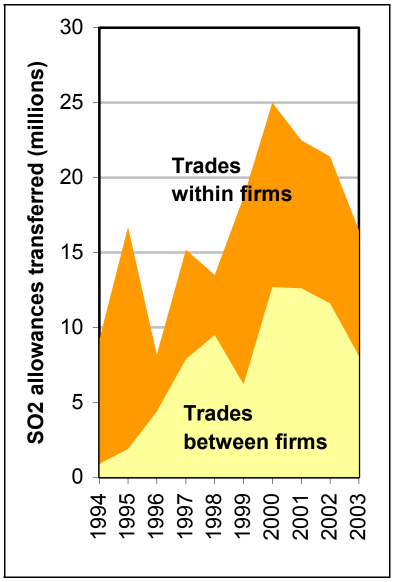

Figure 1. Trading volume in the SO_2 Allowance Trading Program.
Source: Based on data from USEPA "Trading Activity Breakdown" (see http://www.epa.gov/airmarkets/trading/so2market/transtable.html).

decade earlier. The permit system was based on emissions of SO_2 (as opposed to sulfur content of fuels), so that both scrubbing and fuel-switching were feasible options. Moreover, one of the most significant benefits of the trading system was simply that technology standards requiring scrubbing of SO_2 were thereby avoided. This allowed Midwestern utilities to take advantage of lower rail rates (brought about by railroad deregulation) to reduce their SO_2 emissions by increasing their use of low-sulfur coal from Wyoming—an approach that would not have been possible if scrubbers had been required.

In regard to simplicity, simple formulas for allocating permits based upon historical data have proven to be difficult to contest or manipulate. More generally, experience shows trading rules should be clearly defined up front without ambiguity. For example, there should be no requirements for prior government approval of individual trades. Such requirements hampered the EPA's Emissions Trading Program for local air pollutants in the 1970s, while the lack of such requirements was an important factor in the success of lead trading in the 1980s. In the case of SO_2 trading, the absence of requirements for prior approval reduced uncertainty for utilities and administrative costs for government and contributed to low enforcement and other program implementation (transactions) costs.

Considerations of simplicity and the experience of the SO_2 allowance system also argue for using absolute baselines—not relative ones—as the point of departure for tradable permit programs. The difference is that with an absolute baseline (so-called "cap-and-trade"), sources are each allocated some number of permits (the total of which is the "cap"); with a relative baseline, reductions are credited from a hypothetical baseline—what the source would have emitted in the absence of the regulation. A hybrid system—where a cap-and-trade program is combined with voluntary "opt-in provisions"—can also be undesirable because it would create the possibility for "paper trades," where a regulated source is credited for an emissions reduction (by an unregulated source) that would have taken place in any event. Relative baselines would have complicated the program and could have led to an unintentional increase in the total emissions cap.

The SO_2 program has also brought home the importance of monitoring and enforcement provisions. In 1990, environmental advocates insisted on continuous emissions monitoring, which helps build market confidence. The costs of such monitoring, however, are significant. On the enforcement side, the Act's stiff penalties—$2,000 per ton of excess emissions, a value more than 10 times that of marginal abatement costs—have provided sufficient incentive for the very high degree of compliance that has been achieved.

Another lesson involves permit allocation procedures. There are obvious political advantages of allocating permits without charge, as was done for the SO_2 program. But the same characteristic that makes such allocations politically attractive—the conveyance of valuable allowances to the private sector—also makes free allocations problematic. It has been estimated that the costs of SO_2 allowance trading would be 25% lower if permits were auctioned rather than freely allocated, because auctioning yields revenues that can be used to finance cuts in preexisting distortionary taxes. Furthermore, in the presence of some forms of transaction costs, the post-trading distribution of emissions—and hence aggregate abatement costs—are sensitive to the initial permit allocation. For both reasons, a successful attempt to establish a politically viable program through a specific initial permit allocation can result in a program that is significantly more costly than anticipated.

Finally, the SO_2 program's performance demonstrates that once a tradable system is established, the private sector can then step in to make it work. In the SO_2 context, despite claims to the contrary when the program was enacted, entrepreneurs provided brokerage needs, developed price information, matched trading partners, developed electronic bid/ask bulletin boards, and made available allowance price forecasts. The annual EPA auctions may have served the purpose of helping to reveal market valuations of allowances, but bilateral trading has also informed the auctions.

Lessons for Judging Effectiveness of Tradable Permit Systems

When examining the effectiveness of trading programs, economists have typically employed some measure in which gains from trade are estimated for moving from conventional standards to marketable permits. Aggregate cost savings are the yardstick best used for measuring success.

The challenge is to compare realistic versions of both tradable permit systems and likely alternatives, not idealized versions of either. It is not enough to analyze the cost savings in any year. For example, the gains from banking allowances should be considered (unless this is not permitted in practice). It can also be important to allow for the effects on technology innovation and diffusion, especially when permit trading programs impose significant costs over long time horizons.

More generally, it is important to consider the effects of the preexisting regulatory environment. The level of preexisting taxes can affect the total costs of regulation, as emphasized above. Also, because SO_2 is both a transboundary precursor of acid rain and a local air pollutant regulated under a separate part of the Clean Air Act, local environmental regulations have sometimes prevented utilities from acquiring allowances rather than carrying out emissions reductions. Moreover, because electricity generation and distribution have been regulated by state commissions, a prospective analysis of SO_2 trading should consider the incentives these commissions may have to influence the level of allowance trading.

Lessons for Identifying New Permit Trading Applications

Market-based policy instruments are now considered for almost every environmental problem, ranging from endangered species preservation to global climate change. Experiences with SO_2 trading offer some guidance as to when tradable permits are likely to work well and when they may face greater difficulties.

First, permit trading is likely to work best where there are wide differences in the cost of abating emissions. SO_2 trading is such a case. Initially, SO_2 abatement cost heterogeneity was great because of differences in ages of generating equipment and their proximity to sources of low-sulfur coal. When abatement costs are more uniform across sources, the political costs of enacting an allowance trading approach are less likely to be justifiable.

Second, the greater the degree of mixing of pollutants in the receiving airshed or watershed, the more attractive will be a tradable emission permit (or emission tax) system, relative to a conventional uniform standard. This is because taxes or tradable permits can lead to localized "hot spots" with relatively high levels of ambient pollution. This is a significant local or regional issue, and it can become an issue of overall consequence, as well, if damages rise more than proportionally with increases in pollutant concentrations.

Third, economic theory has taught us that the efficiency of a tradable permit system will depend on the pattern of costs and benefits. If uncertainty about marginal abatement costs is significant, and if marginal abatement costs are relatively constant, but the benefits of abatement fall relatively quickly at higher levels of abatement, then a quantity instrument (such as tradable permits) will be more efficient than a price instrument (such as an emission tax). The advantage of tradable permits is reinforced when there is uncertainty about both the marginal costs and the marginal benefits of pollution reductions, and these are positively correlated.

Fourth, tradable permits will work best when marketing and brokerage costs are low, and the SO_2 experiment shows that if properly designed, private markets will tend to render such costs minimal. Finally, considerations of political feasibility point to the wisdom of proposing trading instruments when they can be used to facilitate emissions reductions—as was done with SO_2 allowances and lead rights trading—as opposed to using these instruments only to lower the costs of achieving status quo emissions.

What about Greenhouse Gas Trading?

Many of these issues can be illuminated by considering the current interest in applying tradable permits to the task of cutting greenhouse gas emissions—largely carbon dioxide (CO_2) emissions—to reduce the risk of global climate change (for more on why this might occur, see the Fall 2004 issue of *Choices*). It is obvious that the number and diversity of sources of CO_2 emissions due to fossil fuel combustion are vastly greater than in the case of SO_2 emissions as a precursor of acid rain, where the focus can be placed on a few hundred electrical utility plants.

Any pollution-control program must face the possibility of "emissions leakage" from regulated to unregulated sources. This could be a problem for meeting domestic targets for CO_2 emissions reduction, but it would be a vastly greater problem for an international program, where emissions would tend to increase in nonparticipant countries. This also raises serious concerns with provisions in the Kyoto Protocol for industrialized countries to participate in a CO_2 cap-and-trade program while nonparticipant (developing) nations retain the option of joining the system on a project-by-project basis. As emphasized earlier, provisions in tradable permit programs that allow for unregulated sources to opt in can lower aggregate costs by substituting low-cost for high-cost control but may also have the unintended effect of increasing aggregate emissions beyond what they would otherwise have been. This is because there is an incentive for adverse selection: Sources in developing countries that would reduce their emissions, opt in, and receive excess allowances would tend to be those that would have reduced their emissions in any case.

To the limited degree that any previous trading program can really serve as a model for the case of global climate change, attention should surely be given to the tradable-permit system that accomplished the US phaseout of leaded gasoline in the 1980s. The currency of that system was not lead oxide emissions from motor vehicles, but rather the lead content of gasoline. So, too, in the case of global climate, great savings in monitoring and enforcement costs could be had by adopting input trading linked to the carbon content of fossil fuels. This is reasonable in the climate case, because—unlike in the SO_2 case—CO_2 emissions are roughly proportional to the carbon content of fossil fuels, and scrubbing alternatives are largely unavailable, at least at present. On the other hand, natural sequestration of CO_2 from the atmosphere—such as by expanding forested areas—is available at a reasonable cost (even in the United States), and is explicitly counted toward compliance under the Kyoto Protocol. Hence, it could be important to combine any carbon trading (or carbon tax) program with a carbon sequestration program.

Developing a tradable permit system in the area of global climate change would surely bring forth an entirely new set of economic, political, and institutional challenges, particularly with regard to enforcement problems. But, it is also true that the diversity of sources of CO_2 emissions and the magnitude of likely abatement costs make it equally clear that only a market-based instrument—some form of carbon rights trading or carbon taxes—will be capable of achieving the domestic targets that may eventually be forthcoming from international agreements.

Conclusion

Given that the SO_2 allowance-trading program became fully binding only in 1995, we should be cautious when drawing conclusions about lessons to be learned from the program's performance. But despite the uncertainties, market-based instruments for environmental protection—tradable permit systems in particular — now enjoy proven successes in reducing pollution at low cost.

Market-based instruments have moved to center stage, and policy debates look very different from the time when these ideas were characterized as "licenses to pollute" or dismissed as completely impractical. Of course, no single policy instrument—whether market-based or conventional—will be appropriate for all environmental problems. Which instrument is best in any given situation depends upon characteristics of the specific environmental problem and the social, political, and economic context in which the instrument is to be implemented.

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The Evolving Western Water Markets

Richard Howitt and Kristiana Hansen

Expanding population and environmental protection the world over are placing additional demands on existing water supplies. Meeting these demands by traditional structural supply augmentation is dogged by increasing environmental and fiscal costs, which leave excess water demand to be met largely by conservation and reallocation of existing supplies. Water trading clearly has a role in reallocating supplies and stimulating conservation by providing a clear measure of its value for conservation and a voluntary self-compensating mechanism for reallocation. Despite these advantages, traditional markets have been slow to evolve in the western United States for institutional and hydrologic reasons. However, even when institutional, political, and physical impediments prevent textbook water markets from developing, significant gains in efficiency can result from relaxing restrictions on ownership, use, and transfer. Most water markets in the western United States fall between the two extremes of textbook markets in which, on the one hand, price is determined by unfettered market forces, and on the other, there is an outright legal prohibition of trading.

Three fundamental reasons probably cause the slow evolution of water markets in the West. First, water has many *public good* characteristics, benefiting not only the owner of a water right, but also the public at large. Public interest in water is supported by the fact that most western states retain the ultimate property right to water; individual water rights are more akin to use rights than private property rights. Second, fluctuations in water supply result in periodic "thin" markets with few participants. Third, water transfers often require significant costs, in terms of both institutional costs and the cost of physically transporting the resource. Even in the presence of willing buyers and sellers, trades of permanent water rights are often not approved by regulators because they would result in significant *externalities*—physical impacts on parties not involved in the transaction—and in third party financial impacts to the exporting region.

A worldwide survey of existing markets makes it clear that gains in efficiency can occur even in the absence of theoretically perfect markets (Saleth & Dinar, 2004). The efficiency gains are achieved by moving water to higher value uses. To achieve these gains, many states west of the Mississippi River have implemented legislation to facilitate water trading within their borders. However, because water has both private and public good characteristics, it has often been developed with some degree of public financing or subsidies. Hence, its reallocation generates heated controversy—especially when potential profits are involved.

Water Market Determinants

What factors determine whether and how markets develop? Why is trading heavier in some states than in others? The importance of water's physical characteristics cannot be emphasized enough. In many parts of the West, the water supply is uncertain; there is tremendous temporal and spatial variation in rainfall. Furthermore, supply and demand peaks do not generally coincide within the water year. For example, when snow pack melts in the spring, it is stored in surface reservoirs until late summer when farmers' irrigation demand peaks. These fundamental characteristics of precipitation make water market development all the more desirable, but they hinder the creation of markets in the first place. Transportation and storage facilities have been constructed throughout the West, largely at public expense, to convey water across time and space. Not surprisingly, water markets have tended to develop in locations where the Bureau of Reclamation and state water projects have invested resources in creating an infrastructure to facilitate the transportation and storage of water.

Yet obstacles remain. Even though water garners substantial political attention and controversy, its economic value at the margin is actually quite low relative to the cost of conveyance. For example, the option purchase price for water in a 2002 transaction between Glenn-Colusa Irrigation District in northern California and the Metropolitan Water District serving the Los Angeles area was $110/acre-foot. The cost of transport (including a mandatory 20% environmental mitigation requirement and 300-mile transport and pumping fees) is approximately $143/acre-foot, for a total delivered cost of $253/acre-foot. Such high transaction costs reduce the number of trades that are financially viable and the geographical scope of markets.

Water's mobility also makes property rights enforcement a challenge. Property rights are easier to monitor in some settings than others. For example, annual fallowing transfers from rice growers in the north of California to urban users in the south of California are relatively easy to monitor. If the fields are fallowed, the water must still be in the river and presumably flows to the purchasers. In contrast, monitoring sales of water saved by more efficient field application methods requires the detailed assessment of current and past irrigation technologies as well as the level of implementation.

For trades to occur easily, property rights must be clearly defined, enforceable, and transferable. In most western states, water property rights are governed by prior appropriation, whereby the first to claim the water in a waterway for beneficial use has first priority to the water, and a water right not exercised for a period of some years is relinquished. When appropriative rights were codified into state laws in the late 19th and early 20th centuries, state lawmakers did not envision widespread leasing and permanent transfers of water rights. As a result, western rights holders have historically been reluctant to lease water out, for fear of losing their right to the water in the longer term. Further, permanent transfers of water rights under prior appropriation have usually been costly and time-consuming. Permanent transfers and leases have recently become easier, as state laws have changed to facilitate market transactions.

One water market in the West where property rights are clearly defined, enforceable, and transferable is a Bureau of Reclamation project on the eastern slope of the Rocky Mountains: the Colorado-Big Thompson (CBT). Water rights in the CBT are correlative; shares fluctuate annually in response to water conditions, and all shareholders benefit or lose each year in like manner. The shares are entirely homogeneous, and transfer occurs with minimal fees and paperwork. However, the CBT system has the great advantage of using water imported from another watershed, thus freeing it from the impacts of reduced or altered flows on downstream users or externalities that complicate water trades along natural rivers. In contrast, California water rights are far from homogeneous. California continues to recognize riparian rights (water rights that are attached to the land adjacent to the waterway) alongside appropriative rights, which makes defining water rights with sufficient precision to sell them costly and litigious (Carey & Sunding, 2001). Furthermore, in many parts of California (as elsewhere in the West), federal ownership of developed water resources complicates market development.

The differential in water values between current owners and potential buyers is often great enough to stimulate potential trades. However, another complexity is the physical and environmental externalities intrinsic to trading an environmental resource. Reduced or altered flows on a waterway affect water quantity and quality downstream. Drawdown in an underground aquifer affects neighbors' pumping costs. Such externalities may be positive or negative. When they are negative, there is a role for regulatory agencies to ensure that nonmarket values placed on the waterways by society are taken into account. The absence of adequate protections for those adversely affected by negative externalities may result in trade volume that exceeds the socially efficient level. On the other hand, these concerns have traditionally been handled through lengthy court procedures, which may discourage socially beneficial trading. Over time, regulatory agencies should develop procedures to address these issues in a less costly manner, perhaps through the development of a body of precedent cases to guide water traders and through the standardization of environmental impact reports.

Although water trades may increase overall efficiency within a market, there can be negative financial impacts on third parties in the area of origin through local loss of income and employment and through impacts on neighboring groundwater users. Trades are more likely to occur where impacts on third parties in the area of origin are minimal (perhaps because the water does not leave the watershed in which it originates) or where state law does not recognize them. Standard economic theory does not usually consider these third-party financial losses to be legitimate. However, many trades do provide some compensation to third parties, often to appease public opinion. This concern for third-party financial losses results from fundamental water property rights. In most of the west-

Table 1. Volume and volume-weighted prices for reported water transactions, 1999–2002.

	Volume (thousand acre-feet)				Price ($/acre-foot, in 2004 dollars)	
State	Lease	Sale	Total	Lease/sale ratio	Lease	Sale
AZ	1,371	24	1,395	53	73	894
CA	3,127	227	3,354	14	80	1,207
CO	74	242	316	0.3	22	3,451[a]
ID	692	1	693	692	10	201
KS	4	0.2	4.2	20	51	—
MT	5	—	5	—	5	—
NM	338	10	348	34	66	1,233
NV	—	49	49	—	—	2,572
OK	10	—	10	—	59	—
OR	532	38	570	14	283	1,045
TX	877	322	1,199	3	81	864
UT	6	3	9	2	6	870
WA	68	13	81	5	53	513
WY	105	—	105	—	40	—
Total	7,211	929	8,140	8	86	1,299

[a] CBT sales omitted. If included the average sale price is $7,801.
Source: Data from the Water Strategist. The authors acknowledge Adams, Crews and Cummings (Georgia State University) for generously providing us with their database of Water Strategist transactions; and Alex Lombardi for assistance.

ern states, the ultimate owner of the water is the state itself, which is bound to protect the welfare of its citizens.

Externalities and third-party damages are likely to become more important as a greater volume is traded. Thus, we expect that these pressures will induce a higher percentage of leases relative to permanent sales, as negatively affected parties exert political pressures in regulatory arenas to limit permanent transfers. Examination of columns four and five in Table 1 suggests that states where more volume is traded have a higher lease-to-sale ratio. This tension between the benefits to trading partners and the negative effects on third parties is likely to be the dominant influence on future trading patterns.

What Do Existing Water Markets Look Like?

We were unable to find public source of consistent data on western water trading, so we compiled a summary of trading from fourteen western states for 1999–2002 from back issues of the *Water Strategist.* Although the *Water Strategist* may not record all the trades in western water, it is the only comprehensive source of water trade information. If there is a selection bias in the reported trades, it should be consistent across states and thus not influence the comparisons. We classified the trades as *sales* and *leases*. In a permanent sale, the right to the water for all time is transferred. Lease transactions involve short-term trades of water; the underlying property right remains unaffected by the transaction. Table 1 shows that water leases dominate the market in terms of water volume traded. Permanent sales comprise approximately 10% and leases 90% of the volume traded, although it is important to remember that a permanent water rights sale only appears once, whereas a lease is often an annual contract that must be renewed each year to reflect the same quantity of water over the long term.

A majority of the trades reported in the *Water Strategist* are from agricultural sellers to urban buyers who are grappling with projected increases in demand. In Colorado and New Mexico, municipal agencies are purchasing permanent rights and leasing them back to the irrigators from whom they purchased in the first place until needed to meet anticipated future demand. The *Water Strategist* data suggest that water purchases for municipal and industrial use trade at higher prices than water for agricultural or environmental use.

Market purchases for environmental use have increased in recent years. In California, for example, direct purchases such as those made by state and federal entities to comply with federal environmental regulations (primarily augmenting stream flow to enhance fish runs) accounted for one third of traded volume in 2001. By contrast, municipal buyers only accounted for about 20% of market activity (Hanak, 2002). This trend is repeated elsewhere in the West. In the Pacific Northwest, for example, water market development has been driven by the need to acquire water for environmental purposes (Smith, 1995).

The sale prices reported in the *Water Strategist* in Colorado, Nevada, and New Mexico over the survey period are markedly higher than in other states, probably reflecting the relative scarcity of the resource in these locations. Financial theory would suggest that the price of a right would exceed the capitalized value of a lease for two reasons. First, the purchase of a right eliminates the risk inherent in relying on future lease markets. Second, given the uncertainty of the value of future water rights, rational sellers would require a premium or hurdle rate in addition to the capitalized value of current leases to consummate the deal. A counterpoint to the risk argument is that leases are more likely to be concentrated in years of greater scarcity, whereas the return from the sale of a right should be averaged over all types of water year.

The lease-to-sale price ratios in Table 1 give us the implicit capitalization rate over an infinite planning horizon, which averages 6.6%. This is below the standard commercial capitalization rate of 10%, but it seems a reasonable rate given the risk reduction from permanent sales. It is also worth noting that high-volume states, such as Arizona and California, have rates close to 6.6%, whereas low-volume states exhibit tremendous variation in their implicit capitalization rates. The variation is likely due in part to thin markets with few buyers and sellers.

Permanent Sales, Leases, and Options

One striking aspect of the descriptive statistics provided in Table 1 is the dominance of leases in 12 of the 14 states. Permanent trading is only clearly dominant in the dry states of Nevada and Utah, where diversions and permanent trading have always been an integral part of settlement and development.

In the presence of supply uncertainty, many water agencies in the West seek to purchase water only in dry years when their own supplies are inadequate. This may explain trading behavior in Idaho, Oregon, and Washington, where most water transfers are leases for environmental and (to a lesser extent) agricultural use. Such leases may be in response to annual water year conditions. A water rights transfer would be an appropriate response to permanent shortage rather than the year-to-year supply uncertainty which often prevails. In short, leases are common because temporary transfers of one year or less face significantly fewer environmental regulations, the costs of defining rights sufficiently to sell them permanently are often prohibitive, and the presence of sufficient supply in wet years makes permanent transfers unnecessary and costly in many cases.

A specific type of leasing—the *option agreement*—is gaining currency in California. Under an option agreement, the purchaser pays an option cost in the fall before the winter precipitation for the right to purchase a specific quantity of water in the spring, should the water year turn out to be dry. By paying the option cost, the buyer manages supply risk by avoiding last-minute spring contract negotiations for water, which may no longer be available at a reasonable price. Buyers can further decrease transaction costs by negotiating long-run, multiple exercise options. The benefits of options are twofold.

First, the water remains in the basin of origin during average and wet water years, lowering third-party financial impacts and making it more likely that regulators will approve the transfers. Options undertaken due to the burdensome regulatory requirements of permanent transfers are second best from an economic efficiency perspective, but are preferable nonetheless to no trades at all. Second, given supply and demand circumstances in California, this is an efficient arrangement of property rights and uses. In California, a typical trade might be between small water rights holders in the North with low-value agricultural use and a large municipal water agency in the South with relatively high-value use. Because the municipal agency has a relatively high-value use but sufficient developed supplies during wet and normal years, the water is most efficiently allocated to the municipal user in dry years and the agricultural farmers in wet and normal years.

Who should own the water to best ensure efficient allocation between dry and wet years? If we assume for simplicity that the transaction costs are the same regardless of who owns the water, then the water right should remain with the low-value agricultural use, so that transaction costs are a lower proportion of the buyer's final sale price. If transaction costs vary depending on who possesses the water right (small buyers may collectively face higher bargaining costs than a single large buyer), this further strengthens the case for low-value users to retain their water rights.

An option agreement negotiated in advance of the water year helps the municipal agency manage its supply uncertainty. If the difference in value between the buyer and sellers is larger than the transaction costs, the agricultural rights holders can be sufficiently compensated for this dry-year option contract. To the extent that western states will have to increase water trading to balance demands, and third-party pressures increase, we expect the proportion of option contracts to increase.

Water Markets in the Future

Markets as a mechanism for water allocation are gaining traction in the western United States. However, concern over environmental and economic externalities and third-party impacts in exporting regions will continue to be issues with which developing markets must contend. These institutional impediments to water transfers, combined with the uncertainty of water supply, will probably lead to a proportional increase in the number of lease transactions relative to permanent sales of water rights. In particular, the risk-sharing characteristics of option agreements correspond precisely to the need for flexibility in those instances where supply risk is shared by both parties or where it is possible to sell risk between parties.

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The Future of Wetlands Mitigation Banking

Leonard Shabman and Paul Scodari

Introduction

Concern over historic wetlands loss led to a national goal of no net loss (NNL) of wetlands acres and their environmental services. In support of the NNL goal, the US Army Corps of Engineers (Corps), under authority granted by Section 404 of the Clean Water Act, reviews permits to discharge fill material into wetlands. A permit review process called *sequencing* requires a permit applicant (permittee) to first demonstrate to a regulator that they have applied all practical means to avoid and minimize the filling in of wetlands areas as part of a development project. Then the NNL goal requires permittees to provide replacement wetlands—ecologically successful restoration of former or degraded wetlands or creation of new wetlands from uplands—to offset the adverse environmental effects of the permitted wetlands filling (see Shabman, Stephenson, & Shobe, 2002, for a discussion of offset programs in air and water pollution control programs).

When the replacement requirement was first established, permittees were expected to provide replacement wetlands (or wetlands "credits") that were similar to the types of wetlands filled ("in-kind"), and that were located on or adjacent to the area of the fill ("on-site"). However, over time, program evaluations consistently found that inferior wetlands restoration and creation practices often were employed by permittees who had little skill (or interest) in wetlands restoration. Even when state-of-the-art practices were applied, the on-site and in-kind requirement often prohibited long-term ecological success, especially for replacing lost habitat services (e.g., wetlands hydrology was compromised by surrounding development). Meanwhile, because limited agency resources for monitoring and enforcement had to be scattered among many small wetlands credit projects, the quality of the credits was not assured; in fact, some required credit projects were never undertaken. These problems motivated interest in new approaches—generally called "wetlands mitigation banking"—for securing ecologically viable credits. One approach to mitigation banking relies on third parties (neither the regulator nor the permittee) to produce wetlands credits that can be used as offsets. Third-party wetlands mitigation banking often has been cited as a successful application of market-like environmental policy. After reviewing the experience with wetlands mitigation banking, we will conclude with a comment on whether this regulatory innovation fits the definition of market-like environmental policy.

Mitigation Banking in Brief

The *single-user wetlands mitigation bank* leaves the responsibility for credit production with the permittee. Under this mitigation option, a large land developer or a state Department of Transportation that expected to receive multiple future permits develops one large credit project in advance of and located away from ("off-site") their anticipated fills. The credits, once certified by the Corps, are deposited into a "bank account" that is drawn upon as future fills are permitted. The off-site location and large size of these credit projects increases the chance of ecological success and allows the Corps to better target its limited monitoring and enforcement resources.

Cases where investment in a single-user wetlands bank was not an option because of the small size of wetlands fills (e.g., parts of an acre) or the infrequent nature for a user led to the development of *fee-based programs*. In a fee-based program, permittees pay a fee to a third party, certified by the Corps, who produces wetlands credits in one or more off-site locations. Once the fee is paid, the third-party provider accepts financial and legal responsibility for the success of the credits. In an in-lieu fee (ILF) program, wetlands credit production occurs when a new project is initiated, while in a cash donation program the fees are

What is a wetland? An area that is regularly saturated by surface water or groundwater and is characterized by a prevalence of vegetation that is adapted for life in saturated soil conditions (e.g., swamps, bogs, fens, marshes, and estuaries). However, not all wetlands are subject to regulation under section 404 (US EPA, "Terms of Environment," http://www.epa.gov/OCEPAterms. Photograph by Lynn Betts, courtesy of USDA-NRCS.)

used to expand an ongoing wetlands restoration project beyond its original scope. In either case, credit production does not begin until adequate funds are collected. Because fee-based providers are typically government agencies or nongovernmental conservation organizations that have the mission of wetlands restoration and creation, there is some confidence in the quality of the credits that will be produced. Nevertheless, fee-based programs have been criticized for inadequate credit production practices and for setting fees that either may not recover the costs of producing credits, or that may be so high that they discourage use of the program. Also, there is a temporal loss of wetlands acres and services while sufficient fees are being accumulated (see Scodari & Shabman, 2001, for a review of in-lieu fee programs).

Fee-based programs established a precedent for transferring legal and financial responsibility from permittees to third-party credit providers in return for cash payments. That precedent generated incentives for the development of *commercial wetlands mitigation banks* in which private entrepreneurs make investments in wetlands credit production and then earn a return on those investments by selling the resulting credits to permittees. In developing federal guidance for certification and use of commercial wetlands banks, regulators faced a tension between ensuring high-quality credits and the financial viability of commercial wetlands bankers. The former could be guaranteed by requiring wetlands credits to be produced and certified before they could be sold. However, it may take five or more years before ecological success can be fully judged, and a private investor typically cannot wait that long to begin accumulating returns. Thus, commercial wetlands banks were allowed to engage in limited "early" credit sales (i.e., before the credits have been certified as fully successful) in return for the posting of financial assurances that would be released when credit success was assured. This compromise facilitated the development and use of commercial wetlands mitigation banks that have produced high-quality credits and reduced time lags for securing offsets.

Regulatory Conditions and Commercial Mitigation Banking

Currently, commercial wetlands banks provide only a relatively small fraction, perhaps 10–20%, of all wetlands credits, and there are very few areas where robust credit markets have developed. This situation can be traced to the rules governing when wetlands permits are required and the separate certification rules for commercial wetlands banks that raise costs of credit production and create demand uncertainty.

First, consider investor costs. In addition to investment costs, there are considerable administrative costs to becoming certified as a commercial wetlands bank; the approval process may stretch over several years. These costs and time delays serve as barriers to entry and must be added to credit prices when a prospective banker does successfully navigate the certification process. These increased costs restrict supply of salable credits and at the same time reduce the quantity of credits likely to be demanded by permittees. (For a discussion of these and other regulatory conditions on credit prices, see Shabman, Scodari, & Stephenson, 1998.)

A number of factors work together to create significant credit demand uncertainty. There is market uncertainty about whether future land development in an area will intersect with wetlands and thus require fill permits. But even when permit demand can be predicted, the credit requirements that will be placed on permittees—and the resulting demand for credits—is highly uncertain. In fact, regulatory factors are the greatest source of wetlands credit demand uncertainty. Perhaps most important, the sequencing process continues to give regulatory preference for on-site credits. Only after regulators have determined that on-site credit production is impractical or environmentally undesirable can credits from a third-party credit provider be used as wetlands credits. Then, commercial wetlands banks often must compete with ILF and cash donation programs that do not have equivalent regulatory approval or upfront investment costs. For example, ILF and cash donation programs are not typically required to post financial assurances and do not need to reflect the opportunity cost of capital in credit fees, because they accumulate funds before they undertake credit production. The result is that permittees will favor fee-based credit options over commercial wetlands banks when those alternatives are available. Finally, uncertainty about the future of the regulatory program contributes to credit demand uncertainty. For more than 30 years, administrative and court decisions have rearranged the basic structure of the federal permit program. These changes include matters as basic as what constitutes wetlands, what constitutes fill, and what types of fills are significant enough to warrant sequencing review. These shifting regulatory principles create uncertainty about future permit demand as well as the kinds of credits that may be required or allowed as offsets.

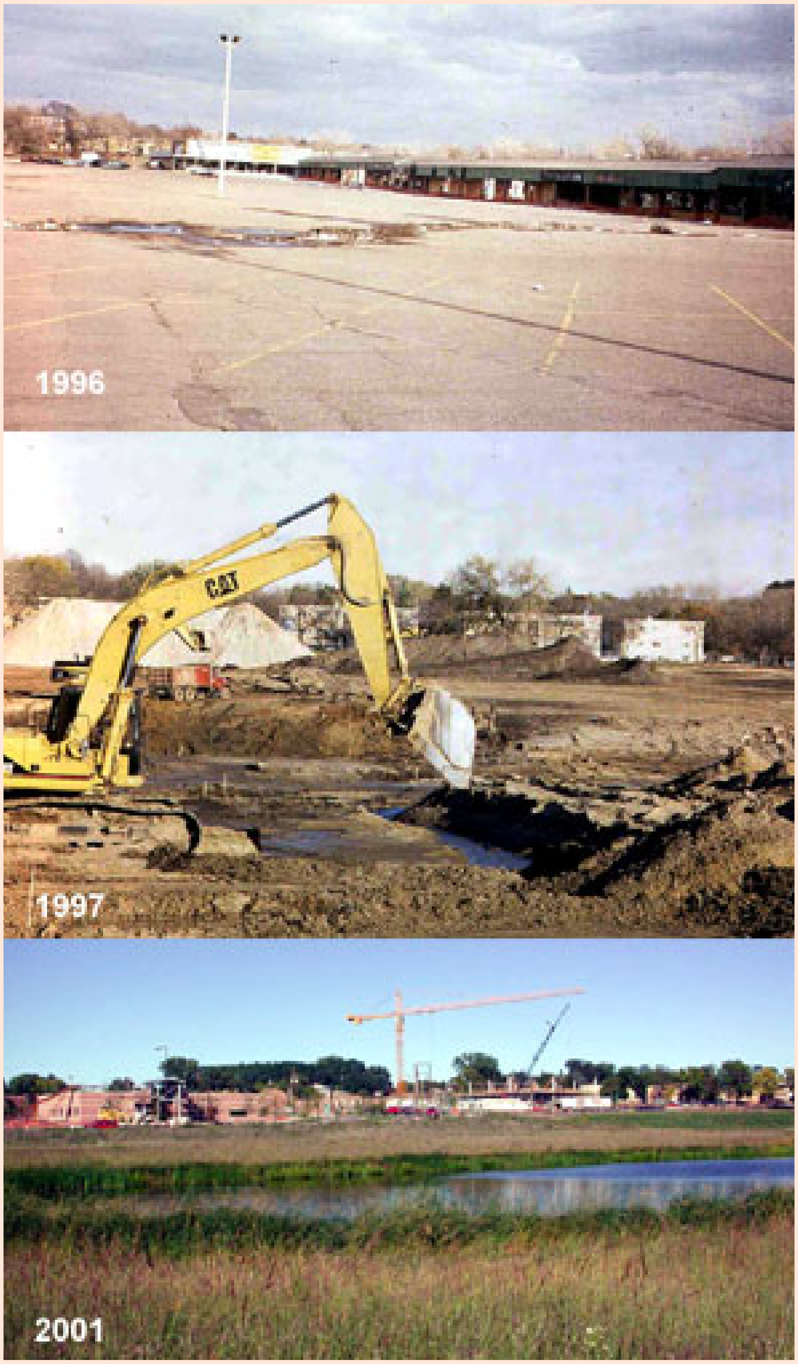
Nonetheless, some commercial wetlands credit production has occurred in many areas of the county since the mid-1990s, indicating that the private sector will provide upfront capital for wetlands credit production if there is an opportunity to profit from such investments. Explicit or tacit understandings with prospective permittees and regulators have offered reasonable assurances that there would be a demand for some of the credits produced, and the allowance for early credit sales (with financial assurances) has helped to ensure a competitive return on investments. It is in such situations that commercial wetlands banks have developed. But, as noted, the amount of credits now supplied by commercial wetlands banks is small relative to other mitigation options, and there are very few areas with multiple commercial wetlands banks competing for business. Moreover, commercial wetlands banks must set credit prices to recover not only the costs of credit production but also the costs of gaining bank certification and the risk costs associated with future demand uncertainty. As a result, the credit prices charged by commercial wetlands banks may exceed what many permittees are able to pay.

A New Form of Mitigation Banking

The private sector has demonstrated the capacity to provide quality-assured wetlands credits, in advance of fill impacts, for use as offsets. To tap this potential of the private sector and to assure that credit prices paid by permittees reflect the full cost of credit production, a new form of mitigation banking is being discussed and developed. Called a *credit resale program*, the approach is now in the early stages of application in the North Carolina Ecosystem Enhancement Program (NCEEP). For a further description of the NCEEP, see Shabman and Scodari (2004).

Three interrelated components characterize a wetlands credit resale program. First, funds to capitalize the program are provided to a government agency that has the mission of securing wetlands credits for permitted fills. Second, that agency uses some of the funding for planning to predict the near-term wetlands credit needs of permittees by type and location. Third, the mitigation agency is given the authority to act as both a purchaser and reseller of credits. In that role, the agency uses a competitive bidding (Request for Proposal or RFP) process to build an inventory of quality-certified credits from private sector suppliers. The bidding process can encourage vigorous competition among wetlands credit providers on both quality and price. The winning bidders immediately begin credit production and are paid by the agency on a defined schedule tied to credit development milestones, the posting of financial assurances, and the attainment of performance criteria. The RFP stipulates credit certification requirements, and the defined payment schedule eliminates credit demand uncertainty, for the winning bidders. The agency then resells the wetlands credits it has purchased to future fill permittees at prices that recover the full costs of securing the credits. As the credit inventory is depleted, new RFPs are issued. If properly designed and administered, this approach can secure the supply, quality, and price advantages of a competitive market for wetlands credits (numerous credit sellers competing for the business of permittees).

Experience to date with the NCEEP wetlands credit resale program suggests two design considerations for helping such a program work as envisioned. First, the RFP application process can be costly, although not as costly as the process



A wetland restoration project at the Phalen Corridor Initiative in St. Paul, Minnesota, 1996-2001. (1996 and 1997 photographs by Phalen Corridor Initiative (http://www.phalencorridor.org). 2001 photograph by Jessie Deegan.)

for getting certified as a commercial wetlands bank. Over time, qualified credit suppliers will need to be the winning bidders on some number of RFPs, or they will not be able to remain in the credit provision business. Thus, the credit resale program will need to issue a significant number of RFPs and then spread the work in some fashion among qualified bidders. However, there will not be enough permitted wetlands fills in one place to assure this result. Extending the program to providing other forms of mitigation credits (e.g., stream restoration, nutrient reduction, etc.) required by different pollution control programs could add to the number of RFPs issued in any year. Also, expanding the wetlands credit resale program concept regionally and across the nation could increase the likelihood that multiple credit providers would be able to prosper.

Second, wetlands offset requirements, and the resulting RFPs for wetlands credits, should be defined in terms of categories of wetlands services (that include hydrology, water quality, and habitat) rather than in terms of the wetlands asset (i.e., wetlands area and aggregate services). The water quality and hydrologic services of wetlands are watershed-location dependent, and if lost to a permitted fill, often must be replaced on or nearby the fill site. However, the values of wetlands habitat services to people and wildlife are less site-dependent, and since wetlands habitat services that are replaced on-site can often be compromised by surrounding development, these services are better secured at off-site locations. In the current wetlands mitigation program, a continuing tension over which services to favor has led to the requirement that wetlands credits be located in the same (usually small) watershed area as the fill permits. However, limiting the location of credits to small watersheds has led to thin markets in wetlands commercial banking (often only one certified bank in many areas). A similar problem would confront a credit resale program in which the RFP process was focused on a very limited geographic area, because this would constrain the possible sites in a watershed where land is suited for a winning wetlands project. As the availability of suitable lands for credit production becomes more limited, it is less likely that competition for credit contracts can be fostered. If offset requirements were stated in terms of wetlands services rather than for the wetlands asset, then a credit resale program could issue RFPs for wetlands habitat services at larger ecoregion scales. This would increase the pool of land parcels that would be suitable sites for credit production, thus making for more robust competition for credit supply contracts.

If the wetlands credit resale approach was used to secure offsets for only the habitat services lost to permitted fills, regulators would still need to secure offsets for any lost hydrologic and water quality services. In determining any needed offsets for site-dependent hydrologic and water quality services, regulators would appropriately consider whether nonwetlands alternatives required by other regulatory programs could provide the necessary offsets. Site design changes (e.g., low-impact development), stormwater ponds, pervious pavement, riparian buffers, and a host of other methods can be substitutes for the water quality and hydrologic services of wetlands and can be implemented on or near the sites of permitted fills. A variety of local and state regulatory programs currently require actions to mitigate for the hydrologic and water-quality effects of land development. Recognition of nonwetlands programs would require wetlands regulators to coordinate with the relevant nonwetlands programs. The responsibility for assuring this coordination could fall to the mitigation agency charged as the credit reseller. (See Scodari & Shabman, 2001, for further discussion of the logic of this approach.)

Discussion

Commercial wetlands mitigation banking and ILF programs are often cited as examples of market-like environmental policy. The reasons for this perception are understandable. A discharger releases a pollutant (fill) into the environment (wetlands) and in turn must pay a price (credit fee) to make that discharge. This appears to be an application of the market-like concept of an effluent discharge fee. Or the permittee must bear the cost of securing an offsetting credit (a manufactured wetland) from another entity, so the NNL goal is met if they make a discharge. This appears to be an application of market-like concepts of cap and trade.

However, the reality does not match the perception. Wetlands mitigation requirements and mitigation credit options are not examples of market-like programs. The polluters (permittees) do pay when they make a discharge, but the discharger does not have discretion on when it is in their interest to avoid the wetlands and when it is in their interest to pay the fee (bear the cost of an offset) and make the discharge. Regulators require permit applicants to do everything the regulator deems practical to avoid wetlands impacts, and regulators determine what kind of offsets will be required and where they can be located. In this regard, the wetlands offset program is like any other offset program. Regulatory reviews drive the permittee towards zero discharge, and then require offsets for the discharges that remain. Wetlands offset requirements are thus best understood as a permit condition tied to a traditional command and control regulatory program.

As with other offset programs, regulators need to have offsets available in a timely fashion and in sufficient quality and quantity to meet the environmental goal—in this case, NNL of wetlands. It was in seeking to meet these needs that the wetlands mitigation program has experimented with different forms of wetlands mitigation banking—some of which have been understood as drawing on the logic of markets. Certainly encouraging private investors to compete for the right to sell wetlands credits is an application of a market-like idea. In the case of commercial wetlands banking, there is a perception that credit prices are being set by a competitive buying and selling. They are not. And it might seem logical that ILF rates are tied to a market price from a competitive credit sales program. They are not.

The wetlands credit resale program is an emerging idea that can use competitive bidding to meet the particular challenge of securing offsets for the wetlands regulatory program. However, unless permittees make the choice about when it is best to avoid making the discharge and when it is best to make the discharge and buy wetlands credits, the wetlands regulatory program should not be viewed as an application of market-like environmental policy. This observation is not offered as a recommendation to change the current practice of wetlands permitting. It is only offered to make the point that applications of market-like environmental policy are rare; at times, what appears to be a market-like policy may not be that at all. That said, as the wetlands credit resale idea suggests, the benefits of competition—certainly an idea derived from the logic for markets—still has much to contribute to the design of wetlands mitigation programs.

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Crunch Time for Water Quality Trading

Dennis M. King

Economists have been promoting water quality (WQ) trading for decades. Over the past few years, many political leaders and upper-level government officials have been joining them. Money has even started to flow from Washington to local trading organizations to help make WQ trading work. However, enthusiasm about WQ trading is based mostly on conceptual arguments about its potential to generate cost savings and ideological arguments about the superiority of market-based solutions over conventional regulatory programs. Experiences with actual WQ trading programs have been discouraging. Under current regulatory conditions, there is simply not enough supply or demand to support WQ trading. The critical question now is whether the regulatory conditions that are inhibiting trading will change any time soon.

According to a recent EPA-funded review, the number of WQ trading initiatives in the United States during 2004 was more than 70 (Breetz et al., 2004), which is up from around 25 just a few years earlier (Environomics, 1999; King & Kuch, 2003) However, this recent review, like previous ones, showed that WQ trading programs are frozen at an awkward pretrading stage of development—plenty of new guidelines, regional trading institutions, and computer simulations of trading, and even some well-developed WQ trading software and websites, but very little actual trading taking place. Most importantly, point/nonpoint[1] trading involving agriculture—the type that will be needed for WQ trading to have a significant impact in many watersheds and the type of trading that will be addressed in this article—has not materialized at all.

Advocates of WQ trading are putting their hopes on the anticipated establishment over the next few years of *Total Maximum Daily Loads* (TMDLs) for individual water bodies. These are a kind of total pollution budget that could be divided among pollution dischargers as individual discharge allowances that could be made tradable. The Clean Water Act of 1972 required each state to develop and implement TMDLs by 1979, but they are only now being developed in most parts of the country. Eventually, TMDLs may provide the market driver that is needed to make WQ trading work. (See Boyd, 2000.) However, establishing TMDLs will merely be the first of many steps that will all need to be taken quickly if WQ trading is to be given a fair chance to succeed. State and local WQ regulators, under increasing pressure to do something soon about growing WQ problems, are beginning to turn to familiar command-and-control methods and subsidy programs that often preclude the possibility of ever having meaningful WQ trading.

The three questions that even diehard trading advocates are beginning to ask are: Why are there so few WQ trading success stories? Why aren't the point and nonpoint sources who are supposed to benefit from WQ trading more supportive? What can be done to improve the situation?

Reviews of regional WQ trading programs reveal the most often cited problems inhibiting regional WQ trading, such as inadequate trading institutions, unclear scoring criteria, and high transactions costs of performing trades, are being overcome in most places (King & Kuch, 2003). What is preventing WQ trading is a simple absence of willing buyers and sellers. Under existing regulatory conditions, the supply and demand curves in fledgling WQ markets barely exist and certainly don't cross at any positive price. Moreover, those attempting to make regional WQ work are usually not in positions to change the situation. Tighter federal and/or state limits on individual dischargers will be required before there will be any commodities (rights) to trade in WQ markets; aggressive enforcement of those limits will then be needed to bolster supply and demand.

1. *Point sources discharge pollution from a single place, such as a pipeline outflow. Nonpoint sources discharge pollution from many places, such as along the edge of a farm or housing development.*

New Water Quality Trading Guidance

In November 2004, the Environmental Protection Agency (EPA) published a *Water Quality Trading Assessment Handbook* (EPA, 2004) to help regional organizations establish "the necessary conditions for successful WQ trading." This national guidance is very general and focuses on tasks such as developing trading institutions, measuring the equivalency of pollution discharges, establishing rules of exchange, setting baselines, assigning liability, and so on. Most of these tasks may be necessary for successful WQ trading. However, none of them will provide the buyers and sellers that are really needed for WQ trading programs to succeed. In fact, managers of the existing regional WQ trading programs that have been failing to produce trades have already completed most of the tasks recommended in these new EPA guidelines. What are needed beyond what is outlined in the EPA guidance are steps that will change the incentives and disincentives facing prospective buyers and sellers in ways that will make them want to trade.

Time Pressure

Developments in the Chesapeake Bay region, especially in the State of Maryland, illustrate why these steps need to take place soon, before WQ trading becomes impossible. More than three years of work by a partnership of state/federal resource agencies and stakeholders culminated in 2003 with a set of guidelines to support watershed-based WQ trading. At that time, it was generally assumed that TMDLs were just around the corner and that once trading guidelines were adopted, trading would take place with wastewater treatment facilities (point sources) that have relatively high discharge treatment costs purchasing WQ "allowances" from agricultural interests (nonpoint sources) with relatively low discharge reduction costs.

In early 2004, however, Maryland's governor and state legislature responded to public pressure to do something about WQ by establishing an innovative \$2.50 per month "flush tax" on water and sewer users (mostly urban dwellers) to create a fund to subsidize the installation of state-of-the-art discharge treatment technologies at the state's wastewater facilities. A similar tax was levied on households on wells and septic systems (mostly rural dwellers) to subsidize the planting of agricultural cover crops and other agricultural "best management practices." Of course, the flush tax all but eliminated the expected demand for WQ credits by wastewater facilities; and the subsidization of agricultural practices all but eliminated the expected supply of low-cost agricultural WQ credits. With the stroke of the governor's pen, prospects for WQ trading any time soon in Maryland evaporated.

Beyond the ABCs of WQ Trading

In principle, establishing an emission trading program is a simple three-step process involving: (a) establishing an overall cap on pollution discharges, (b) allocating portions of the cap as allowances to individual discharge sources, and (c) allowing each source to meet its allowance by reducing its discharge or by purchasing credits from other sources that reduce their discharges below their allowances. As long as there are differences in discharge reduction costs, sources with high costs of meeting their allowances will purchase credits from sources with low costs, and a market will be born. This is the process that established the highly acclaimed and apparently successful air emission trading programs that helped reduce SO_2 emission (acid rain) problems (see Stavins, this issue).

However, the land and water use decisions by nonpoint sources that cause local water quality problems are very different than the point source smokestacks that cause regional air pollution problems. Most water emissions are difficult to measure, change with the weather, have different impacts depending on where they occur, and are the results of ever-changing locally made and locally regulated decisions. This is a complicated problem to attempt to address with trading. In fact, two areas of recent economic research suggest that in this type of situation a great deal of political and regulatory reform may be necessary to interest anyone in trading.

The first area of economic research won two economists—Finn Kydland of Carnegie Mellon University and Edward Prescott of Arizona State University—the 2004 Nobel Prize in economics. Kydland and Prescott (1977) explained why and how people "game" regulatory programs; that is, why and how they strategize to evade regulations and employ legal and political maneuvering to avoid, delay, and reduce penalties for violating regulations they cannot avoid. The second involves work in what might be called "environmental enforcement economics." This area of research also addresses how people "game" regulatory programs, but focuses specifically on that little benefit/cost calculation that each regulated entity performs to determine whether or not to comply with a regulation.

Market-based solutions to WQ problems, despite considerable rhetoric to the contrary, are not substitutes for regulatory solutions; they rely on and complement regulations. It is well known, for example, that the acid rain trading program succeeded because precise individual SO_2 discharge limits were established and strictly enforced with 100% monitoring and severe financial penalties for violators (see Stavins, this issue). For now, at least, most nonpoint water pollution dischargers are either unregulated or do not expect that violating regulations will be detected or will be very costly. As a result, they have little incentive to get involved in allowance trading. Many of them are also aware that accepting the notion that tradable discharge allowances (i.e., "pollution rights") can be neatly defined and assigned to individual entities could undermine their long-term political and legal strategies for fending off regulations. Asserting that they have a credible basis for earning money by selling WQ credits now, in other words, means that others will have a credible basis for justifying future restrictions on their emissions that could result in significant long-term costs later.

Based on the above-mentioned economic research, what is being observed in WQ trading programs, in other words, is exactly what should be expected. In the face of weak, rarely enforced emission discharge restrictions and penalties for noncompliance that are small and easily avoided, few dischargers are interested in buying WQ credits. Where there is no demand for WQ credits, there is no incentive for anyone to try to supply credits. This is a fairly simple conclusion, but it implies that strategies to improve point/nonpoint WQ trading should focus on demand-side and supply-side issues, rather than the institutional and technical issues that occupy the time of most WQ trading experts.

Demand-Side Issues

To appreciate what needs to be done to stimulate demand, it is useful to abandon the standard economist's operating assumption that a potential buyer's willingness to pay for a WQ credit is based on that entity's marginal cost of complying with nutrient discharge restrictions (e.g., dollars per pound of nutrient discharge reduction). Instead, assume that the correct measure of an entity's willingness to pay for a credit is the expected cost of *not* complying with a government-imposed discharge restriction. If the expected cost of not complying is lower than the cost of complying by purchasing credits, there is no economic incentive to purchase credits.

Virtually everywhere that WQ trading is being attempted, laws limiting nutrient discharges (on nonpoint sources at least) are weak, rarely enforced, and involve such low penalties that the expected cost of noncompliance is near zero. The corresponding willingness to pay for nutrient discharge credits, therefore, is also near zero. There is no "natural" demand in regulation-driven markets; demand always depends on what regulations are in place and how they are enforced.

The two 2004 Nobel-winning economists examined the deterrent effects of regulations in considerable detail and pointed out the impact of what they labeled "time inconsistency problems" with many regulatory programs. In case after case involving financial and real estate markets, flood insurance markets, and environmental compliance, they showed that people, acting alone and in groups, significantly discounted the expected cost (penalty) of not complying with a regulation if they believed that it would not be implemented consistently over time and could be influenced later. Kydland and Prescott's work demonstrated that people tend to believe that if government yields to one kind of political pressure to pass laws restricting their polluting behavior now, they can be expected to yield to other political pressure later that will prevent the enforcement of those laws or the imposition of meaningful penalties.

Their research showed that the success or failure of regulatory systems (market based or otherwise) depends overwhelmingly on bottom-up microeconomic decisions regarding opportunities to game those systems, and far less on macroeconomic governmental decisions about how those systems are supposed to work.

Based on this research, it seems that bolstering the demand side of WQ markets will require mustering the political will to establish a credible system for enforcing individual allowances, and imposing meaningful penalties for exceeding them.

Supply-Side Issues

The gaming model (as opposed to the marginal cost model) also explains what is inhibiting the supply side of regional WQ trading markets. In watersheds where agricultural sources are significant, it is usually assumed that they will be the primary suppliers of WQ credits. However, the willingness of farmers to supply WQ credits depends in critical ways on how it might affect their ability to continue receiving agricultural subsidies and green payments and to fend off future environmental regulations. The main problems farmers face here (although they do not refer to them in these terms) are what in environmental trading circles have become known as *baseline/additionality* issues.

To protect the integrity of trading programs, trading guidelines nearly always prohibit farmers from selling credits for undertaking land use/land management changes that are legally required (e.g., by state regulation) or for which the farmer has already been paid (e.g., green payments). Setting the baseline for credits in this way reduces the ability of farmers in most watersheds to supply low-cost WQ credits. However, it has other impacts on farmers as well. It means producing WQ credits by implementing management practices that go beyond what they are already required to do will require farmers to somehow validate that these practices do, in fact, reduce discharge levels. The need to establish a baseline and show additionality poses two problems for farmers who are considering supplying WQ credits.

First, it requires that someone examine and document what farmers are already doing to meet their legal requirements in order to establish the baseline for measuring marketable WQ credits. Most farmers, for obvious reasons, are not interested in having government representatives or their agents examining, thinking, and talking about the legality of their on-farm land use/land management practices or their justification for green payments.

Second, farmers know that their discharges are not regulated as much as discharges from most other sources because, presumably, farm discharges are too difficult to control or measure, too dependent on the weather, too expensive for farmers to manage, and so on. Selling credits requires farmers to provide evidence to validate that, in fact, they can reduce their discharges and document the results. Many analysts have addressed validation requirements in terms of their potential to increase transaction costs associated with completing market trades and the likelihood that these higher costs could drive a wedge between buyers and sellers. However, a more important problem may be that if farmers show that they can validate the creditworthiness of their on-farm activities, it is bound to call into question whether they should be regulated any differently than other dischargers.

There are also other disincentives facing farmers. The price farmers will accept for WQ credits reveals their discharge control costs and shows the world that they are most certainly lower than the discharge control costs of those buying credits. This focuses attention on what many already believe are inequities in the way discharges are regulated and, perhaps, in the way allocations of discharge allowances are made to farmers and others. It also provides evidence that a better long-term cost-saving strategy for dealing with WQ problems might be to tighten restrictions on farmers with low treatment costs and relax them on other dischargers who have higher marginal treatment costs.

The sources of these disincentives on the supply side of WQ trading are similar to those on the demand side. Weak, vague, and largely unenforced discharge restrictions inhibit potential suppliers from engaging in trading, just as they inhibit potential buyers. However, the strategies that farmers can and will use to game market-based environmental programs are intertwined with their strategies for gaming other government programs, so supply-side problems appear to be more complex.

The Immediate Challenge

Careful observers of emerging WQ trading understand that this type of market-based solution is not an alternative to WQ regulations. However, this is still not fully understood by many political leaders and agency heads. One immediate challenge, therefore, is to convince those who are using the promise of market-based environmental solutions as a justification for relaxing regulations that this strategy cannot succeed. Another immediate challenge is to convince those who are introducing new WQ initiatives, such as mandatory engineering or discharge standards, that their decisions may make it impossible to have WQ trading or to realize potential cost savings from WQ trading. At the same time, it would be useful for those involved in developing regional WQ trading to perform what might be called a "WQ enforcement audit" in their region to determine how much political and regulatory reform will be needed to stimulate supply and demand and make WQ trading work.

The fact remains, however, that the regulatory context that provides the incentives and disincentives for buyers and sellers to participate in regional WQ trading is usually not within the control of the people who are attempting to make regional WQ trading work. One useful strategy, therefore, is for those people (and all the rest of us who want WQ trading to have a chance to live up to its potential) to work together to influence state and federal agencies and elected officials who set the legal and regulatory context for WQ trading. Such an initiative could focus on the following five tasks:

- Make sure the new EPA guidance is followed when establishing a WQ trading program;
- discourage command-and-control regulatory programs that inhibit WQ trading;

- encourage binding discharge restrictions on point and nonpoint sources;
- encourage meaningful monitoring and enforcement of restrictions with stiff penalties; and
- determine gaming strategies that point and nonpoint sources will use to limit regulation and avoid penalties and encourage countervailing public policies.

If these tasks are undertaken soon, the potential of WQ trading might be realized. If not, WQ trading will probably wind up in the overflowing dustbin of well-intentioned economic policies that attracted attention for a while but never delivered.

For More Information

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