ECOSYSTEM MULTIPLE MARKETS

A White Paper

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EXECUTIVE SUMMARY

In examining the potential applications of multiple environmental commodities markets to support restoration projects in the Great Lakes, this white paper which coins the term "Ecosystem Multiple Markets" (EMMs). Specifically, this term refers to a market-based framework that generates multiple environmental commodities from an integrated ecosystem restoration design approach. Credits for greenhouse gas emissions reductions, nutrient or sediment reductions ("water quality" credits), wetlands and habitat creation from such projects are sold in local, regional and/or global environmental markets. The strategy is to identify and sell various ecosystem services produced by one project. This concept of commoditizing such services is thought to have two outcomes. First, restoration design will be more comprehensive to maximize environmental benefit and services. And secondly, there will be additional incentives for creating new projects resulting in environmental improvements that go beyond a minimum threshold or compliance level established by current regulatory schemes. This white paper therefore attempts to:

- Compare and contrast existing market-based frameworks for Great Lakes applications;
- Evaluate the underlying market mechanisms related to deriving multiple market benefits;
- Poll the existing literature and partners to identify potential market interests that will support the project hypothesis;
- Examine the interagency partnerships, policy needs, and regulatory framework necessary to implement multiple market trades;
- Assess the future needs for communications, promotion, information transfer and marketing;
- Identify opportunities to leverage other programs; and
- Define the operational needs of the ETN to pursue future pilot demonstration projects

The paper also recognizes projects that have been initiated in areas other than the Great Lakes but where conceptually, these might apply to the Basin. We highlight here, some of examples used to illustrate the concept and its applicability from the Draft white paper.

<u>The EMMs Concept</u>

Existing market-based frameworks, which focus singularly on the sale of one commodity, fall short of achieving the best possible environmental outcome, i.e., optimized ecosystem benefits. Best management practices (BMPs), stormwater treatment designs, conservation measures, and other land use practices often do not consider a range for functional ecosystem management issues. This leads to:

- Ecologically fragmented markets that prevent the capture of multiple environmental benefits available from the synergies among various ecosystem management efforts;
- Thin markets and high transaction costs;
- High compliance costs and diminishing returns from environmental investment; and
- Lack of funds and other resources.

In the EMMs framework examined in the white paper, these issues are conceptually addressed by the markets' abilities to foster ecologically integrated environmental designs. Compared to the individual environmental commodities markets, EMMs would conceptually transform environmental protection activities from reactive measures to proactive undertakings.

A beneficial consequence of ecologically integrated markets is the increased market size for environmental commodities. One restoration project may generate multiple environmental commodities for markets of various sizes where commodities may be sold to pools of buyers and over different geographic ranges. As a result, each commodity market is expanded.

This white paper focuses its research on the Great Lakes region to address application issues. The opportunities and issues identified in this region, however, are applicable in principle to other regions in the nation.

The Ecosystem Multiple Markets Framework

The EMMs framework is built on two objectives: (1) to create market demand for environmental commodities and (2) to stimulate the production of these commodities. The center piece of the framework (Figure ES-1) is the production of multiple environmental commodities. The hypothesis is that the more such commodities are produced, the closer we are to the goal of functioning ecosystems. Environmental commodities can be emissions credits, environmental services (e.g., habitat for endangered species and ecological functions of wetlands such as denitrification and flood storage), and/or units of treatment and pollution controls. Because most of the environmental improvement levels required by current law and regulations are necessary to achieve some minimum ecosystem functions (e.g., designated uses), in order to realize optimally functioning ecosystems, only environmental commodities produced in absence of these law and regulations or in exceedance of the required improvement levels can be traded in the EMMs to generate economic returns.

By allowing purchase of environmental commodities to reduce the cost of compliance (e.g., air emission and water quality standards), ecosystem improvement (e.g., habitat restoration), and/or environmental risk management (e.g., pollution prevention and flood storage), the EMMs framework would create the markets and subsequently, demand for these commodities. Demand stimulates supply and promises economic returns on investment in producing these commodities. By designing market mechanisms to facilitate the exchange of multiple environmental commodities in an integrated market place, the EMMs framework would increase the flow of these commodities on the markets. A high volume of commodity exchange reflects a high production level of this commodity, which can lead to an efficient allocation of resources used to produce the commodity. Furthermore, as the primary markets develop and mature, the EMMs framework encourages the growth of secondary markets to facilitate trading and reduce business operation risks (e.g., environmental financial products).

Why Might EMMs Work?

Fundamentally, it is envisioned here that EMMs would foster an ecologically integrated environmental market, allowing capture of the synergies among various ecosystem management efforts. The ability of EMMs to integrate fragmented environmental markets can be illustrated by nitrogen management in the EMMs framework.

Currently, nitrogen management is still centered around traditional solutions, namely conservation subsidies to farmers, the use of best management practices (BMPs), and tighter controls on point sources. The limited progress we have achieved so far in reducing nitrogen loading to our nation's water bodies made it apparent that these conventional approaches are not adequate. The reasons are clear—these traditional solutions are too expensive and address too small a segment of the problem. The EMMs framework, on the other hand, can take advantage of the synergies among water quality, drinking water protection, wildlife habitat, and climate protection that nitrogen control can provide.

Nonpoint sources, particularly agriculture, contribute significantly to water pollution and remain largely unregulated. The National Research Council estimates that approximately half of the national nitrogen and phosphorus residual results from excess nutrient use. Nitrogen not only contributes to fresh and estuarine water quality problems, it is also a contributor to climate change. Nitrous oxide is one of the most powerful GHGs, with the ability to trap 310 times as much heat as carbon dioxide. About three-quarters of total U.S. emissions of nitrous oxide emissions come from agricultural production each year.

Many of the same activities can improve water quality, reduce or prevent GHG emissions, and provide wildlife habitat. For example, fertilizer management plans reduce the surplus nitrogen available to be lost to water as well as to the atmosphere. Protected or restored wetlands can remove nitrogen from the water and prevent it from transforming to nitrous oxide. Forested buffer zones can simultaneously protect water bodies from diffused nitrogen sources, increase carbon sequestration, and provide habitat for wildlife. Research by World Resources Institute (WRI) has shown that a well-targeted water quality program aimed at reducing nutrients and using market-based mechanisms to provide flexibility in meeting water quality goals in the Mississippi River Basin, could also provide climate co-benefits of up to 15% GHG reductions in all the sub-basins. In the EMMs framework, all these co-benefits would be commodities explicitly defined and tradable. As a result, nitrogen management would be geared towards generating the most possible co-benefits. This coincides exactly with the essence of the holistic ecosystem restoration approach—considering all interconnected aspects of an ecosystem.

Because of the markets and the economic incentives associated with them, the EMMs framework has the potential to promote innovative pollution reduction approaches, new technology, and more ecologically holistic improvements. Compared to the individual environmental commodities markets, EMMs would transform environmental protection activities from reactive measures to proactive undertakings. In addition, in EMMs because ecosystem services such as habitat restoration are produced and traded just like other commodities in the economy, these services are brought to the general public with a realization of their existence and their economic as well as ecological value.

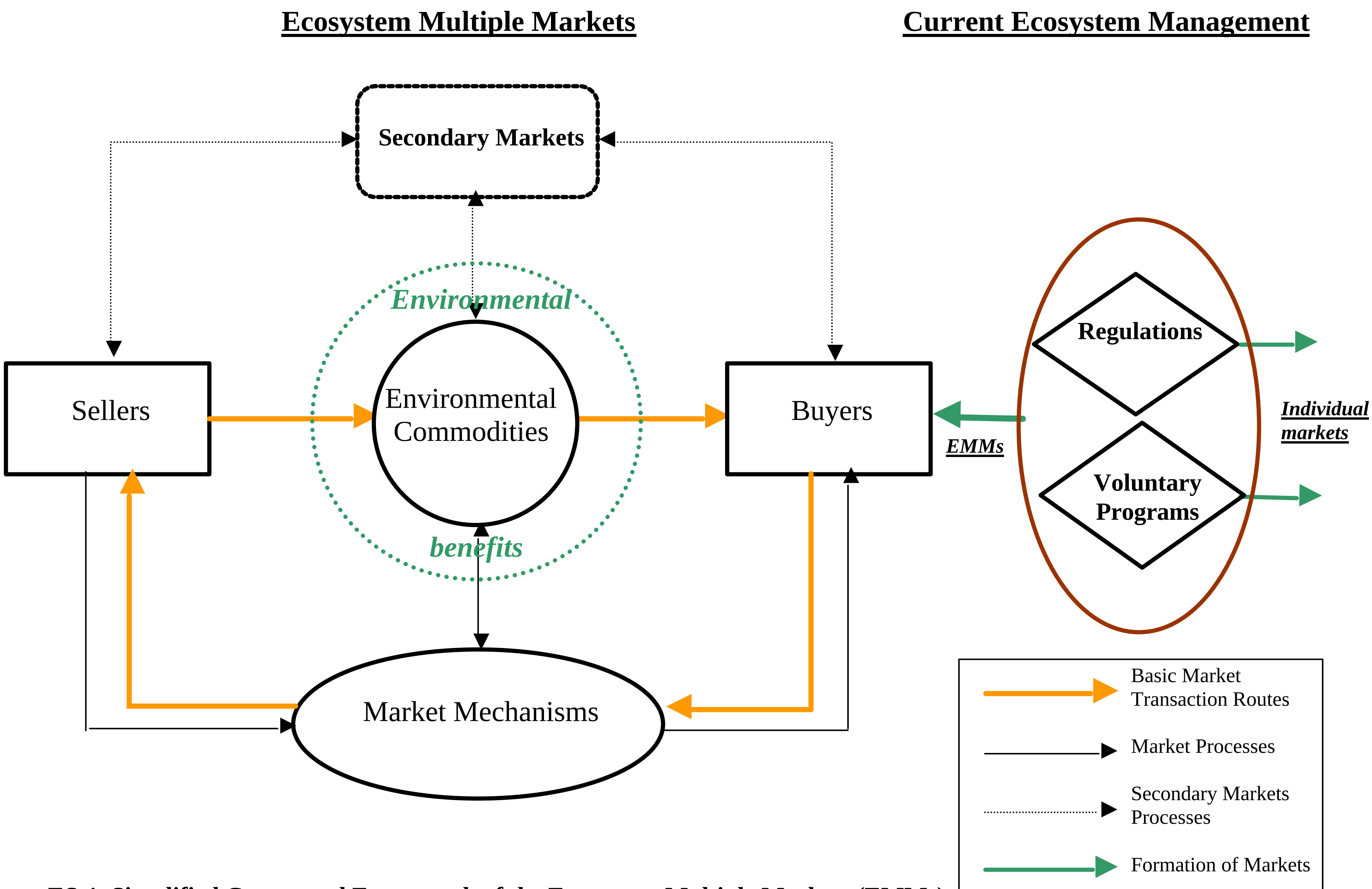


Figure ES-1. Simplified Conceptual Framework of the Ecosystem Multiple Markets (EMMs)

Another important beneficial consequence of ecologically integrated markets is the increased market size for environmental commodities. One restoration project may generate multiple environmental commodities for markets of various sizes. Each commodity may be sold to pools of buyers and over different geographic ranges. As a result, each commodity market is expanded.

Feasibility of Demonstrating EMMs in the Great Lakes Region

The white paper outlines select examples to examine the potential for demonstrating the EMMs framework in the Great Lakes region. The issue is approached from the following perspectives: existing market-based environmental programs and infrastructure, political willingness, public acceptance, and market potential for EMMs.

Under the current regulatory conditions, and through existing and developing market-based programs, four potential environmental commodities were specifically considered in these regards for a pilot program in the Great Lakes region:

- Water quality credits from direct water quality improvement measures
- Ecosystem function mitigation for wetlands
- Greenhouse gases
- Endangered species/wildlife habitat

By examining the potential market value of restoring coastal wetlands in the Great Lakes region, the feasibility analysis suggests, for example, that the annual market value of 1,970 acres of costal wetlands could reach up to $168 million for a combination of all four environmental commodities. Whether actual markets would bear out these returns is speculative. However, the need for broader consideration of the potential for multiple market commodities is aptly illustrated by this example.

Funding opportunities for initiating projects to generate environmental commodities are also examined in the paper. Among other sources, provisions in the 2002 Farm Bill create the Conservation Innovation Grants (with a 50% match) as part of the expanded Environmental Quality Incentives Program (EQIP). This newly established grant program awards governmental organizations, non-governmental organizations or individuals that leverage federal funds to implement innovative approaches to conservation including market-based incentives. Up to $15M are available for these projects in 2004 with proposals due May 28th. U.S. EPA recently issued a request for proposals for 2004 Watershed Initiative Grants ($21M) focusing on market-based incentive programs. EPA has also proposed another $4M for Targeted Watershed Grants in 2005 that specifically address water quality trading initiatives. The success of the Chicago Climate Exchange to garner significant support and interest in a voluntary greenhouse gas market highlights the potential for private sector interest in these markets. Other private sector interest is growing for overlapping market opportunities with wetlands mitigation and conservation banks, though typically outside of the Great Lakes Basin.

Steps in the Implementation Phase of a Pilot Project under the EMMs Framework

The white paper examines in detail, the fundamental elements of EMMs in the context of an experimental framework. Demonstrations would serve to identify functional aspects and requirements theoretically leading to operating markets. Carrying out a pilot in the region would involve identifying the supply and demand of environmental commodities for a select geographic area, establishing market institutions or infrastructure to facility trading (where none exist), tracking and potentially brokering actual trades. Five simplified process steps are outlined here for a potential pilot project implementation:

1. Project site selection—in this step, a geographic area (likely a watershed) or multiple areas in the Great Lakes region are identified where existing market drivers for improvement (TMDLs, wetland/habitat losses, flooding, regulated entities) are present. Existing organizational infrastructure, robust environmental data, regulatory willingness should be present for these sites.
2. Framework building—in this step, the institutional arrangements for the EMMs strategy are created to facilitate and oversee trading in the framework. This step would include designing market institutions for each environmental commodity as appropriate to meet the local need, with transferable elements to other systems to ensure environmental efficacy and market efficiency. Proposed market structures would utilize and incorporate currently available exchange markets (e.g., the CCX) and trading tools (e.g., the NutrientNet by the WRI).
3. Environmental commodity production—in this step, the design/engineering work is performed to improve or restore ecosystem functions and maximize potential credit generation.
4. Transaction of the environmental commodities—in this step, various commodities generated in the pilot project are traded in the experimental market framework.
5. Research and reporting—in this final step, documentation will be needed to facilitate transferability to other settings.

CHAPTER 1.

INTRODUCTION TO THE ECOSYSTEM MULTIPLE MARKETS CONCEPT

This chapter introduces the concept of ecosystem multiple markets and provides an overview of the white paper. Detailed explanations of the multiple framework are the focus of Chapter 2.

I. Background

Traditional regulatory programs manage water and other natural resources for their designated uses and to protect human health. Managing natural resources to protect and conserve healthy, balanced ecosystems has shifted subtly to managing for human-based designated uses over the last twenty years. The tremendous progress that has been made in reducing atmospheric emissions and discharges of pollutants to the nation's waters to meet designated uses has nonetheless been accompanied by a loss of contiguous wetlands, inland and coastal floodplains, and habitat for aquatic and terrestrial fauna and flora. Agricultural, urban and residential runoff, and other non-point sources remain a serious challenge to making further progress in many areas. Air pollution continues to threaten the health of large populations in urban centers and global warming increasingly shows signs of its detrimental effects on all levels of ecosystems.

Even with the intermediate goals of human-based designated uses, the traditional command-and-control (CAC) approach to environmental protection regulation has run into problems of rapidly rising costs and decreasing effectiveness. Market-based regulations, first proposed by economists in the 1960s (Baumol and Oates, 1988) as an alternative to the CAC approach, have promised cost savings and technological innovations in pollution control. After over two decades of experimenting and particularly after the successful implementation of the national Acid Rain Program in reducing the SO_2 emissions, market-based regulations have seen increasing acceptance by policy makers as well as economists in the United States (U.S.). A number of states in the nation are actively developing water quality trading programs to facilitate implementation of total maximum daily loads (TMDLs) as required under the federal Clean Water Act (CWA). The U.S. Environmental Protection Agency (US EPA) is also stepping up efforts to promote water quality trading as part of its watershed management toolbox (Christen, 2002) with the official issuance of its Water Quality Trading Policy on January 13, 2003 (US EPA, 2003a). Recently, the US Fish and Wildlife Service released its guidance for the application of conservation banks to "aid in the recovery of the species" (US FWS, 2003).

Although market-based programs such as water quality trading have the potential to significantly reduce the cost of achieving and maintaining current regulatory pollution reduction goals, they typically focus on relatively small geographic areas where impairments have occurred or individual pollutants are the targets of the programs. This approach, in many cases, results in fragmented efforts rather than holistic management. Such fragmentation is caused by the segregated management of various ecosystem components and resources that are close-knit and inter-dependent by nature. It reduces the potential for establishing multiple markets that might simultaneously incorporate water quality, air, wetlands, habitat, fisheries and other ecosystem goods and services (e.g., commercial and recreational fishing, hunting, logging). The CWA set water quality goals for the nation's waters to achieve attainment of designated uses (Figure 1), not go beyond them. These intermediate ecosystems goals typically drive funding and environmental priorities. While water quality trading and other CWA tools offer the ability to reduce the costs of achieving these goals by optimizing compliance expenditures, (as well as offset growth), there are few opportunities to support (i.e., fund) additional improvements to reach some optimal level of ecosystem function. Therefore, a paradigm shift is needed to broaden (de-fragment) and weave these markets together to optimize environmental improvements that will serve to holistically benefit the broader ecosystem by capitalizing on ecosystem investments.

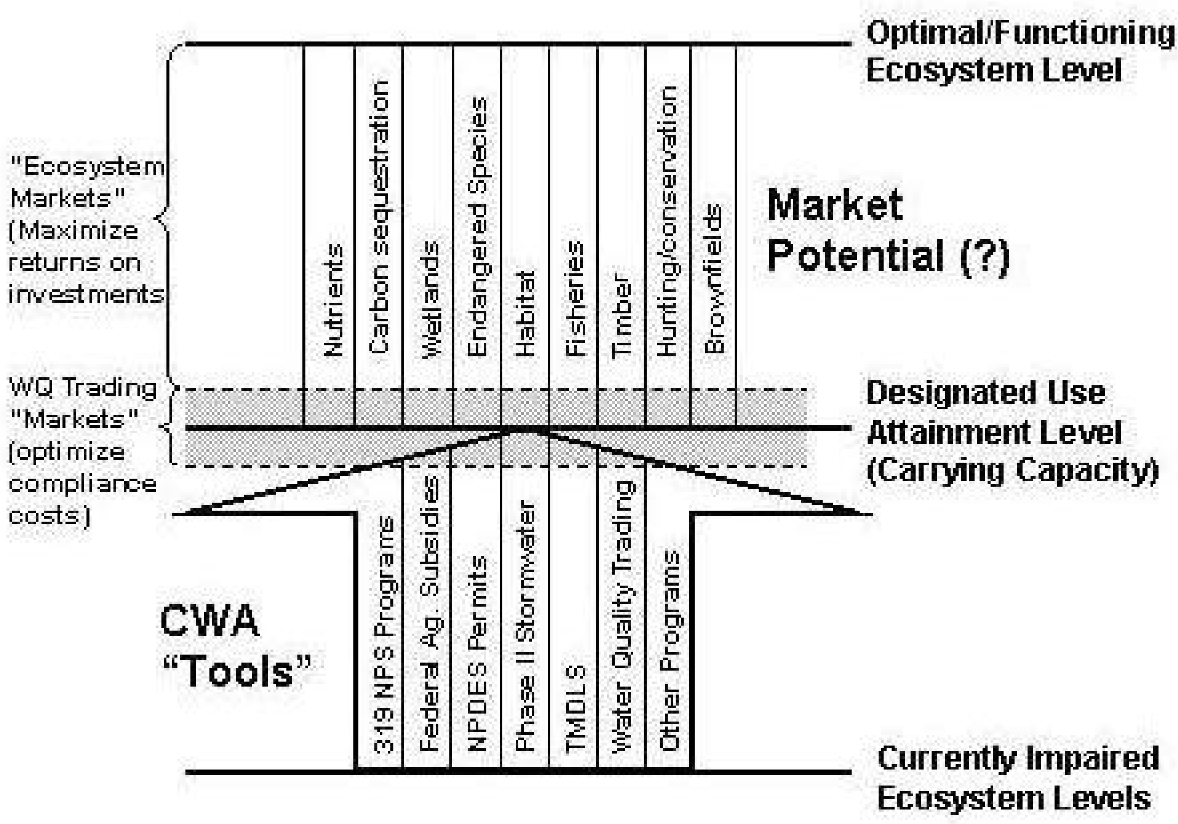


Figure 1. Conceptual Schematic of Conventional Approach to Environmental Management and the Potential for Marketing Multiple Ecosystems Uses, Goods or Services.

II. The Ecosystem Multiple Markets (EMMs) Concept

It is the higher level of improvement (functioning ecosystem), going beyond a minimum level of compliance through capitalized investment in ecosystem uses and function (Figure 1), that provides opportunities for multiple market-based environmental improvement incentives. This white paper is a first attempt to identify these opportunities and further lay out a conceptual framework for the operation of such multiple markets within current economic and political realities.

Ecosystem multiple markets (EMMs) are defined here as **ecosystem-oriented environmental commodity markets where multiple environmental services are produced and traded.** These environmental services or commodities can include but are not limited to:

- Pollution prevention and load reduction (e.g., wastewater treatment, SO_2 and NO_x emission control, and toxic chemical usage elimination)
- Pollution remediation (e.g., carbon dioxide [CO_2] sequestration, nutrient removal, and groundwater remediation)
- Wildlife habitat restoration, creation, and protection
- Natural hydrological regime protection and restoration (e.g., floodplain management, wetland restoration, and artificial groundwater recharge)

In the EMMs framework, ecosystem enhancement will be realized with the environmental services and ecological functions provided by the environmental commodities produced and traded. Treating these environmental commodities just like other common goods and services, entrepreneurs in EMMs invest in the producing and trading of these environmental commodities for the purpose of obtaining economic returns. Environmental benefits of such economic activities will be ensured by market mechanisms that set and enforced by rules regulating market operations and controlling the quality and quantity of environmental commodities (e.g., commodity exchange mechanisms, commodities quantity and quality requirements, and post-trading obligations, etc.).

It is clear from the sample environmental commodities listed above that ecologically, environmental services do not exist or function independently from each other. For example, a forested stream buffer built to protect the stream from surface runoff nitrogen sources can also provide carbon dioxide sequestration and habitat for wildlife. Therefore, when planted and managed properly such a forested buffer can produce multiple services to our ecosystem and its ecological benefits go far beyond nitrogen removal. It is these multiple environmental services that the EMMs framework is designed to capture and promote. Because only a forested buffer that is designed and managed with an ecosystematic approach can provide the most and sustainable environmental services, EMMs reward such environmental production with the highest economic returns. Such economic incentives would promote the production of high quality environmental services. The more high quality environmental services we can produce, the closer we are to the goal of an optimal/functioning ecosystem illustrated in Figure 1.

This concept of utilizing markets to attain optimal ecosystem function is compatible with other prevailing approaches that target market-based incentives triggered by regulatory caps, offset requirements or voluntary agreements. However, it fundamentally differs and improves from those approaches in two aspects. First, the commodities traded in EMMs are multiple environmental and ecological functions provided by a natural, restored, or created component of the ecosystem, but not the component itself. For example, a fully restored wetland in EMMs would generate credits for pollutant removal, flood storage (if applicable), and wildlife habitat all at the same time. While these credits can all be traded in the EMMs framework, this piece of wetland itself does not have a market where it can be sold as a "wetland credit". In other words, a poorly restored wetland without many environmental functions is worth little in EMMs, no matter how many acres of land it occupies. Conversely, a small wetland providing many high quality environmental services can produce generous economic returns rewarding scientifically sound restoration practices.

Second, rather than establishing individual markets for targeted pollutants in segments of a geographic area (e.g., an airshed or watershed), EMMs integrate these individual markets to allow the simultaneous trading of multiple environmental services. This would lead to greater environmental improvements and economic returns, as a result of a higher level of trading activities taking place on a broader geographic scale. For example, a point-nonpoint source nitrogen reduction credit trading program in a small watershed in the Mississippi River Basin may not generate many trades and hence, significant load reduction if the watershed is predominantly agricultural and point sources account for only a small fraction of the total nitrogen loading to the Mississippi River. In an EMMs framework, the trading would be expanded to the entire Mississippi River Basin. In addition, an array of environmental commodities, such as phosphorus reduction credits, CO_2 sequestration, flood storage, and wildlife habitat, can also be traded in the Basin or beyond (CO_2, for example). Such expansion of the trading zone and tradable environmental commodities would increase trading opportunities and thus economic returns of applying nonpoint source control practices in the Basin, such as floodplain wetland restoration and forested stream buffers. If the economic incentive is high enough to promote a higher adoption level of these practices in the Basin, the environmental commodities produced by these pollution control practices can eventually lead to, on the Basin level, the elimination of the hypoxia problem in the Gulf of Mexico caused by excessive input of nitrogen from the River; on the regional level, less flood damages caused by losses of floodplains and wetlands; on the local level, less eutrophication problems caused by high phosphorus levels in waterbodies; and many other environmental and ecological improvements on all geographic scales.

III. About this Paper

In its Proposed Water Quality Trading Policy, the U.S. EPA (US EPA, 2002a) explicitly encourages the development of "other market-based programs that bundle ecological services to achieve multiple environmental and economic benefits." Nationwide on a grass root level, the idea of generating multiple environmental services through market-based incentives has been recognized and considered to solve specific environmental problems in several places (K& A personal communications). In West Virginia, a project is being considered for surface land reclamation from old strip mines through reforestation. Wastewater rich in nitrogen from power utilities would be used to irrigate the young trees rather than discharged to waterways facing TMDLs. Trading opportunities are being sought for nutrient reduction credits from the reuse of wastewater and carbon (CO_2) sequestration credits from the reforestation. In Colorado, two projects are being developed to generate multiple environmental services and credits. The Chatfield/LinksVest project on Jackson Creek will provide stream bank stabilization and restored wetlands to generate phosphorus and wetlands mitigation credits while providing habitat for the endangered Preble's meadow jumping mouse. The second project is located in the Lower

Colorado River/Grand Junction where a framework of trade-offs between selenium and endangered species have been created. In Michigan, investors in wetlands mitigation banks are looking for funding opportunities from the sale of nutrient and carbon credits that restored or created wetlands will generate.

Such efforts have been focusing on the production of environmental services and benefits that may be translated into tradable credits. Market mechanisms through which these multiple services and benefits can be traded to generate economic returns, which in turn can be used to further improve the ecosystem, have not yet existed. Research is needed to explore the feasibility and development of these market mechanisms. This paper will theoretically build the framework for EMMs and present a feasibility study on the potential application of the concept. Specifically, the paper

- Conceptualizes the EMMs framework;
- Illustrates why EMMs can lead us to functioning ecosystems;
- Illustrates why EMMs can maximize returns on environmental investments;
- Identifies market potential for EMMs; and
- Defines operational needs for future pilot demonstration projects.

To address the application issues, the paper focuses its research on the Great Lakes region. The opportunities and issues identified in the Great Lakes region, however, are applicable in principle to other regions in the nation.

CHAPTER 2.

THE ECOSYSTEM MULTIPLE MARKETS FRAMEWORK

In this chapter, the ecosystem multiple markets (EMMs) framework is described in detail with explanation on each of the five primary components and the sixteen processes that connect these components (Figure 2).

I. Components of the EMMs Framework

Like any other commodity market, EMMs exist because there are buyers who need the commodity, producers who can generate it, and market mechanisms that can bring the two parties together to make commodity transactions happen. Unlike many other commodity markets, trading activities in EMMs have ecological and social consequences directly affecting the well-being of large human populations and/or other living organisms. Therefore, although formulated in the context of a free-market economy, the presence of properly designed market regulations and institutions is of paramount importance in the EMMs framework. As discussed throughout this chapter, the conceived EMMs framework has its own inherent mechanisms to prevent harmful consequences from occurring. The EMMs framework achieves this by steering the commodity production process towards a more positive direction at the very beginning and by providing strong economic incentives for ecosystem-friendly market behaviors.

Buyers

Buyers in EMMs are entities who want to use or control one or more environmental services for various reasons. For example, a buyer could be an industrial manufacturer who uses a natural resource (a river or lake) as the sink for wastewater discharges. Should this river be under a TMDL with a trading option, the manufacturer would pay others to discharge less than their share allotted by the TMDL. When there is no regulatory driver, those who depend on the resource (a smaller scale resource, such as a recreational lake) could pay a discharger (e.g., an upstream farmer) to reduce his use of the resource as a sink (see Section I of Chapter 5). While may be argued that the upstream resource user should not be polluting in the first place, and the downstream user should not have to pay him to not pollute, the goal is to make environmental protection economically feasible. Setting a discharge limit of zero would certainly create an unfavorable competitive disadvantage and likely force the discharger out of business, making environmental protection and economic viability incompatible. Trading in the EMMs framework allows both goals to be realized. The buyer will pay the seller to protect the resource if the cost is less than or equal to what the buyer would normally pay to reduce its own discharges or remediate the resource after it was impaired. In essence, this concept encourages more cost-effective pollution abatement activities and promotes pollution prevention as a lower cost and more effective method of environmental protection than remediation.

In EMMs, reasons to buy can be divided into three general categories: voluntary/private arrangements, regulatory-driven mandatory responsibilities, and perceived economic gains from

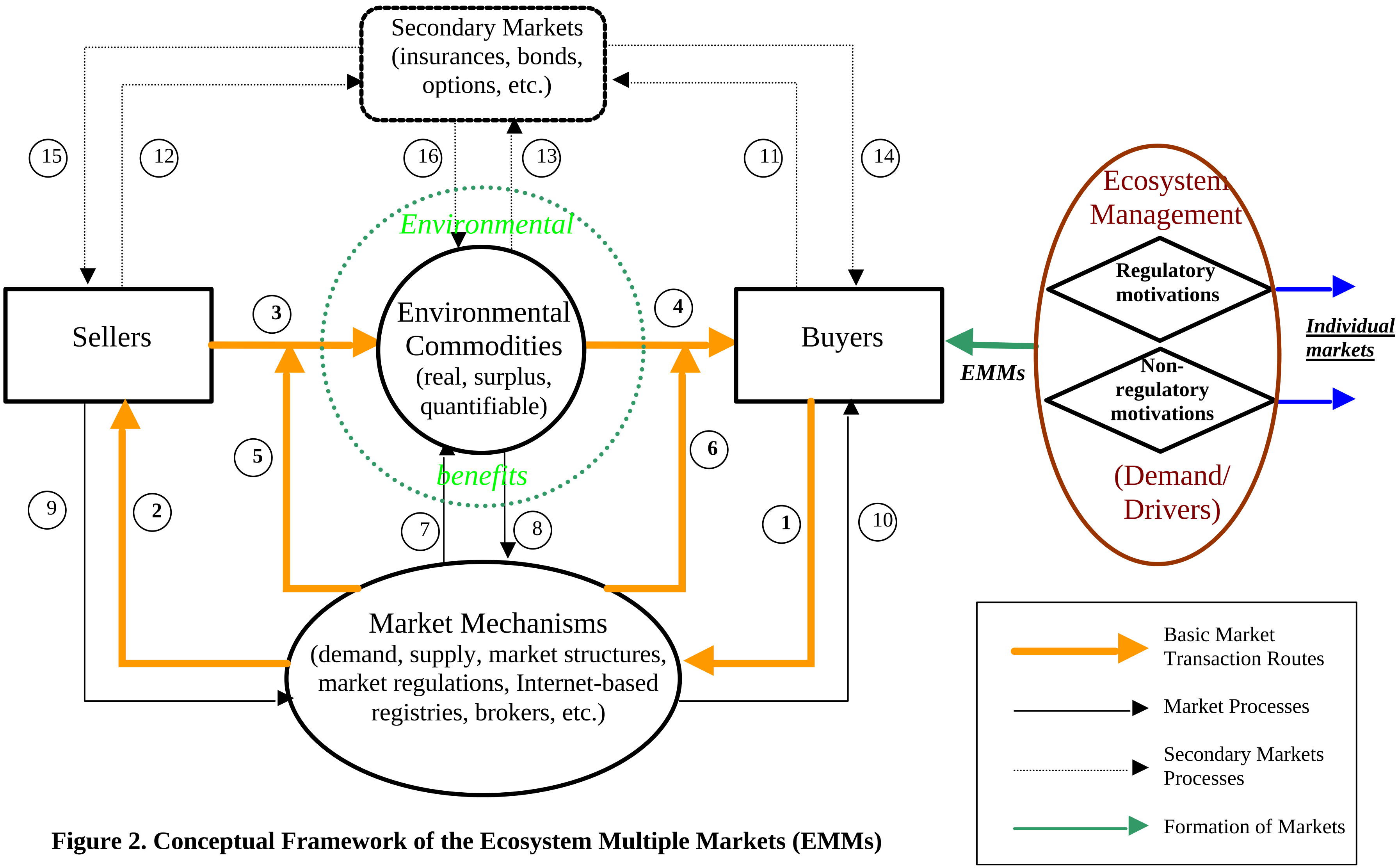


Figure 2. Conceptual Framework of the Ecosystem Multiple Markets (EMMs)

resale. In other words, a buyer will participate in a trade if 1) he values and respects the resource and sees a situation in which he can buy resource protection from another resource user (discharger), 2) a regulation impacts on his discharge (or on a collective discharge such as a TMDL), or 3) he sees economic gains from facilitating environmental commodity trading. The existence of these three types of environmental commodity buyers is not a creation of the EMMs framework. They are recognized participants in various individual environmental markets because motivations for them to make purchases do exist (Chapter 5). The EMMs, however, can present all three types of buyers a unified environmental commodity market where they have greater commodity options in terms of both quality and quantity. Specific examples of these types of trades follow.

Buyers Driven by Non-regulatory Motivations

When resource users or concerned citizens wish to protect or maintain the integrity of that resource, they identify the impairments to that resource. Small-scale resources, such as a sub-watershed or adjoining pieces of land, can be protected through cooperation among small groups and private arrangements. A regulation is not required to lead this protection, just the foresight of resource users to identify the impairments and the creative ways in which to minimize or eliminate those impacts. The small-scale nature of the protected resources makes such cooperative arrangement economically and politically viable. In addition, with growing public support for environmental protection, non-regulatory driven market-based environmental activities continue to gain acceptance and create demand for environmental commodities. Specific examples of non-regulatory motivators (and corresponding buyers) include:

- Reducing operating costs for remediation activities such as lake restoration and harbor dredging (communities, municipalities, harbor authorities)
- Increasing recreation, hunting and fishing opportunities (landowners, public and private)
- Improving public health (e.g., by reducing emissions reduces asthma cases—governments at all levels)
- Establishing good public relations/green image (industrial manufacturers, business owners, utilities)
- Attracting new customers or tourists (retailers, resorts, national/state parks)
- Reducing insurance costs (homeowners on floodplains)
- Using private funds for ecosystem conservation (Nature Conservancy, World Wildlife Fund)
- Improving quality of life by creating green cities or other nature experiences (municipalities, developers)

Buyers Driven by Regulatory Motivations

A major reason for trading is regulatory caps placed on discharges to a watershed or the atmosphere. A cap can encompass the entire shed or be specified for each discharger (an allocation). The basic idea of market-based programs is that some dischargers can cost-effectively reduce their loads below what is required of them. They can then sell these surplus, measurable, real reductions to those who find it costly to meet their own discharge goals. Trading between such parties them equalizes the marginal costs of pollution reduction across the trading area and minimizes total costs of keeping the total discharge under the cap. Trading can be allowed to occur through national regulations, state laws and/or municipal/city ordinances (see Chapter 5 for more discussions). Regulatory motivations are generally found to be more effective in creating demand for environmental commodities as the economic consequences of non-compliance are often prohibitive.

<u>Buyers Driven by Perceived Economic Returns</u>

For purchasers under this category, the incentives to buy are almost always purely financial. As with any other commodity, trading facilitators (e.g., brokers), and EMMs business entities that have specialties and information sources can buy multiple environmental commodities and sell them later when demand increases. Their activities establish a pool of environmental commodities which producers can sell into and other buyers can buy from. Economic returns can be generated during the processes of buying, selling, and/or providing information regarding the availability of various environmental commodities. The Market Mechanisms section below illustrates that buyers of this type are an indispensable part of the EMMs framework.

Environmental Commodities

Essentially, environmental commodities can be divided into two categories:

1. surplus pollution reductions generated by sound management practices, improvements in abatement technology, and restoration of natural abatement mechanisms (e.g., wetland); and
2. services, environmental and/or economic, provided by an ecosystem.

There is no clear boundary between these categories and, just as with an ecosystem, many of their components are inter-related and inter-dependent. For example, a farmer who adopts an erosion control best management practices (BMPs) can generate sediment credits. These credits, as a Category 1 commodity, can then be sold in EMMs. Meanwhile, the lake that formerly received muddy runoff from his farmland benefits from the same BMP with much better water quality. The economic returns (more recreational opportunities on and off the lake, and more valuable lakeshore and private properties) and environmental benefits (improved habitat for aquatic plant and animal species) resulting from this water quality improvement are Category 2 commodities in EMMs.

Category 1 commodities include but are not limited to the following:

Water quality trading credits (nitrogen, phosphorus, sediment, etc.)
Greenhouse gases (GHGs) credits
Acid rain gases credits

Category 2 commodities include but are not limited to the following:

- Habitat for endangered and threatened species
- Recreational opportunities in private and public land

- o Development rights
- o Flood storage

The healthier the ecosystem, the more environmental commodities it can produce. This is the foundation on which the EMMs concept builds. A fully functioning ecosystem is the ultimate "commodity" that can provide the most environmental and economic services in both quality and quantity. Such a "commodity", in turn, will generate the maximum economic returns. As a result, environmental commodities producers will choose to produce or restore a ecosystem that can provide far more environmental services than individual trading markets do (Figure 1). For example,

Sellers

Sellers in EMMs can be any producers or owners of one or more environmental commodities. Wastewater dischargers that have achieved extra pollutant reduction beyond requirements (e.g., TMDLs or NPDES) will have generated credits for water quality trading. A landowner who restores wetland on his property will have credits for habitat mitigation, flood storage, water quality, and possibly GHGs trading. Urban landowners, including municipalities, who preserve ecologically significant land could generate credits for development rights trading.

In the EMMs framework, there is expected to be a host of environmental commodity sellers in addition to these traditional landowners. Because of multiple economic returns to be potentially realized in the EMMs, investors such as investment banks or funds, venture capitalists, and even individuals could supply capital to these markets and claim economic returns from the sale of produced environmental commodities. An investment bank could make a loan to a nature conservation organization that wants to purchase management rights from a forest owner to set up a forest bank (see Section III of Chapter 5). The investment bank would then claim part of the economic returns generated by the forest bank from the sale of carbon sequestration credits, timber, and potentially other environmental commodities such as water quality credits and endangered species habitat. The direct seller and producer of the environmental commodities would be the forest bank management but the investment bank would also be a beneficiary of trading under this scenario.

Trading facilitators are another important group of sellers, most visible through brokerage services. They are also buyers in the market (see the section on buyers above) and, as shown in the following section, are an essential element in a functioning EMMs framework.

Market Mechanisms

Market mechanisms are institutions and regulations, abstract or concrete, that manage market transactions within EMMs. Changes and innovations, as well as some traditional market mechanisms, are necessary for an EMMs framework to work in a way that ensures maximum environmental improvements while providing sufficient economic returns to investors. Some of these traditional and new mechanisms are outlined in this section. Also explained are why the EMMs concept incorporates intrinsic mechanisms that work to bring us both environmental and economic benefits.

Market Structures

Efficient market structures increases the liquidity of commodities. In EMMs, market efficiency is important to keep the transaction costs low. However, market efficiency should not be pursued by compromising the environmental efficacy of the markets—a high level of certainty that environmental targets are reached (Woodward et. al, 2002). In the US, there are primary three types of market structures in existing individual environmental markets: exchange markets, bilateral negotiations, and clearinghouses. In EMMs, all of them would find its applications. The adoption of a particular market structure is a function of the physical and legal environment in which the targeted environmental commodity is produced and traded.

In the case of GHGs, due to their potential large volume of transactions and uniformity in measurement (metric tons in CO_2 equivalent) and environmental consequences (increase of temperature on a global scale), an exchange market can best facilitate credit transactions between buyers and seller. In fact, the Chicago Climate Exchange (CCX), the first voluntary, organized pilot GHGs emissions trading market in the US, has launched its operation in September 2003 (see Appendices A and D). Bilateral negotiation applies to situations where substantial interaction between the buyer and the seller to exchange information and negotiate the terms of trade (Woodward et al., 2002). In EMMs, trades of habitat mitigation and flood storage may require such a market structure to be carried out. For water quality trading credits, a clearinghouse approach seems to be most appropriate. In a clearinghouse market structure, the linking between the buyer and the seller is made by an intermediary. The diversity of credit sources (point and nonpoint) and the different requirements for verifying credits generated from these sources with a variety of pollution reduction techniques pose potentially significant barriers to the establishment of an efficient market. A clearinghouse specialized in water quality trading and certified by regulators would be in a position to overcome these barriers.

Intermediaries

In traditional market, the demand and supply of a certain commodity are the reasons for and the results of the existence of the commodity market. As a market-based system, market mechanisms such as demand and supply will also be present in EMMs. Consequently, traditional market mechanisms, such as brokerage services, can be part of EMMs and will play an important role in reducing transaction costs by facilitating trading and encouraging market entry (Stavins, 1995). In the EMMs, brokers (e.g., a water quality credits clearinghouse) could purchase environmental commodities, such as phosphorus credits, from a farmer who practices conservation tillage and sell them to a paper mill in the same watershed where a TMDL has been established to allow water quality trading. The existence of the brokerage service could help the paper mill find credit sources whenever it needs to make a purchase. On the other hand, knowing his phosphorus credits will always have a buyer, the farmer is assured that his conservation practices will also produce a financial return. As a result, he is likely to continue his conservation practices and even make further improvements.

Commodity registries can significantly reduce transaction costs that typically occur when obtaining necessary market information (e.g., prices, potential buyers or sellers) to enter the market. For example, a landowner who wants to profit by restoring a wetland on his property and selling the nutrient credits to be generated by the wetland needs to know how much it would cost to restore the wetland and how much he could sell credits for. A nutrient credits registry that records all relevant trades in the market by reporting volumes, prices, and potential buyers and sellers of such trades will provide that necessary information. He can then decide whether or not he should enter the market and who he could sell credits to. Advances in internet technology provide an ideal platform to establish environmental commodity registries far more effectively than ever before. A good prototype example of such on-line registry is Nutrient Net (www.nutrientnet.org) designed by the World Resources Institute in Washington D.C. (see Section III of Chapter 5). Such advances in application technology provide true opportunities for the EMMs framework to become a practicable ecosystem management system.

Market Regulations

Due to potentially significant environmental consequences of environmental commodities trading, regulation of EMMs will require its own unique characteristics. Most obviously, many of the environmental commodities will need to be certified for its quality and quantity before they can be traded. For instance, the number of carbon credits a newly planted forest could produce in 30 years is a question only a specialized government agency or a qualified private institute can answer. The environmental commodity certification process is an important step in which government agencies will be involved in either running the certification directly or inspecting private certification firms. Government agencies, such as the EPA and state level environmental protection agencies, would have the responsibility to set important standards to ensure the quality of environmental commodities in EMMs. Establishment of an appropriate trading ratio in a water quality trading market is such an example.

Mechanisms that Ensure Ecosystem Enhancement

Under EMMs, public or private investment to produce environmental commodities should provide economic returns while maximizing ecosystem enhancement. Two primary underlying market mechanisms in the EMMs framework can ensure achievement of a functioning ecosystem. First is the variety of environmental commodities allowed to be traded in EMMs. As previously noted, an investment in wetland restoration could produce wildlife habitat, water quality credits, flood storage, and possibly GHG credits. Total payments for environmental services provided by this restored wetland could, therefore, be several times higher in EMMs than what is possible in current wetlands mitigation markets. Second, because a functioning ecosystem provides more environmental services, it also generates more tradable environmental commodities in EMMs. A poorly managed wetland restoration project would produce fewer ecological benefits and would not generate as many tradable environmental commodities. Therefore, cost-benefit analysis will likely drive a profit-seeking investor to derive more environmental commodities out of his restoration effort. As a result, both the economic goals of a private investor or investment group and the environmental goals of society can not only coexist but also work to each other's advantage through EMMs.

Secondary Markets

Secondary markets as used here refer to those that can provide services to the primary markets and facilitate trading and reduce business operation risks. In EMMs, the establishment of secondary markets is promoted by multiple types of environmental commodities directed in large quantities to the marketplace(see more discussion in Section II of Chapter 3). Two primary types of secondary markets are envisioned: the technical services market and the financial services market. From the current status of environmental services markets, it is plausible to envision technical services for producing and certifying environmental commodities (e.g., wetland restoration and the subsequent nutrient credit quantification) in EMMs, which could be supplied by environmental consulting firms with specialties in trading and related technical areas. The financial services market in EMMs, on the other hand, is likely to need more structural foundation work. Nevertheless, the basic principles of financial services markets can be readily applied and there are ample opportunities with EMMs for creating these markets.

According to Landry and Faeth (2002, Appendix B), farmers face three types of risk associated with adopting BMPs that may potentially generate nutrient credits for trading:

- Innovation Risk – early adopters of the BMP are using a system that has not been tested in a wide variety of commercial farming conditions and therefore is not trusted;
- Test-Trust Risk – it is difficult to "bet the farm" on a procedure or practice, no matter how well established or proven it may be; and
- Operating Risk – farmers often over-apply manure and fertilizer in order to avoid losing nutrients in years of extreme, heavy rains. For example, split application of nitrogen is not widely accepted because farmers run the risk of not being able to get into the field a second time to apply nitrogen in wet years.

BMP insurance is one way to address such risks. Farmers pay premiums to insure that they will get the same economic returns on their crops and the projected nutrient credits after the adoption of a certain BMP. A variety of insurance policies can be developed in EMMs as the risks outlined above also exist in producing other environmental commodities (e.g., fire insurance in a forest bank).

Other financial products might also be developed within the EMMs framework. For example: weather derivatives may be used to manage weather related risks in producing environmental commodities; environmental bonds could be freely traded to encourage environmental investments, and; exchanges of environmental commodity futures, hedges, and options could be organized to facilitate trading. While secondary markets cannot function unless "primary" environmental markets exist, once established, secondary markets could play an important role in fostering more efficient primary markets.

II. Processes of the EMMs Framework

From the perspective of developing a working EMMs framework, processes in the framework (Figure 2) illustrate the underlying dynamics and mechanisms that connect the various components of EMMs. These dynamics and mechanisms function in the market processes created by the flow of environmental commodities and secondary market services. A basic market transaction route (Processes 1 – 6) is identified which includes those market processes essential for any trading to take place. Other processes shown in Figure 2 are necessary to complete the basic route and assure the best function of EMMs.

The Basic Market Transaction Route

Process (1)

The driving force behind the formation of EMMs is ultimately the demand for a functioning ecosystem where people can obtain sufficient natural resources, tangible or intangible, for individual well being without incurring harm to other living organisms in the system. Based on such demand, environmental regulations and philanthropic/green activities constitute the two basic components of our current ecosystem management approach (Figure 2). Either of these two management components can create demand for environmental commodities. Demand creates a market. EMMs take shape because of the demand. For example, an ecologically functioning forest stand can be demanded both by a CO_2 emission source under regulation to compensate for his excessive CO_2 emission and by a non-profit nature conservation organization with private funds available to protect a particular plant species unique to this forest region.

Process (2)

Market mechanisms are formed by the nature of the demand or by design, to seek supply for the demand. Market mechanisms in this process include (but are not limited to) a market place (real or abstract) where commodity information can be exchanged and transactions can take place, market regulations that encourage or prohibit certain market behaviors, and intermediaries that facilitate commodity transactions. Market mechanisms work together to provide opportunities and directions to environmental commodity producers on the quality and quantity of the commodities demanded by the markets. For example, a water quality credits registry (e.g., NutrientNet) can provide producers of water quality improvements with key information on the quality and quantity of nutrient load reduction credits demanded in a particular watershed under a nutrient TMDL.

Process (3)

Environmental commodities are generated by sellers following the information fed from the markets via Process 2. For example, a farmer may retire his marginal production land and create habitat for an endangered species when there is a high demand in his area for such habitat mitigation.

Process (4)

Environmental commodities are transferred to buyers in the marketplace. For example, nutrient credits generated by a farmer can be sold to a wastewater treatment plant by direct trading between both parties or via an environmental commodity broker.

Process (5) and (6)

Because market mechanisms set standards for commodity transactions and determine how these transactions take place, they play an important role in processes (3) and (4). A farmer wanting to sell nutrient credits may be required to sign a contract with the buyer or the broker to ensure his practice of conservation tillage will last for as long as the credits are used for something such as a discharge offset. On the other hand, the buyer of a piece of land for habitat mitigation use will not be allowed to develop this land for any other purpose for at least similar or a long period of time.

Other Processes

Process (7)

Market mechanisms of EMMs will affect the quantity and quality of environmental commodities produced. Due to a holistic approach under the EMMs framework, producers will always opt to generate environmental commodities that move towards the goal of a functioning ecosystem. For example, a surge in demand for carbon credits within a certain geographic area may prompt some producers to plant a single species woodland that has the highest carbon sequestration capacity in the short term. In the EMMs framework, however, because a species-diverse forest can also generate credits for wildlife habitats and nutrient removal (hence more economic returns even in the short term), well-informed producers would not adopt the single species, get-the-credits-quick approach. Furthermore, the owner of land more suitable for floodplain restoration would likely think twice before they convert it just for carbon because of the multiple credits a floodplain wetland can generate in EMMs (flood storage, wildlife habitats, and nutrient removal). Therefore, under the EMMs framework, markets themselves are conducive to driving more appropriate ecosystem improvements.

Process (8)

The nature of environmental commodities provides the basis for market mechanism development and innovation. For example, the process of wetland banking allows wetlands to provide more ecological services. A continuous large wetland parcel has the capacity to function better ecologically than several isolated small wetlands. The addition of streambank erosion prevention as a phosphorus credit generating practice in the Kalamazoo River Water Quality Trading Demonstration Project was resulted from the fact that phosphorus has a strong affinity with soil particles and streambank erosion is one of the leading causes of soil loss in the region. Interactions between environmental commodities and market mechanisms, as illustrated by processes (7) and (8), should be fully explored in a demonstration/pilot project to ensure design of a workable EMMs framework.

Process (9)

Sellers/producers will provide feedback to the market mechanisms with their needs and suggestions. In developing an EMMs framework, this process would help to improve the design of market mechanisms to better facilitate transactions. In a developed EMMs framework, this same process could lead to identification of new commodities, innovations in pollution treatment/removal, new conservation practices, and reduced transaction costs.

Process (10)

Transaction costs that buyers face when they enter the markets are represented in this process. How market mechanisms function will determine what a buyer would have to do to enter the market and how he could purchase environmental commodities. Therefore, a buyer of nitrogen credits would first need to know what the general market price is for such credits. This information is crucial because the buyer could then compare the cost of purchasing the credits on the market with that of his treatment options. He would then decide if entering the market is the most cost-effective way to meet his discharge limit. Prior to entering the market, he should also know who is selling the credits and at what price. Offers to potential sellers could then be made and negotiations initiated as needed. Only after that, can he decide how many credits he wants to buy and from whom. During the entire process, substantial costs can be incurred through information collection. Market mechanisms can lower or increase such costs to the extent the buyer feels it makes economic sense to enter the market and make transactions or not enter the market at all.

Secondary Markets

Process (11), (12) and (13)

The needs of buyers and sellers, and the nature of environmental commodities should stimulate the creation of secondary markets. For example, a buyer who wants to acquire a restored wetland for habitat mitigation that is required to be completed for delivery in three months may also want to protect himself from uncertainties on both the timelines of delivery of the wetland and the promised credits it is expected to generate. A futures market can be created to meet these needs by guaranteeing the delivery of such a wetland at the time and quality desired. On the sellers (producers') side, insurance policies would be an example against the loss of yields when a farmer adopts a BMP on his farmland. The premium payment would protect him from such a loss.

Process (14), (15) and (16)

Secondary markets can eliminate many of the risks that investors or producers of environmental commodities could incur in the EMMs framework. The provision of such safety mechanisms would likely encourage buyers and sellers to enter the markets and stimulate an increase in the volume of transactions in the markets. Furthermore, secondary markets are seen to generate another revenue stream in EMMs and diversify investment opportunities.

III. An Example of the Operation of the EMMs

An example is given here to illustrate how the EMMs framework operates to realize both environmental and economic benefits, and to assist the reader in relating the concept to real life experiences. Wherever appropriate, corresponding components and market processes of the EMMs framework (Figure 2) are indicated in parentheses as they appear in the example. For ease of understanding and to simplify the example, only market components and basic transaction routes are designated.

Imagine (it is actually already happening) a phosphorus (P) TMDL established for a lake in a watershed. The TMDL sets a maximum P load that each source in the watershed can discharge to the lake directly or to tributaries feeding the lake. Assume also that an EMMs framework has been instituted in this watershed. This TMDL would create a demand (*Process 1*) for P load reduction credits (P credits) by point and nonpoint sources (*Buyers*) who seek to buy credits at a cost lower than that of reducing their own discharge. This credit demand is reflected on an Internet-based credit registry where intentions to buy and sell P credits are posted (*Market Mechanisms*). An environmental entrepreneur, Joe (*Seller*), sees this opportunity and investigates the possibility of investing in construction of a forested stream buffer on the major tributary of the lake. He knows that a forested stream buffer can substantially reduce phosphorus loading to the stream and generate credits for trading (*Process 2*). Since Joe has to buy the land and pay for construction costs (e.g., design, soil grading, and tree planting), the revenue Joe would receive from selling the P credits may not cover his initial investment. However, Joe learns that if managed properly, the forest buffer can also become a sink for the greenhouse gas, CO_2. Further, it may provide habitat for marbled salamander a threatened amphibian living in floodplains and low-lying fertile areas dominated by hardwood trees (*Environmental Commodities*). Because of the EMMs framework, all of these environmental services can be traded. There is a global market for CO_2, and a regional market for marbled salamander habitat. Income from all three markets would be profitable for Joe to invest in a project that aims to create a hardwood forest stream buffer constructed to provide all three types of environmental services. Joe then posts the estimated value of each type of credit to be generated from the project on their respective trading registry.

After the project is completed (*Process 3*), Joe can sell the credits to different buyers (*Process 4*) while the stream buffer provides the environmental services to the ecosystem. During the process of constructing the forest stream buffer and subsequent credit trading, there are market regulations controlling production and market activities to ensure real, surplus, and quantifiable environmental improvements resulting from the trades. Such regulations may include trading ratios for P credits and habitat mitigation, certification procedures required for generated credits, and the ecological sustainability of the project (*Market Mechanisms and Processes 5 and 6*). Our environmental entrepreneur, Joe, may contract qualified private firms to carry out part of the construction and trading activities. He may also buy insurance from policy providers against potential flood, disease, or other unpredictable damages to his stream buffer during and after the construction (*Secondary Markets*).

CHAPTER 3.

BENEFITS OF THE ECOSYSTEM MULTIPLE MARKETS

This chapter describes benefits of the EMMs framework and the potential to overcome multiple barriers within existing market-based programs. Barriers as well as potential within existing programs to achieve the goal of a functioning ecosystem are summarized. Mechanisms built into the design of EMMs that can overcome these barriers and make full use of the potentials are explained. Some guidance for the proposed demonstration project in the Great Lakes region, some issues and questions for further research are also provided. The reader is also referred to Appendix B for a detailed analysis of how a multiple markets framework can improve our management of a specific environmental challenge—nitrogen pollution control.

I. Barriers within Existing Programs

Within the existing market and/or incentive-based programs barriers to achieving the goals of a functioning ecosystem and maximum economic returns on environmental investment can be summarized into the following four categories:

- Ecologically fragmented markets
- Thin markets and high transaction costs
- High compliance costs and diminishing returns from environmental investment
- Lack of funds and other resources

Ecologically Fragmented Markets

Currently, individual environmental commodity markets typically trade only one target commodity (e.g., phosphorus in the water quality credits market) or several commodities with similar origins, physical-chemical properties, and environmental consequences (e.g., SO_2 and NO_x in RECLAIM). However, elements in an ecosystem function inter-dependently in a delicately maintained balance. Not considering multiple ecological consequences when targeting a single environmental commodity provides the potential to create unexpected ecological problems. For example, storm water retention/detention facilities can remove sediment and nutrients from urban storm water and thus generate nutrient credits in a water quality credits market. However, a recent study (Kieser et al., 2003) indicated that thermal shocks from these facilities can increase the potential for significant damages to coldwater fish habitats in urban areas. Therefore, in water quality credits markets where only nutrient credits are traded (e.g., market under a phosphorus TMDL), there is the danger of unexpected habitat degradation caused by nutrient removal facilities.

Conversely, the individual markets approach also tends to overlook the multiple ecological benefits that many environmental commodities can provide. Thus producers of the commodities are not awarded all potential economic returns. In turn, this does not provide sufficient economic incentives to the producers to generate these commodities. For example, wetlands are capable of nutrient removal, flood mitigation, and potentially carbon sequestration. If they are used for only nutrient removal in a water quality trading market, potential producers may not see any economic opportunity to restore a wetland. Rather, their income opportunity is unlikely to be higher than what it would be if the land was sold for a housing development. If, on the other hand, the price for nutrient credits from a wetland is set high, to encourage production, buyers may be shunned away. As a result, wetland restoration might cease to be an option in a water quality trading market.

Thin Markets and High Transaction Costs

Many existing market-based programs have encountered the problem of thin markets—markets with only a few buyers and sellers (Goodstein, 2001). For example, in a small watershed where water quality trading would occur under rules dictating where in the watershed a trade is restricted to, there would likely be only a limited number of buyers and sellers of trading credits and credit trading would not likely be frequent. This might lead to price distortion if the buyers were under regulatory obligation to buy credits and there were only one or two sellers. Another result of low market activity is the lack of a clear price signal, the critical information without which the anticipated cost savings from trading are difficult to realize. A possible solution could be private negotiation and contracting between buyers and sellers. However, as evident in the trading under NPDES Permits in the Minnesota River Basin (see Section II of Chapter 5), substantial transaction costs can be added to trading that undermine the cost saving objective. Cross-watersheds trading can theoretically increase market size and solve the thin markets problem. However, due to the localized nature of water pollution, cross-watersheds trading may result in the “hot-spot” problem, which has been understandably strongly opposed and concerned citizens and environmental groups (Christen, 2002; Drury, 1999). A thin market problem also exists in air emission trading markets. The relative failure of EPA’s “bubble” policy on air pollutants reduction can be attributed to firms’ difficulty in locating potential deals and trading partners. Most firms thus simply did not choose to participate in trading (Atkinson and Tietenberg, 1991).

High Compliance Costs and Diminishing Returns from Environmental Investment

Market-based environmental programs, such as water quality trading and SO_2 emission allowance trading, aim to minimize and equalize pollution reduction costs. However, just like any other waste reduction process, when the initial stage (Stage 1) of substantial gain in abatement efficiency expires (Figure 3), rapidly rising cost and diminishing efficiency gain (Stage 2) will occur. If a functioning ecosystem is the ultimate goal, an even greater amount of investment will be required because the abatement efficiency gain with regard to investment in Stage 3 is very limited. For example, in Phase I (1995-1999) of the national Acid Rain Program, significant SO_2 emission reduction (over 40% in North Central, Southeast, and Mid-Atlantic regions, compared with 1990 levels) were achieved by low-cost approaches. These included internal optimization (trading between individual boiler units within single operating systems), development and application of new fuel-blending technologies (to use low-sulfur coal), and taking advantage of the modernization of rail transport which made low-sulfur coal more readily available (USDOE, 1997; Environmental Defense, 2000). Phase II of the program (through 2010) is set to achieve a permanent nation-wide total annual emission level of 8,950,000 tons of SO_2, a level roughly equal to 50% of electric utility emissions in 1980. The total cost to achieve this is expected to be higher than the Phase I goals (Kerr, 1998) because the reduction requirements are more stringent and initial cost-savings from implemented low-cost approaches are being exhausted. New methods of compliance such as installing scrubbers require substantial capital investments (USDOE, 1997). While the purchase of emission allowances is always an option, as

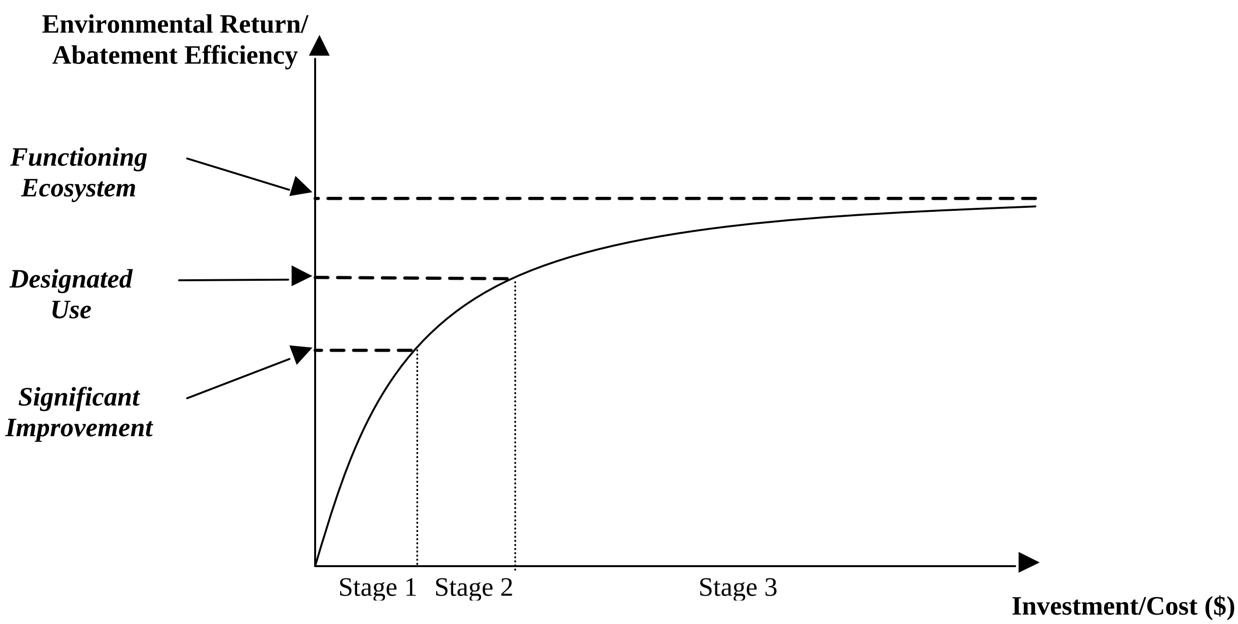


Figure 3. Relationship between Investment and Environmental Return within Current Trading Programs

reduction costs increase so will the price of the allowances. The two phases of the Acid Rain Program are analogous to the first two stages of investment and efficiency gain illustrated in Figure 3. While the environmental benefits of the program remain to be carefully studied by scientists (Environmental Defense, 2000), there is little doubt that we need to further reduce emissions beyond the Phase II target level if we want to eliminate those adverse effects on the ecosystem caused by SO_2. If the power industry is the only party responsible for all required reductions to achieve this desired low level of SO_2 emission, substantial capital investments or even fundamental technological changes in power production will have to be made. This scenario is represented by Stage 3 in Figure 3.

Lack of Funds and Other Resources

Ecosystem restoration and enhancement measures often require a substantial amount of initial capital investment. Existing federal and state environmental incentive programs (e.g., the conservation titles of the Farm Bill) are also facing increasing challenges caused by limited funds and a shortage of staff resources. For example, restoring wetland can cost $3,500 to $80,000 per acre (BNL, 2002) and is a substantial financial burden to individual landowners who desire to restore wetland. Although federal or state cost-sharing programs, such as the Wetland Reserve Program that pays up to 100% of the restoration cost, provide financial assistance to farmers, these programs typically have only limited funds. According to the USDA-Natural Resource Conservation Service (NRCS, http://www.nrcs.usda.gov/programs/wrp/factsheets) in the state of Iowa, since the program started in 1992, only about 51% of the application acreage was funded. In addition, NRCS offices must certify farm improvements for enrollment in various programs and they are often under-staffed and under-budgeted. Other examples are:

- In 1997, the Farm Services Agency announced that it planned to limit accepted CRP bids to 19 million acres, so not all bids, which included more than 25 million acres in total, could be accepted. Funding levels to reenroll land currently available in the program were also insufficient (Zinn, 1997).

- The Farmland Protection and Forest Legacy Programs have been funded by Congress since 1992 to match state and local funds to help protect thousands of acres of farms and forest lands, but the small level of funding, less than $100 million since 1992, have limited their impact (MRBA, 2002).

- US EPA funded $320 million of the $417 million requested for remediating Superfund sites in fiscal 2002. Seven Superfund sites—ranked as priorities for cleanup because of the risk they pose—did not receive any funding for the year (C&EN, 2002).

- A recent study by US EPA (2003b) put a cost estimate of more than $19 billion for meeting goals for cleaning up the Chesapeake Bay by 2010, tripling the original estimate. At a time when the tree states working to restore the Bay—Virginia, Maryland, and Pennsylvania—are all fighting budget problems and economic downturns at home, most leaders of the states "reacted with shock and mild humor at the new price tag (Harper, 2002)."

- A study by the Great Lakes Commission (2002) found that more than $80 million in additional annual funding is needed for Great Lakes conservation districts to carry out their mission of improving and conserving the natural resources of the basin. The U.S. General Accounting Office in his April 2003 report *Great Lakes: An Overall Strategy and Indicators for Measuring Progress Are Needed to Better Achieve Restoration* (GAO, 2003) also found that 24 of 33 federal programs and 3 of 17 state programs received insufficient funding for federal and state Great Lakes specific programs and that insufficient funding for program activities was a major barrier and a reason for not achieving and measuring restoration progress in the Great Lakes despite of major planning efforts in the basin.

For many current point/non-point source water quality trading programs, non-point sources usually do not have the necessary initial funds to carry out pollution load reduction measures. Typically, they have to wait for funding from point sources or some sort of public fund to undertake these measures (Fang, 2002). Besides the limited funds available from these sources, transaction costs, involved in negotiation and application to obtain these funds, are often significant and many non-point sources turned away from trading programs due to these costs.

II. Benefits of EMMs

The EMMs are conceptualized to overcome the barriers within existing programs and have the underlying mechanisms to do so. In the EMMs framework, the necessity and ensuing benefits of a holistic approach to improve the environment are particularly evident when individual environmental markets are integrated to achieve multiple pollutants reduction. Programs such as water quality trading, wetlands mitigation banking, and the Chicago Climate Exchange (CCX) become inter-dependent components in the EMMs. The interactions bring multiple environmental and economic benefits.

Integrate Fragmented Environmental Markets

As described, EMMs foster an ecologically integrated overall environmental market, allowing capture of the synergies among various ecosystem management efforts. A recent study by Greenhalgh and Faeth (2001) on policy options to reduce nitrogen loss to the Gulf of Mexico highlights the synergies between water quality improvement and climate change mitigation strategies. Their study indicated that nutrient trading can produce reductions in nitrogen fertilizer use in the Upper and Lower Mississippi sub-basins and simultaneously have the potential to achieve a 3-15% GHG reduction in all Mississippi River sub-basins. In EMMs, such synergies are explicitly evaluated in the open market, creating financial incentives for environmental commodity producers to take comprehensive conservation management actions that can ultimately lead to functioning ecosystems.

Picture a situation in which only GHG trading were available. A producer wishing to maximize profits would plant a homogenous stand of plants most able to sequester carbon, with little consideration for habitat quality or whether the plants are native to the region. Contrast this with a situation in which the producer can earn habitat, water quality and GHG credits from his restored land with EMMs. To achieve maximum return on his investment, he will choose to restore the type of system that can provide all of these services, thereby encouraging restoration of functional ecosystems, as opposed to simple monocultures.

The ability of EMMs to integrate fragmented environmental markets is best illustrated by wetland restoration. Currently, commercial wetland restoration is concentrated in wetlands mitigation markets created by the wetlands mitigation program (Section 404 of the CWA). However, a recent National Research Council (NRC) report on this program concluded that "the goal of no net loss of wetland is not being met for wetland functions by the mitigation program, despite progress in the last 20 years. (NRC, 2001)" The NRC committee pointed out that the current mitigation program data do not report wetland functions lost due to permitted filling and required mitigation projects either not undertaken or that fail to meet permit conditions. It is quite clear that the mitigation program does not promote restoration of the ecological integrity of the nation's waters, as mandated by the CWA.

Under the EMMs framework, however, it would be the environmental and ecological functions of a restored wetland being traded, not the mere acreage of the land. It follows that a filled wetland should be mitigated for its lost ecological functions and not only the acreage. In the EMMs framework, should a floodplain wetland that provides flood storage and wildlife habitat be filled, both lost functions should be mitigated. A restored wetland without these functions can not be used for mitigation even if it provides a much larger surface area. The framework would allow two pieces of wetland, one with only flood storage capacity and the other providing the same (quantity and quality) wildlife habitat, to meet the mitigation requirements. The net result of such functional mitigation is the full compensation of any lost ecological function.

In fact, in its most recent regulatory guidance on wetland mitigation (US ACOE, 2002a) and the accompanying action plan (US ACOE, 2002b), the US Army Corps of Engineers (US ACOE) explicitly states that "The Corps has traditionally used acres as the standard measure for determining impacts and required mitigation for wetlands and other aquatic resources, primarily because useful functional assessment methods were not available. However, Districts are encouraged to increase their reliance on functional assessment methods." The guidance further points out that "For wetlands, the objective is to provide, at a minimum, one-to-one functional replacement, i.e., no net loss of functions, with an adequate margin of safety to reflect anticipated success. Focusing on the replacement of the functions provided by a wetland, rather than only calculation of acreage impacted or restored, will in most cases provide a more accurate and effective way to achieve the environmental performance objectives of the no net loss policy. In some cases, replacing the functions provided by one wetland area can be achieved by another, smaller wetland; in other cases, a larger replacement wetland may be needed to replace the functions of the wetland impacted by development." This functionality mitigation rather than acreage replacement is precisely what the EMMs framework is designed to promote and facilitate.

Increase Market Size

An important beneficial consequence of ecologically integrated markets is the increase in market size for environmental commodities. One restoration project may generate multiple environmental commodities for markets of various sizes. A wetland restoration project may generate water quality and flood storage credits which are then sold to a downstream wastewater treatment plant and downstream municipality, respectively. Should this wetland support migratory birds, habitat or endangered species credits might be sold to an investor in South America. This would assume that regulation allows for such transactions or the trade takes place under an international agreement. As a result, each commodity would be marketed/sold within pools of buyers of different sizes and over different geographic ranges.

In the case of nutrient credits trading restricted in small watersheds, EMMs can also help partially solve the thin markets problem. To avoid potential price distortion in thin markets, a price cap may be used to encourage purchasing. Because in EMMs, ecosystem restoration can generate multiple incomes from the multiple environmental services such an ecosystem can provide, regulation on pricing could become possible without discouraging the production. If a farmer can receive GHG credits, habitat credits, and flood storage credits from restoration of a riparian native grassland from the national market place, then a price cap for nutrient credits tradable only in his sub-watershed would be more acceptable, especially when tradable nutrient credits are the only source of economic return he can locally receive from the grassland. In essence, EMMs indirectly increase the market size for nutrient credits by returning the farmer a comparable economic return for his investment in grassland restoration.

Maximize Cost-effectiveness of Environmental Investment

In the EMMs framework, several driving forces encourage and enable investors or responsible parties to find the most cost-effective pollution abatement methods. First, as already noted, economic incentives are greater in EMMs than individual trading markets because multiple economic returns can be achieved from multiple environmental commodities produced by a functioning ecosystem. This has the potential to stimulate innovative pollution reduction approaches and new technology. Greater economic returns can also alter the way cost-effectiveness is calculated, particularly on the effectiveness end, and thus make adoption of capital-intensive environmental improvement measures more viable. Using the Acid Rain Program as an example, reducing SO_2 emissions by installing scrubbers incurred high capital costs. Not a popular option during Phase I of the program, it is expected to remain with the same secondary-choice status in Phase II (USDOE, 1997). However, in a joint demonstration project by the U.S. Department of Energy, the Tennessee Valley Authority, and the Electric Power Research Institute, scrubber byproducts (mostly gypsum) are being used to sequester CO_2. When applied as a mulch to soil at a former mine site, the scrubber byproducts can help increase the survival rate of native tree species and promote growth of vegetative ground cover. The alkaline nature of the scrubber material will reduce acid runoff into local streams from the former mine site and also provide cover and habitat for wildlife (http://www.worldbank.org/html/fpd/em/912001k.html). Therefore, installing scrubbers can bring an expanded array of credits to the emitters. If GHGs credits are allowed to be sold and generate economic returns in an integrated ecosystem market (i.e., the EMMs), the same amount of capital investment would have a much higher economic return rate. This could very well create a market-driven approach that could turn scrubbers into the option that compliance managers in SO_2 sources would consider first.

EMMs maximize the cost-effectiveness of environmental investment by providing more cost-effective abatement options. For example, if utilities in the RECLAIM program could purchase NO_x credits from the automobile industry, it would provide the latter with incentives to improve automobile fuel efficiency. Considering the millions of vehicles on the road everyday, such fuel efficiency improvement offers a highly cost-effective NO_x reduction method. Society as a whole would see an improvement in cost-effectiveness of NO_x reduction. The EMMs framework is essential to substantially prolong Stage 1 in Figure 3 as we move to the goals provided by functioning ecosystems.

Place Monetary Values on Intangible Environmental Services

Water quality trading and air emissions trading markets have already started to link pollution control investments with significant economic returns. Governmental programs (e.g., conservation titles in the Farm Bill) that compensate conservation practices (to some degree) assign economic values to the environmental services these practices can supply. However, besides not adequately rewarding these investments and conservation practices, current trading markets and governmental programs are not capable of revealing the economic values of many intangible environmental services provided by sound environmental practices. A landowner may face the prospect of selling his vacant land to a developer for a new supermarket. The choice is rarely a difficult one. The landowner can cash in by selling to the developer. The undeveloped land is not making him any money, and may even be considered waste land. Although it is becoming increasingly clear that Americans value open space, this is typically an abstract sense of value, seldom associated with a dollar amount. Economists use various methods such as willingness to pay and travel costs to give monetary values to open space and ecologically significant land or water. However, the general public still finds it difficult to relate these values to economic gains or losses in their daily life. Many Americans want land preserved simply for the purpose of knowing it is there and available for their grandchildren's grandchildren to enjoy. Aesthetics is also a reason for placing a value on these lands. However, such sentiment is generally reserved for famous lands, such as national parks, or lands of exceptional beauty and frequently expressed with the caveat that their preservation should not cost much money or inconvenience. In the conflict between development and land preservation, it is difficult to justify preservation just for the sake of aesthetics or other "non-use" values.

We have come to understand that open spaces also perform a myriad of ecosystem services. These include cycling of elements, such as carbon and nitrogen, storm water impact mitigation, and groundwater protection, to name a few. Unfortunately such services are often not recognized until they are lost. EMMs, with its market-based approach, place a dollar value on open spaces, recognizing the services provided by those lands. When greenhouse gas sequestration credits, for example, can be produced and traded, the existence of this service will be recognized and associated with a monetary value. With EMMs, ecosystem services are brought into the mainstream with a full recognition of their existence, their economic and their ecological values. They will be seen as a consumer good that must be invested in. By discussing these services in a public and economic context, they bill become more understood by the lay-public. With the growth of EMMs, an argument for land preservation is strengthened, as proponents can point out that development causes the irreversible loss of not only ecosystem services but also these potential economic values. Development may yield fewer economic returns and also means ecosystem credits can no longer be sold. Further, storm water mitigation credits may have to be purchased by the proposed development since it would increase imperviousness and cause potential violation under storm water NPDES.

Expand Financial Resources and Diversify Revenue Sources

As previously mentioned, under the EMMs framework, a specific investment for ecosystem restoration or enhancement will realize greater economic returns due to the multiple environmental commodities generated. In a mature EMMs scheme, environmental investment can actually become self-sustainable with the generation of sufficient economic returns to recover initial capital costs and subsequent operational costs. It can even become profitable just like any other investment in a market economy. Compared to the individual trading markets approach, EMMs will transform environmental protection activities from reactive measures to proactive undertakings. In addition, the creation and growth of secondary markets will increase market activities and add more streams of income for environmental investors.

Perhaps the most important benefit from an EMMs approach is the introduction of private funding and human resources to environmental protection activities. Private resources have always played an important but limited role in environmental protection in the form of donations and voluntary workers (except pollution sources under regulation to invest in remediation). These resources are more or less charitable in nature and donors usually do not expect an economic return. This limits the amount of private funds and other resources available for protecting and restoring ecosystems. As discussed previously in this chapter, governmental environmental programs are increasingly impeded by limited funds and a shortage of staff. However, when investing in ecosystem restoration can generate substantial economic returns, like any other profitable business, private funds will be mobilized in the capital market to invest in ecosystem markets. The potential availability for funds will then become virtually limitless.

Facilitate Market Transactions with Brokerages and Private Certification

Environmental Registries and brokerages have served the market well in individual trading markets (see Chapter 5). The Acid Rain Program and the RECLAIM program, with their built-in registry system, have stimulated the formation and active involvement of many emission allowances/credits brokerage services in the emission trading market. With EMMs, an integrated multiple environmental commodities market will enable brokerage companies to expand their business by creating more tradable environmental commodities and increasing their volume of trades.

Besides brokerages, in the EMMs, intermediary services can extend their role to the area of environmental commodity certification. Constrained by financial and human resources, government agencies will unlikely be able to provide all the necessary services in one of the most important steps in environmental commodity trading--commodity certification in a market where multiple commodities are traded. In fact, one of the drawbacks of some current water quality trading programs is the high administrative costs associated with credit certification and project monitoring provided by government agencies. In EMMs, certification and monitoring services can and should be supplemented by the private sector in the form of qualified private certification organizations or businesses. Government could then focus on the authorization of such private certification services and subsequent accountability checking. Many professional certification programs that directly affect the lives of millions of people have been traditionally managed by private organizations and professional associations. As one example, the Board of Certified Safety Professionals has been certifying practitioners in the safety profession with the Certified Safety Professional (CSP) designation since 1969. The CSP designation today has become the mark of professionalism within the safety field and the importance of this designation as a measure of professional standing and competence is accepted not only by the profession, but is also gaining acceptance by federal, state, and local governments, by employers, and by the public (BCSP, 2002). With careful design and appropriate execution, there is no reason that such certification programs cannot be implemented for environmental commodity products.

CHAPTER 4.

IMPLEMENTING THE ECOSYSTEM MULTIPLE MARKETS

Design and implementation of EMMs has the potential to create conflicts with the status quo of environmental regulations and political thought. The process of reconciling conflict through innovative policy changes can provide challenges as well as opportunities. How to address challenges with opportunities for environmental and economic gains will be a focus of developing an operational EMMs framework. A good way to move EMMs from a concept into a working policy tool is by implementing a pilot or demonstration project. This chapter outlines the potential for demonstrating the EMMs framework in the Great Lakes and other regions of the nation. Used here, the Great Lakes region refers to the eight lake states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin) in the United States and the two lake provinces (Quebec and Ontario) in Canada. Feasibility of establishing demonstration projects is analyzed from the following angles: current ecosystem threats, existing political infrastructures and market-based environmental programs, political willingness, public acceptance, market potential for EMMs, financial resources, and proposed institutional arrangement.

I. Demonstrating EMMs in the Great Lakes Region

Threats to the Ecosystem of the Great Lakes Region

The Great Lakes region supports unique terrestrial and aquatic habitats and resources requiring protection. For example, Lake Michigan’s coastline dunes constitute the most extensive freshwater dune complex in the world. The State of Michigan alone contains 275,000 acres of such dunes, of which only roughly 40% of these acres are publicly owned (LMF, 2002). This means these unique natural features are not protected against mining and/or development pressures. The dune systems support the piping plover, federally listed as an endangered species. Coast dunes also act as a guide and resting area for many migrating birds.

The importance of preserving and restoring natural prairie systems in the Great Lakes region is also becoming more recognized and widespread. Historically, tall grass prairie systems stretched from Northeastern Illinois and Northwestern Indiana across Southern Michigan to Ontario. Since the mid-1800s such prairies have largely been converted to agriculture. Presently, only 0.01 percent remains (US EPA, 2000). They provide stable, diverse habitats and are currently being researched for their role in carbon sequestration. Oak savannahs, the semi-open areas existing between prairies and forest, have had a fate similar to tall grass prairies, with only 0.01 percent of original coverage remaining. In Northwest Indiana and Central Wisconsin those areas provide habitat for the federally endangered Karner blue butterfly (US EPA, 2000).

In contrast to the biodiversity of the Great Lakes are such major industrial centers and cities as the Chicago-Gary, Indiana complex at the southern end of Lake Michigan, the paper mill area of Green Bay, Wisconsin and the City of Detroit on Lake Huron. The Lake Michigan basin supports the greatest concentration of paper mills and steel mills in the world. Over 2,000 miles

(20%) of the shoreline are considered impaired because of sediment contamination and fish consumption advisories remain in place throughout the Great Lakes and many inland lakes, including forty-two “Areas of Concern (AOCs)” that have been federally listed in the Great Lakes Basin by the U.S. and Canada for the fourteen beneficial use impairments that have been identified for these AOCs. While these same waters and their basins are impaired by industrial and land use pressures, they are also supplying drinking water for 10 million people and supporting a growing tourism and recreation industry (US EPA, 2000).

The Great Lakes region also supports valuable fisheries and tourism industries. In the U.S., sport and commercial fishing is a $4 billion industry annually (GLIN, 2002a), with the Great Lakes being the most widely fished freshwater system. In 2001, the Great Lakes attracted 2 million anglers (USFWS, 2002). The Great Lakes region has one-third, or 3.7 million of the nation’s registered recreational boats. Scuba diving at shipwrecks is a growing recreational activity in the Great Lakes, due to the presence of many underwater preserves (GLIN, 2002b). However, these natural features and recreational opportunities are increasingly threatened by resource use, urban sprawl and water quality degradation, which promote eutrophication, erosion and sedimentation and loss of wetlands.

Wetlands loss is generally the most frequently quantified evidence of degradation in the Great Lakes watershed. The State of the Great Lakes 2001 (Environmental Canada and US EPA) estimates that over two-thirds of the Great Lakes wetland have been lost and many of the remaining are threatened by development, drainage, and pollution. For example, since the 1780s the four states surrounding Lake Michigan (Indiana, Illinois, Michigan, and Wisconsin) have lost 21.9 million of their 34.8 million original wetland acres (Dahl, 1990). This exceeds the national average of 52.8% of wetland acres lost. The 12.9 million remaining acres are crucial to sustained biodiversity of the region, especially those situated along the coasts of the Great Lakes. The Hine’s Emerald dragonfly, one of the most endangered dragonflies in the United States is only know to occur in three areas in the Lake Michigan Basin: the coastal wetlands on dolomite bedrock of Door County, Wisconsin, Northeastern Illinois, and, in Michigan’s Upper Peninsula. Drowned river mouth marshes along the eastern shore of Lake Michigan have had their hydrology altered by road crossings and have been impaired by ditching, agricultural practices and invasive species. Nutrient loadings from nonpoint sources provide the greatest threats to the water quality of these marshes.

Political and Regulation Settings in the Great Lakes Region

In 1983, the Council of Great Lakes Governors (CGLG; sates including Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin; provinces including Quebec and Ontario) was established to “encourage and facilitate environmentally responsible economic growth ” in the region. In 1985, the Great Lakes Charter was signed by the eight US governors and two Canadian province premiers. The Charter outlined principles for managing Great Lakes water resources and organized programs to implement these principles. On June 18, 2001, the governors and premiers released a Supplementary Agreement to the Charter, Annex 2001, which called for, among other principles, all new water withdrawals and diversions from the drainage basin should not individually or cumulatively cause significant adverse impacts and would result in an improvement to the basin’s waters and water dependent natural resources. On October 1, 2003, the Council released nine priorities for the protection and restoration of the Great Lakes (http://www.cglg.org/1projects/priorities/index.asp). These priorities include, among others, diffuse pollution sources control and protection of costal wetlands, fish and wildlife habitats. The Great Lakes Governors also reiterated their commitment to working with local governments and other stakeholder organizations on a coordinated approach to safeguarding the Great Lakes.

The International Joint Committee (IJC) was created by the 1908 Boundary Waters Treaty between the U.S. and Canada to assist the two governments in finding solutions to problems in these waters. The Great Lakes Water Quality Agreement (GLWQA), first signed in 1972 and renewed in 1978, "expresses the commitment of each country to restore and maintain the chemical, physical and biological integrity of the Great Lakes Basin Ecosystem and includes a number of objectives and guidelines to achieve these goals. It reaffirms the rights and obligation of Canada and the U.S. under the Boundary Waters Treaty and has become a major focus of Commission activity. In 1987, a Protocol was signed amending the 1978 Agreement. The amendments aim to strengthen the programs, practices and technology described in the 1978 Agreement and to increase accountability for their implementation. Timetables are set for implementation of specific programs" (http://www.ijc.org/agree/quality.html). The GLWQA listed seventeen programs and measures to fulfill the purpose of the Agreement and to meet its objectives. These programs and measures range from specific pollutants such as phosphorus and persistent toxic substances to the human activities that generate these pollutants. It is clear from CGLG's priorities and the GLWQA that the Great Lakes should be considered one integrated ecosystem when restoration efforts are considered and implemented. The leaders in the basin have also recognized the importance of a holistic approach in the protection and sustainable use of the Great Lakes.

On the U.S. federal level, EPA's Great Lakes Strategy 2002 (US EPA, 2002b) set forth a number of goals targeting to simultaneous restoration of the chemical, physical, and biological integrities of the Great Lakes. Specifically, the Strategy calls for restoration and enhancement of 100,000 acres of wetlands by 2010; establishment of 300,000 acres of buffer strips in agricultural lands by 2007; clean-up and delisting of 3 "Areas of Concern" on the U.S. side by 2005, and; having 90 percent of beaches open for 95 percent of the season by 2010. Although the Strategy warned that more money could be needed to meet some of its objectives, no additional government funding has been allocated. Considering the ecosystem-wide restoration approach and the potential shortage of funds, an EMMs concept appears well suited to the overall goals and could provide mechanisms to bring private funds into these restoration efforts.

In terms of specific ecosystem restoration, the Estuary Restoration Act of 2002 (Public Law 106-457) made Great Lakes Freshwater estuaries eligible for federal funding to restore costal wetland habitat. Under the law, a non-federal entity can request funds for a coastal restoration project, with the stipulation that a one-to-one match must be provided. On the U.S. side alone, there are approximately 252,000 acres of coastal wetland on the Great Lakes (RAE, 2002). Using an average costal wetland loss rate of 66 percent for the Great Lakes (Environmental Canada and US EPA, 2001), it is estimated that approximately 382,000 acres of coastal wetland need to be restored in the region. For contaminated sediment in the Great Lakes Basin, the Great Lakes Legacy Act of 2002 "authorizes $270 million over five years from fiscal years 2004 to 2008. The Act authorizes $50 million per year for "Projects" which may include: site characterization, assessment, monitoring, remediation, and/or pollution prevention, $3 million per year for technology research, and $1 million per year for public information programs" (http://www.epa.gov/glnpo/sediment/legacy).

Currently, there are two more bills introduced to the U.S. Congress funding general ecosystem restoration efforts in the Great Lakes: the Great Lakes Environmental Restoration Act (S. 1398) and the Great Lakes Restoration Act (H.R. 2720). The Senate bill would provide up to $600 million per year for a ten-year period for grants to Great Lakes restoration activities while the House bill would provide up to $800 million per year over five years for states to conduct restoration activities. These current and pending federal funding sources not only provide financial support for the Great Lakes ecosystem restoration but also reflect the commitment of the federal government to achieve measurable progress in the restoration.

There is increasing agreement to the thought that new management tools and financial resources are needed to fund these initiatives and strategies aiming to best manage Great Lakes ecosystem resources and functionality. Market-based concepts, on which the EMMs framework is based, are gaining national attention and interest. The US EPA (Office of Research and Development, National Center for Environmental Research) and the Water Environment Research Foundation (WERF), for example, recently issued requests for proposals relating to identification and development of new market mechanisms and incentives for enhancing environmental management. Besides issuing the Final Water Quality Trading Policy (US EPA, 2003a), EPA is funding eleven pilots projects to get more experience and actual "on the ground" implementation (http://www.epa.gov/owow/watershed/trading/tradingpolicy.html). This clearly indicates a growing trend to explore market potential not only for reducing the costs of compliance but also for enhancing environmental management beyond traditional environmental regulations and programs.

Existing Market-based Programs in the Great Lakes Region

The Great Lakes region provides ample opportunities for market-based environmental management policies and has hosted a number of feasibility studies and pioneering programs. The State of Michigan has a voluntary program to buy development rights from agricultural landowners. As of July, 2001, the program had protected 12,000 acres. This additional tool for resource protection places value on Michigan's agricultural heritage. Due to a unique lakeshore microclimate along the lower peninsula's western region, Michigan supports numerous fruit orchards, growing most of the tart cherries in the country. However, as crop values are lowered and land values rise, production is threatened by sprawl. Michigan ranks second nationally in the number of golf courses and first in the number of second homes (AFT, 2001). The State of Michigan is also in the process of finalizing trading rules for water quality protection (MDEQ, 2001). Supported by the US EPA, Michigan's draft rules provide the legal basis for making nutrient reductions towards a TMDL, early reductions prior to a TMDL, or voluntary reductions to offset growth. Nutrient trading is expected to occur in Michigan once the state provides legislative approval and finalizes its electronic registry. The Kalamazoo River Water Quality Trading Demonstration Project from 1997 to 2000 (funded by WERF) detailed the challenges and opportunities to point-nonpoint source trading under a phosphorus TMDL. A unique cooperative agreement incorporated in the current Kalamazoo River/Lake Allegan Watershed

TMDL allows the use of point-nonpoint source phosphorus trading (The Kalamazoo River/Lake Allegan TMDL Implementation Committee, 2002).

Minnesota is another Great Lakes state that has pioneered market-based approaches to solve environmental problems. Since 1997, the Minnesota Pollution Control Agency has administered two point-nonpoint source water quality trading programs (see Section II, Chapter 5). The Minnesota Department of Transportation operates a wetlands mitigation bank to offset wetland loss incurred by road construction and maintenance activities. The Ohio Wetlands Foundation, a non-profit organization, was formed in 1992 by the Ohio Home Builders Association (www.ohiowetlands.org). This foundation was the first banker in the country to construct a wetlands mitigation bank and to complete the required five year monitoring period. The foundation has sold all of its credits in its first three banks representing approximately 500 acres of wetland restoration at three different locations. Credits are being created and available at three more banks.

Across the border in Canada, a regulated water quality trading program between point sources and nonpoint sources has been in operation since 1998 in the South Nation River Watershed (southeast of Ottawa). This is a well established program with a community based watershed organization, the South Nation Conservation acting as the broker for phosphorus credits (O'Grady and Wilson, South Nation River Conservation, personal communication). In the area of atmospheric pollution reduction, the Chicago Climate Exchange (CCX)'s GHG trading program (see Section I, Chapter 5, and Appendix B) focuses on a seven-state region in the Midwest, which includes six Great Lakes states (MI, MN, IN, IL, OH, and WI) for the first phase of the program.

Public Acceptance toward Market-based Programs in the Great Lakes Region

In terms of public acceptance and experiences with market-based approaches to environmental protection, the Kalamazoo River Water Quality Trading Demonstration Project showed that by identifying common interests between environmental and economic goals (critical to the community and watershed), it is possible to bring a diverse group of stakeholders to the table and establish strong partnerships among them (Kieser, 2000). When their individual concerns were addressed and the benefits of a trading program were understood, municipalities, industrial and agricultural sectors all eventually became trading partners.

Both trading programs in the Minnesota River Basin went through an open public comment period before the NPDES permit containing trading provisions was officially issued. The trading provisions reflected inputs from the public and the program trust fund (see Section II, Chapter 5) was managed by a board mandated to include a representative from local water resources organizations (Fang, 2002). Involvement of farmers, environmental groups and local watershed officials in the trading programs brought the unregulated nonpoint sources to the spotlight. The trading programs provided much needed funds for nonpoint sources to implement pollution control measures. This would likely result in positive public awareness impacts for both the nonpoint source pollution problems and the opportunity to use trading to introduce nonpoint source pollution controls.

Potential EMMs Commodities in the Great Lakes Region

Under the current regulatory conditions, with the experience gained from previous projects, and through existing and future market-based programs, four potential environmental commodities have been identified for trading in a pilot EMMs program in the Great Lakes region:

- Water quality credits (e.g., phosphorus and nitrogen loss reductions) from direct water quality improvement measures (e.g., agricultural BMPs and tertiary wastewater treatment)
- Ecosystem function mitigation for wetlands
- Greenhouse gases (GHGs)
- Endangered species/wildlife habitat

Establishing multiple markets through existing water quality markets is viewed as the most efficient way to start building an EMMs program. A working water quality market offers a market place where water quality credits generated through the production of the other three environmental commodities can be sold. Furthermore, the market infrastructure, services, and trading mechanisms (e.g., the producer and buyer bases, credit registries, and trading organizations) in a water quality trading market can all be adopted and modified to accommodate trading of the other three environmental commodities. Incorporating wetlands, GHGs, and habitats markets could also break the geographic and temporal limitations often seen in watershed based water quality trading since measures taken to generate water quality credits in one watershed may also produce GHG or habitat credits suitable for trading in another watershed. For example, Dr. Donald Hey of The Wetlands Initiative, a Chicago-based non-profit institution and a collaborator of this study, has previously identified a potential nitrogen market for constructed and managed wetlands where wetland plants could be harvested specifically to remove nitrate-nitrogen (see Appendix A). In an EMMs framework, these wetlands would generate nitrogen credits for water quality trading within their watersheds and at the same time, be able to participate in the wetlands mitigation market, which has a less restrictive geographic requirement under current wetland mitigation bank rules.

An EMMs pilot project could also come from the voluntary Chicago Climate Exchange program (CCX, see discussions in Appendices A and C). The CCX explicitly incorporates and encourages improvement of water quality in the region when mitigating GHGs in the context of protecting the global ecosystem. Nitrous oxide, one of the most powerful greenhouse gases, is 310 times more efficient in trapping heat than CO_2. Three quarters of the total U.S. emissions of nitrous oxide come from agricultural production due to the volatilization of synthetic nitrogen fertilizers. Agricultural BMPs that reduce the use of these fertilizers can decrease the generation of nitrous oxide as well as reduce nutrient losses waterways. Opportunities exist to merge the CCX with water quality trading under an EMMs framework in the Great Lakes region.

The Nature Conservancy and the US Environmental Protection Agency conducted a feasibility study for the development of a forest bank in the Great Lakes region. The study determined that the Kakogan-Bad River watershed, which straddles the border of Wisconsin and Michigan's Upper Peninsula, would be an ideal ecosystem for banking (The Nature Conservancy, 1998). Sand dunes cannot be restored due to the lengthy geological processes which create them. Sand dune banking could be used to preserve high-priority dune areas in perpetuity and direct mining pressures to previously damaged areas. Establishing a dollar value on dune systems for their habitat, recreational, aesthetics and erosion prevention capabilities could aid in protection against mining and development.

Market Potentials in the Great Lakes Region

It is difficult to estimate the full market potential of individual EMMs commodities in monetary value in the Great Lakes region because, other than wetlands restored and sold for mitigation, no real markets currently exist for the potential EMMs commodities discussed in the previous section. Table 1 provides a compilation of literature and reported values regarding the potentials

Table 1. Literature and reported credit and market prices for several potential EMMs commodities.

	Wetland (/ac/yr)	*Forest (/ac/yr)*	*Grassland (/ac/yr)*	*Price ($)*
Phosphorus removed (lb)	8.9 [a] – 9,117 [b]			1.64 [j] – 89.89 [k]
Nitrogen removed (lb)	11.3 [c] – 58,632 [b]	326 [f]		0.30 [l] – 13.15 [m]
Carbon sequestrated (metric ton)		0.006 [g] - 4.8 [h]	0.067 [i]	0.60 – 6.27 [n]
Mitigation bank (ac)	0.3 - 0.5 [d]			1,700 – 42,500 [o]
Habitat bank (ac)		0.3 - 0.5 [d]	0.3 - 0.5 [d]	4,333 [p] – 18,000 [q]
Flood storage (ft)	3 [e] - 15 [e]			12.00 – 60.00 [e]

[a] North American wetlands, statistical analysis of EPA's wetland water treatment data (Richardson and Qian, 1999).
[b] P sorbed by sedimentation in a Gulf coast freshwater lake (DeLaune, et al. 1990)
[c] Denitrification in restored wetlands from rice fields in Spain (Comin, et al. 1997).
[d] Assuming mitigation ratios of 1:3 and 1:2.
[e] Based on the 1993 Mid-West flood data (Don Hey, Appendix A).
[f] Wetland forest receiving treated sewage effluent in Louisiana (Boustany et al., 1997).
[g] Model simulation result for a forest in Buserud, Norway (Hoen and Solberg, 1994).
[h] Oregon Klamath Cogeneration Demo Project (Cathcart, 2000).
[i] Model simulation result for pastures in South Central US (Lee and Dodson, 1996).
[j] Cost of agricultural BMPs (Kieser, 2000).
[k] Average cost (including transaction costs) of agricultural BMPs in the South Nation River Basin in Canada.
[l] Cost for wetland N removal (Hay, see Appendix A).
[m] North Carolina Tam-Pac program.
[n] Average price of verified emissions reductions traded among the Kyoto agreement Annex B countries for the vintage years of 2008-2012 (Rosenweig et al., 2002).
[o] Values of the US Army Corps of Engineers report, 1996 (US ACOE, 1996).
[p] North Florida (gopher tortoise habitat; Florida Fish and Wildlife Conservation Commission, 2001).
[q] Monterey Bay slough, CA (S. Holbrook, 7/18/00, *Santa Cruz Sentinel* article: "Agencies struggle to put a price tag on damage to Monterey Bay").

of three types of ecosystems—wetland, forest, and grassland—in generating various environmental services and their corresponding economic returns. Literature values vary widely, often over several orders of magnitude. This is not surprising due to large variations in the quality of services produced, credit measuring methods employed, and market values of land in different geographic locations.

Values cited in Table 1 were used to make "best" estimates for the Great Lakes region on levels of environmental services that potential EMMs commodities could provide and the market values of these commodities. These estimates (Table 2) were based on the following four selection criteria:

1. values obtained from research and/or actual market trades taking place in the Great Lakes states (e.g., price for wetland mitigation banks);
2. available or average reported values (e.g., amount of nitrogen removed by forests);
3. "best" values as judged by the authors based on the literature sources (e.g., amount of phosphorus removed by wetlands); and
4. reasonable estimation made by the authors based on experiences (e.g., mitigation ratios for wetlands and habitats).

Table 2. Most reasonable ("best") estimates of credit and market values for several potential EMMs commodities in the Great Lakes region.

	Wetland (/ac/yr)	*Forest (/ac/yr)*	*Grassland (/ac/yr)*	***Price ($)***
Phosphorus removed (lb)	8.9 [a]			88.89 [h]
Nitrogen removed (lb)	1,152 [b]	326 [e]		13.15 [i]
Carbon sequestrated (metric ton)		4.8 [f]	0.067 [g]	2.30 [j]
Mitigation bank (ac)	0.5 [c]			14,500.00 [k]
Habitat bank (ac)	--	0.5 [c]	0.5 [c]	11,000.00 [l]
Flood storage (ft)	3 [d]	--	--	12.00 [d]
Market Value ($/ac/yr)	**22,527.84**	**9,797.94**	**5,500.15**	

a. North American wetlands, statistical analysis of EPA's wetland water treatment data (Richardson and Qian, 1999).
b. Denitrification, macrophytes accumulation and sediment accumulation in restored wetlands from rice fields in Spain (Comin, et al. 1997).
c. Assuming a 1:2 mitigation ratio.
d. Based on the 1993 Mid-West flood data (Hey, see Appendix A).
e. Wetland forest receiving treated sewage effluent in Louisiana (Boustany et al., 1997).
f. Oregon Klamath Cogeneration Demo Project (Cathcart, 2000).
g. Model simulation result for pastures in South Central US (Lee and Dodson, 1996).
h. Average cost (including transaction costs) of agricultural BMPs in the South Nation River Basin in Canada (D. O'Grady and M. A. Wilson, South Nation Conservation, 2002; personal communication).
i. North Carolina Tam-Pac program.
j. Average price of verified emissions reductions traded among the Kyoto agreement Annex B countries for the vintage years of 2008-2012 (Rosenweig et al., 2002).
k. Average price of wetland banks maintained by the non-profit Ohio Wetlands Foundation: www.ohiowetlands.org.
l. Median value of North Florida (Florida Fish and Wildlife Conservation Commission, 2001) and Monterey Bay, CA (S. Holbrook, 7/18/00, *Santa Cruz Sentinel* article: "Agencies struggle to put a price tag on damage to Monterey Bay").

Table 2 indicates that wetland restoration has the highest market potential on a per acre per year basis in the Great Lakes region. As mentioned previously in this section, as much as 382,000 acres of coastal wetland have been lost during the last 200 years on the US side of the Great Lakes. Assuming that half of these acres (191,000 acres) could be restored over the next 100 years leads to an average annual restoration rate of 1,910 acres. The market potential of EMMs commodities for the Great Lakes can then be estimated based on the values cited in Table 2.

Table 3 shows potential market values for four potential commodities associated with wetland restoration (habitat mitigation[1], phosphorus load reduction credits, nitrogen load reduction credits, and flood storage) in an EMMs framework. For habitat mitigation, because usually only one lump sum payment is made to a restored wetland, the annual economic return will be

Table 3. Market potential analysis for restoring costal wetlands (1,910 acres per year) in the Great Lakes region.

	At Year 1 End (million $/yr)	*At Year 5 End (million $/yr)*	*At Year 100 End (million $/yr)*	*Overall (million $/100 yr)*
Habitat mitigation	13.8	13.8	14.3	1,384.8
Phosphorus	1.5	7.6	7.6	740.4
Nitrogen	28.9	144.7	144.7	14,177.8
Flood storage	0.02	0.1	2.3	229.2
Total	**44.3**	**166.2**	**168.4**	**16,532.1**

constant throughout the 100 year period when a constant annual restoration rate (1,910 acres) is assumed. Load reduction credits for phosphorus and nitrogen, according to Michigan's water quality trading rules, can be banked for trading for a period of 5 years. Because the restoration rate is assumed constant, after 5 years, new credits produced will be balanced by old credits retired and tradable credits will reach constant. Flood storage capacity, on the other hand, will continue growing with the accumulation of restored wetlands. These wetlands can receive payment for their flood storage services because the risk of major floods is usually spread out by payments made on an annual basis (see Appendix A). Green house gases (GHGs) are not included in this analysis because there is still no consensus in the scientific community regarding the effectiveness of wetland in sequestrating or generating GHGs.

Table 3 indicates that after the phosphorus and nitrogen credit markets reach equilibrium (the *At Year 5 End* column), the annual market value of 1,910 acres of costal wetlands alone can reach $166 million. The majority (87%) of this value is accounted for by nitrogen load reductions. Mitigation and phosphorus loss reduction also amount to multi-million dollar levels. Even if we do not include nitrogen (as most of the water quality trading programs in the US so far have only phosphorus as the target pollutant), the remaining three environmental services provided by

[1] In an EMMs framework, the price for a restored wetland is evaluated by its ecological and environmental functions. Wetlands mitigation in EMMs focuses on the mitigation of these functions, not merely the acreage of the lost wetland. Consequently, habitat mitigation assumes the economic returns that the current "wetlands mitigation" would receive in Table 3. See discussions in Section II of Chapter 1, Section I of Chapter 2, and Section II of Chapter 3 on the different concepts of wetlands mitigation in the current mitigation market and mitigation in EMMs.

coastal wetland restoration through an EMMs framework will still reach $21.5 million per year with mitigation and phosphorus load reduction accounting for about 2/3 and 1/3 of the total market value, respectively.

Proposed Institutional Arrangement and the Environmental Trading Network (ETN)

As a new concept, institutional arrangement for an EMMs framework would also have to be innovative. Considering the geographic scope of potential EMMs trading and the necessity to involve all interest groups, a balance needs to be well maintained between streamlining the decision making process to reduce transaction costs and ensuring the quality of tradable environmental commodities through EMMs market activities. To achieve such a balance with minimum effort, institutional arrangement is crucial during the preparing phase of any potential pilot project. Some guidelines are proposed here as the first step to establish the most efficient arrangement.

1) Develop stakeholder partnerships to include locally-led initiatives, environmental conservation groups, municipal governments, state (e.g., MDEQ and watershed districts) and federal (EPA, USDA) agencies;
2) Establish a market governing body through which stakeholders can voice their opinions;
3) Set clear trading rules and dispute resolution procedures by the governing body of the pilot project during the preparation stage based on existing regulations and what we have learned from single market trading programs in the Great Lakes region, such as the Kalamazoo Phosphorus Trading Program;
4) Rely on market forces to drive the formation and maturing of the markets;
5) Build a working EMMs framework that has the flexibility to make institutional adjustments if needed.

In light of these guidelines, a trading organization that could conduct coordination among stakeholders and facilitate trading with policy and market assistances would be essential to running any potential pilot project. The Environmental Trading Network (ETN) is the ideal candidate to carry out such missions. The ETN partner projects and collaborators on the study leading to this report have already created institutional inertia, identified program sustainability needs and engaged the environmental community to varying degrees. Formerly the Great Lakes Trading Network (GLTN), the ETN was initially established in May 1998 with funding from the Great Lakes Protection Fund (GLPF), as an adjunct to maximize the regional impacts of the Kalamazoo River Water Quality Trading Demonstration Project (Kieser, 2000). Currently, the ETN is seeking not-for-profit status, dedicated solely to the development and implementation of successful water quality trading programs and other market-based strategies for achieving healthy sustainable ecosystems.

The ETN is also the only national clearinghouse for key policy and regulatory issues and transferable water quality trading program design elements. Many of the active and emerging trading programs across the county are represented on the ETN. The US EPA and several of its program offices, the National Wildlife Federation, the World Resources Institute, a number of states and academic institutions are also represented and actively participating on the ETN. Members of the ETN remain at the forefront of both research for as well as practice of market-based environmental programs. Collectively, they have the expertise and practical experience to organize and implement an EMMs pilot project. Since its establishment in 1998, the ETN has remained active through a series of conference calls, presentations, interactive features of the world wide web and collaboration with other organizations, agencies and institutions. The ETN is, therefore, in a unique and an appropriate position to lead and oversee the pilot project in the Great Lakes region.

Potential Project Funding Sources

Overlapping initiatives include large-scale agricultural subsidiary programs, municipal storm water improvements, and research-funded grants. Among currently active grants are conservation development and nutrient trading through the Joyce Foundation and CH2M Hill; benefits bundling through the Great Lakes Protection Fund (GLPF) and the Institute for Agriculture and Trade Policy (IATP); and large scale wetlands restoration in Saginaw Bay. All offer ideal opportunities to leverage other ongoing efforts.

There are many other funding sources in the Great Lakes region and the country dedicated fully or partially to restoring the ecosystem of the world's largest freshwater bodies. With its current funding interest in using market mechanisms for environmental improvement, the Great Lakes Protection Fund (GLPF) has provided funding for this white paper. Applying for initial funding for the next preparation phase of the pilot project will be pursued.

Provisions in the 2002 Farm Bill create Conservation Innovation Grants (with a 50% match) as part of the expanded USDA Environmental Quality Incentives Program (EQIP). This newly established grant will award government or non-government organizations or individuals that leverage federal funds to implement innovative approaches to conservation (Farm Bill 2002). The Conservation Innovation Grants provide an excellent opportunity for funding the operation of the pilot project, particularly in the environmental commodity generating stage of the project.

Private for-profit investment is an important funding source the pilot project will actively seek to attract. One of the key outcomes that the pilot project will pursue is to demonstrate that the EMMs framework can protect and improve the health of our ecosystems as well as provide returns to the financial resources used to achieve it. Therefore, private investors such as venture capitalists will be brought into the project as important stakeholders.

Projected Benefits of a Pilot Project

The benefits of an EMMs pilot project in the Great Lakes region are multifold. A successful EMMs pilot project would establish the practicability of the EMMs framework for use in environmental protection and ecological restoration. In a region known to be facing significant environmental and ecological challenges, a successful EMMs pilot project would establish a new precedent for using market-based approach to meet the challenges of restoring a functioning ecosystem. Success would prove that economic gain and environmental protection are able to beneficially coexist and promote one another. With an emphasis on attracting private investment in the environmental commodity markets in EMMs, experience gained in the pilot project would establish groundwork for future efforts that use market approaches to solicit private funds for the protection of the Great Lakes' ecosystems.

Since the produced and traded commodities in an EMMs framework are environmental services, a pilot project would generate multiple environmental benefits. Regionally, water quality improvements and habitat restoration would benefit the Great Lakes ecosystem. Nationally, the project has the potential to contribute reductions to the hypoxia problem in the Gulf of Mexico. Reduced GHG emissions from the region would benefit populations living in other parts of the world.

A pilot project in the Great Lakes region would also include information dissemination available through the ETN to participants across the country (for example, the Chesapeake Bay and Long Island Sound programs, both of which are represented on the ETN). Monitoring associated with pilot projects would provide quantitative and qualitative information necessary to establish the technical, economic and political basis of trading in multiple markets. Information of this type would also generate valuable data to address technology uncertainty that has posed what is likely the most significant barrier to environmental trading programs, especially in the area of non-point source pollution reduction.

Public receptivity for this new approach remaining largely unknown. Through education programs and information dissemination, the public would become aware of the costs and benefits of ecosystem restoration and improvement and the importance of a holistic approach towards environmental protection. A successful pilot project that generates high volume of trades will also have the potential for creating local job opportunities, including an increased demand for ecosystem restoration experts. Related supplies, materials, and labor will increase as well, stimulating the regional economy.

II. Steps in the Implementation Phase of an EMMs Pilot Project in the Great Lakes Region

Realization of a pilot EMMs project in the Great Lakes region will involve identifying the supply and demand of environmental commodities; establishing market institutions to facility trading; and enforcing actual trades. Four steps are proposed here to accomplish these tasks.

Step 1. Project site selection—in this step, one geographic area (likely a watershed in an Area of Concern) or multiple areas in the Great Lakes region will be chosen to implement the EMMs framework.

The ETN would lead the initial effort in this step. Site selection criteria are centered on three aspects of the EMMs framework—the potential for producing multiple environmental commodities, the demand for these commodities, and the environmental benefits and economic returns derived from trading these commodities. Generally, a watershed with existing environmental quality improvement needs, such as a TMDL, is preferred because the demand for reducing identified TMDL pollutants is already present. In terms of the selection approach, four successive stages leading towards the outcome are envisioned:

1.1. bringing together significant potential partners and experts to form a selection advisory board
1.2. identifying areas according to the three aspects of the EMMs framework
1.3. meeting with stakeholders (government agencies, citizens groups, potential sellers and buyers of environment commodities identified in this white paper) from these areas to determine the supply and demand potential of each area for environmental commodities
1.4. deciding on the final selection of project site(s) with approval from the advisory board

Step 2. Framework building—in this step, an institutional arrangement for EMMs is made to facilitate and oversee trading witin the framework.

Past experiences with water quality trading (Kieser, 2000; Fang, 2002) identified the paramount importance for collaboration among participants with diverse interests involved in a trading program. Prior to the emergence of well-established markets, support from participants in potential trades is crucial to forming markets and bringing together trading partners. From local and state regulatory agencies, who directly decide and oversee the legality of every step of a trade, to a well-respected and trusted member of a local citizens' group, who has the knowledge of local environmental and economic needs, stakeholders can be partners and drivers in building markets for environmental commodities. At the same time, they also can be opponents and erect barriers to market-based initiatives if not well-informed and included in the decision-making processes. The following stages are envisioned to accomplish the framework building step.

2.1. bring together stakeholders in the project area to build a stakeholder coalition
2.2. form a coalition-based trading authority and define the scope of work and authority of this organization
2.3. design market institutions for each environmental commodity to ensure environmental efficacy and market efficiency of EMMs

In designing market structures for environmental commodity trading, the key issue is to strike a balance between environmental efficacy (i.e., a high degree of certainty that environmental targets are reached) and market efficiency (i.e., a market's ability to complete transactions without imposing high transaction costs on market participants [Woodward et al., 2002]). Different market structures for the different legal and physical environments in which each of the commodities exists are required. Proposed market structures include:

2.3.1. using the CCX as the exchange for GHGs credits
2.3.2. establishing a clearinghouse for water quality credits
2.3.3. adopting a bilateral negotiation trading structure for habitat mitigation and flood storage credits

2.4. develop operating rules for the different market structures according to the project area's physical and legal environment
2.5. develop an on-line trading registry for all environmental commodities that incorporates the application of currently available tools such as NutrientNet (World Resources Institute)

Following the establishment of market structures and rules of operation, the majority of the work would focus on individual trades—the production and transaction of environmental commodities. Technical details are important within the following two steps.

Step 3. Environmental commodity production—in this step, field work is performed to improve or restore ecosystem functions and generate tradable credits.

3.1. environmental commodities are produced with support from private investment and funding from the pilot project
3.2. environmental commodities are registered with the registry and credits are verified by independent parties (e.g., USDA-NRCS and pilot project designated consulting firms)

Step 4. Transaction of environmental commodities—in this step, various credits generated in the pilot project are traded in the market framework established in Step 2.3.

4.1. credit trading in different market structures is enacted according to the rules and tools established from Step 2.3 through 2.5
4.2. due to the experimental nature of the pilot project, depositing some of the surplus credits with the trading authority for future trading or retiring them for the benefit of the environment may be considered

Step 4 (trading) may take place before a commodity is produced (Step 3). For example, contractual agreement can be reached so that a buyer pays for the engineering work required to reduce pollution and generate credits. Unforeseen situations could arise during these two steps. Adjustments in market operating rules may be necessary to accommodate them. The pilot project would have the flexibility to quickly adopt such adjustments.

Step 5. Research and report of the pilot project—in this step, the following questions will be answered:

5.1. Has the pilot project been able to make ecosystem improvements in the project area?
5.2. Has the EMMs framework been able to generate trading?
5.3. Is the EMMs framework more efficient in providing high quality ecosystem improvement work and the consequent environmental commodities/credits than individual trading markets?
5.4. Is the EMMs framework more efficient in generating market activities than individual trading markets?
5.5. What are the keys to the success/failure of the framework?
5.6. What can be done to improve the framework?
5.7. How can the experience from the pilot project be generalized to provide a model to other areas in the Great Lakes region and the country?

By answering these questions not only can we evaluate the outcomes of the pilot project but also provide critical guidelines and valuable lessons on designing future markets for environmental commodities. The practicality of the EMMs framework, to a large degree, depends on the transferability of the market structures and rules of operation established in the pilot project.

III. Issues in Implementing the EMMs Concept

In order to turn EMMs from concept into practice, several conceptual and practical issues should be addressed. As a new concept, EMMs will have to not only firmly establish itself theoretically but also provide convincing arguments when faced with questions on its effectiveness in reaching the goal of a functional ecosystem. This section addresses issues that either have emerged during the development of the EMMs concept or will likely surface in a potential pilot project. That more issues will emerge after the concept is put into practice is precisely why a pilot project is vital to the success of the EMMs concept.

<u>Acceptance by the Public and Government Agencies</u>

For a new concept that will require some fundamental changes in how ecosystem restoration be conducted and has the potential to become an important market force, it is crucial for the concept to be accepted first by the public and governmental agencies. Regarding multiple environmental markets, there could be three types of views could lead to public questioning of the EMMs concept.

(1) EMMs would provide dischargers with the right to further pollute the environment or damage ecosystems;
(2) There would be no net gain and perhaps even net losses for the environment in an EMMs framework; and
(3) Profit-seeking investors would produce commodities and services that are not environmentally sustainable.

The first view has already been given voice by concerned parties in various water quality trading programs. It stems from the belief that trading will make it easier for dischargers or developers to freely dispose of wastes or destroy ecologically significant land as long as they have the money to buy credits. Trading rules proposed by the US EPA have explicitly addressed such potential problems by requiring compliance with all current environmental standards and prohibiting trades that will result in backsliding practices (US EPA, 1996). When implemented, an EMMs framework will include similar rules to ensure that trading activities will not result in further pollution to the ecosystem on the larger air-/watershed scale as well as the local scale.

Perhaps the most significant obstacle facing implementation of an EMMs framework is the perception of so called “double dipping”. This is an understandable concern by regulators and citizen groups for the possible negative impact to the environment that would result from awarding one ecosystem restoration effort with multiple marketable credits. It is reasoned should we allow a restored wetland to be used for both wetlands mitigation under Section 404 of the Clean Water Act and water quality trading under a TMDL program, a less than desired acreage of wetland will be restored and the ecosystem/watershed may suffer a net loss. The ability of a well-designed EMMs framework to avoid or compensate for such potential losses can best be illustrated by the following example.

A recent report on wetland mitigation by the National Research Council (NRC, 2001) concluded that "the goal of no net loss of wetland is not being met for wetland functions by the mitigation program (Section 404, Clean Water Act), despite progress in the last 20 years". From 1993 to 2000, 42,000 acres of wetland were required annually as compensatory mitigation for approximately 24,000 acres of wetland permitted to be filled. However, while the quantity requirement is being met under the Section 404 mitigation program, the quality (the ecological functions) of these mitigation wetlands is not satisfying the overall goal of no net loss. The council further pointed out in the report that performance expectations for mitigation wetland are often unclear and compliance often not assured nor attained. The council recommends that one of the goals of wetland mitigation projects should be that individual compensatory mitigation sites are "designed and constructed to maximize the likelihood that they will make an ongoing ecological contribution to the watershed" and "this contribution should be specified in advance". To achieve this goal within the current wetland mitigation permitting framework, the cost of wetland mitigation is likely to increase significantly and some regulatory changes must be made to establish effective legal and financial assurances for wetland mitigation projects monitoring and long-term site sustainability.

The EMMs concept, on the other hand, can be used to introduce market forces in order to save costs and minimize the necessary institutional changes. As discussed in Chapter 3, if we allow the trading of multiple environmental services that a restored wetland can provide, a profit-seeking investor of wetland restoration projects will make quality the primary goal of the projects because only high quality wetlands with multiple ecological functions can provide the maximum economic returns from trading of multiple environmental services they produce. Table 3 indicates that water quality improvement (phosphorus and nitrogen removal) has the potential to provide between 35 to 92% of the total annual revenue for restored coastal wetland in the Great Lakes region. With some additional requirements placed on the quality of mitigation wetlands, market potential from water quality trading will very likely shift the emphasis on mitigation wetland from quantity to quality because only a functioning wetland with balanced hydrology, soil, and vegetation characteristics has a sustained capacity to remove nutrients. The potential for creating endangered species habitats would only further strengthen the desirability of a functioning wetland. Compared to the current status of Section 404 wetlands mitigation, the introduction of an EMMs framework would encourage mitigation projects producing high quality wetlands that truly can compensate for the lost ecological functions of filled wetlands. With a carefully selected trading ratio (>1), net gain for the environment can be at least expected.

This same argument also applies to the third potential negative view on EMMs listed at the beginning of this section. The EMMs concept in essence ties economic returns from environmental commodities with their ecological functions. Only maximum functions can yield maximum returns.

In summary, it is understandable to assume that the general public and government agencies will likely be skeptical about environmental benefits of an EMMs concept, particularly when maximizing economic returns is treated as a legitimate goal in an EMMs framework. In addition to the argument made above for an EMMs framework in wetland restoration, it is also important to recognize that the current situation of ecosystem restoration (including wetland) makes the

EMMs concept appealing--it is not that we have too many restored and ecologically functioning ecosystems earning multiple credits. The reality is that we are still losing these ecosystems in spite of all current efforts to stop such losses, as exemplified by the National Research Council's wetlands mitigation report (NRC, 2001). An EMMs framework has the potential to help us reverse this trend. The General Assembly of Maryland in its 2002 session created a two-year pilot program designed to increase the number of permanently protected forested stream buffers (Alliance for the Chesapeake Bay, 2002b). This program allows landowners to use forested stream buffers established under contracts with the federal Conservation Reserve Enhancement Program as "forest retention banks". These banks may be used for mitigation purposes at a rate of 2.5 acres per each acre of mitigation required. This program clearly has a multiple credits element in it. The approval of this program by the State of Maryland lawmakers showed their acceptance towards the multiple credits approach, particularly during a time of funding shortage and slowed progress in environmental improvements.

Commodity Quantification and Verification

An important issue for the design of an EMMs pilot project is the process used for environmental commodity (credit) quantification and verification. Because of the potentially extensive involvement of nonpoint sources in environmental commodity-generation projects, scientific uncertainty in quantifying the effectiveness of nonpoint source pollution loading and reduction can lead to difficulties in accurately verifying environmental commodities produced. The approach currently taken by most single market trading programs is to use the best available knowledge on the effectiveness of individual pollution reduction practices and/or apply the most suitable quantification methods appropriate for the project sites (MPCA, 1997 and 1999; Kieser, 2000; O'Grady and Wilson, South Nation Conservation, personal communication, 2002). This approach often involves reaching a consensus through extensive consultation with all stakeholders in the project area that the quantification methods used were suitable for a specific project. In addition, trading ratios greater than one have been used in nearly all water trading programs to account for such uncertainty. In the phosphorus credit trading project in the Kalamazoo River Basin, the project steering committee applied an approach of consensus on methodology and use of a 2:1 trading ratio and the credit quantification issue posed no significant obstacles to progress through out the project.

In EMMs, this "best knowledge, most suitable methods, and consensus developing" approach can be a good starting point for initializing trading. As environmental commodity markets start to take shape, quantification methods should be verified by post-application monitoring and revised periodically. Expected high trading volumes of multiple environmental commodities will likely prompt the market entry of businesses specializing in the quantification of these commodities (Section 1 of Chapter 2). Practices and research on quantification methods by these entities can be expected to standardize the quantification/verification procedures. Moreover, innovations and advances in science for quantification methods should be expected to take place in a market driven EMMs framework.

The Baseline Issue

Another critical issue related to commodity/credit quantification in trading is the so-called baseline issue. Baselines represent the pollution loading rate or the ecological function level that is the minimum requirement for any pollution remediation or ecological restoration/enhancement activities to achieve in order to produce tradable environmental commodities. It is a common issue shared by all the current single market trading programs, such as water quality trading and the National Acid Rain Program. In water quality trading programs, the baseline for point sources is usually the technology-based water quality standards as required by the US EPA in its Proposed Water Quality Trading Policy (US EPA, 2002a). The baseline for nonpoint sources, on the other hand, is subject to program specifications. For the Acid Rain Program, the appropriated emission allowances each power generating unit receives establishes the baseline. Because there are multiple environmental commodities involved, this issue will be particularly important in an EMMs framework. Baselines must be clearly defined in the framework because they are the cornerstone of trading schemes. The baseline issue can be illustrated by the following example.

A workshop in Saskatoon, Canada in 1998 brought together agricultural landowners to discuss carbon sequestration and trading potentials. One of the concerns brought out by the discussion groups was the fact that farmers did not want to install BMPs or change tillage practices because they felt that a GHG trading program might not come into place very soon. If they make an improvement now, they would not have been able to receive credits for it. They would have to achieve reductions over their already lowered emission levels when the trading program started. In this case, the baseline problem rises when a reference scenario—against which achieved emissions reductions are measured—needs to be determined. In this case, it was proposed that reductions be measured against estimated 1990 levels. This would encourage current improvements and allow farmers to receive credits for their reductions. Participants here are aiming to create credits before a regulation is in place so that they will be ready for it once implemented. They might even earn early enrollment incentives (ACFA, 1998).

The baseline problem also rises when we cannot impose a uniform reference level of required control measures from which additional efforts will earn tradable credits. For example, conservation tillage has been recognized as a very effective agricultural BMP in reducing sediment and phosphorus losses from cropland. In an EMMs framework, farmers who switch from conventional tillage to conservation tillage might want to receive credits and be able to sell them for water quality improvements. However, many farmers will have already initiated conservation tillage before any trading program is established. Allowing only those new practitioners of conservation tillage to earn credits would not only create an equity problem but also discourage farmers who are at the forefront of practicing environment-friendly farming. On the other hand, should progressive farmers be awarded credits, these credits in effect would not result in any net pollution reduction from the current level and create what many environmental groups regard as “paper credits”.

Both of the above baseline problems are in essence about the same question: how can we find an appropriate reference pollution level so that both the environment and the stakeholders benefit from the EMMs. To initialize trading, it is necessary to reach some sort of compromise between the two. The 1990 reference level proposed in Saskatoon, Canada is an example of such compromises and it can be used in the conservation tillage case. Again, getting all the stakeholders involved, including environmental groups in the process to reach such compromises, would be the key to success.

IV. Applying EMMs in Other Regions

Besides the Great Lakes region, at least two more regions in the U.S., the Chesapeake Bay region and the entire Mississippi River Basin, have the potential to adopt the EMMs concept to help reach their ecosystem restoration and protection goals. Between them, the Chesapeake Bay is particularly suited for testing the EMMs concept.

As the nation's largest estuary, the Chesapeake Bay supports one of the most productive shellfish fisheries in the world and provides habitats for numerous species of native fauna and flora. However, water quality degradation, primarily due to excessive nutrient inputs from contributing watersheds, has had substantial negative impact on the health of the Bay's ecosystem. As a result, there has been substantial destruction of the shellfish fishery and threats to the survival of many native living organisms. To restore the Bay's ecosystem, the Chesapeake Bay Agreement of 1983 was signed by the Bay Program partners including the states of Maryland, Pennsylvania and Virginia; the District of Columbia; the Chesapeake Bay Commission, a tri-state legislative body; the U.S. Environmental Protection Agency, representing the federal government; and participating advisory groups including many environmental organizations. The Agreement recognized that the Bay's ecosystem management relies on a network of protective agencies and private groups, voluntary actions, laws, and regulation. The US EPA stated that the regional framework should focus on the integration of all component parts of the ecosystem, including biological, physical, economic, natural, and cultural factors at play (US EPA, 2001c).

In 2001, the EPA's Chesapeake Program published its nutrient trading principles and guidelines for the bay watersheds, endorsed by virtually all partners in the Bay Program (US EPA, 2001d). This is a clear indication the federal and state governments as well as private interest groups have come to realize the benefits of nutrient effluent trading and started to look at the practical issues of implementing trading programs in the bay basin. In the latest Chesapeake 2000 Agreement, the Chesapeake Executive Council, responsible for setting goals and guide policy for the restoration and protection of the Bay and its living resources, outlined 93 commitments detailing protection and restoration goals critical to the health of the Bay watersheds. These commitments were grouped into five categories: living resource protection and restoration, vital habitat protection and restoration, water quality protection and restoration, sound land use stewardship, and community engagement. To simultaneously achieve the goals in all five of these categories by traditional command-and-control approaches, despite the excellent coordination the Bay Program is able to provide, would still incur formidable costs to the stakeholders and likely delay clean-up efforts. Recent estimates of the costs for the states of Virginia and Maryland to meet the 2000 Agreement goals on nutrient and sediment alone were $4.8 billion and $4 billion, respectively (Alliance for the Chesapeake, 2002a). With the political infrastructures laid down by the Bay Program, the partnerships built over the years, the nutrient trading principles and guidelines endorsed by many stakeholders, and the multiple ecosystem protection and restoration goals, the Chesapeake Bay watersheds are in a good position to add more tradable environmental commodities to their potential trading scheme. The participation of multiple watersheds in one overall program with the same ultimate goal of restoring one large ecosystem (the Chesapeake Bay) provides an excellent opportunity for the implementation of EMMs. An EMMs framework can be specifically designed for the Bay watersheds, taking into account existing laws and regulations, water quality goals, and the unique physical and biological conditions of the Bay watersheds.

The Mississippi River Basin is a major source of environmental protection attention in the nation, due to the issue of the large hypoxia zone in the Gulf of Mexico. Excessive nutrient inputs from the watershed, particularly nitrogen, reach the Gulf, creating a zone of low dissolved oxygen. To restore water quality in the Gulf of Mexico, nutrient reductions must take place in the entire Mississippi River basin. The federal action plan (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, 2001) estimated that a 20 to 30 percent reduction in the amount of nitrogen reaching the Gulf is needed for controlling hypoxia in the Gulf. The plan calls for watershed-based approaches to water quality management and voluntary incentives for nitrogen reductions from both point and nonpoint sources. Both this study (see Appendix B) and a policy study by Greenhalgh and Sauer (2003) found that nutrient trading is not only the most cost-effective strategy to reach the reduction target but also provides the greatest overall environmental benefits. Nutrient trading between point and nonpoint sources promotes the application of agricultural BMPs that reduce the loss of nutrient to waterways by using less fertilizer and preventing nutrient-laden runoff from entering these waterways. Furthermore, these BMPs can achieve climate change mitigation by reducing the emission of nitrous oxide from nitrogen fertilizer application and improving carbon sequestration and storage in the soil.

Applying the EMMs framework in the Mississippi River Basin would be facilitated by 1) one single ultimate goal of reducing nutrient load at the mouth of the Mississippi, 2) involvement of multiple watersheds in a basin occupying 1.2 million square miles in 33 states, and 3) presence of existing water quality and GHG trading programs (e.g., the Minnesota River basin water quality trading and the CCX in the Midwest region). Additionally, since the Mississippi River serves as a valuable shipping conduit, it is continually maintained for flooding and sedimentation. Major urban centers, such as St. Louis and New Orleans, located along the river corridor, have been armored to protect these areas from flooding. Upstream areas that support agricultural lands are protected by levies. Therefore, trading both flood storage and sediment credits could have great potential in the Mississippi River Basin. Conservation practices on agricultural lands and the restoration of wetlands would create multiple environmental commodities (flooding, sediments, nutrients, carbon) in the entire Mississippi River watershed.

CHAPTER 5.

CURRENT MARKET-BASED PROGRAMS AND NEW CONCEPTS

This chapter provides examples of exiting market-based environmental protection and ecosystem enhancement programs and some new market-based concepts. It also describes some features of the market institutions associated with these programs and concepts. The purpose of this chapter is to provide the reader an introduction to the practical examples of market-based solutions in environmental and natural resources management, from which the Ecosystem Multiple Markets (EMMs) concept is developed and upon which an EMMs framework can be built.

Existing market-based programs are broadly divided into two categories, non-regulatory programs and regulatory programs. Non-regulatory programs here refer to market-based programs created by non-regulatory motivations as outlined in Section I of Chapter 2. These programs are voluntary in nature. Often times, they are the results of private arrangements backed by significant economic returns to the sellers and substantial cost savings and environmental benefits to the buyers. Regulatory programs, as the name indicates, are associated with some specific regulations imposed by governments of all levels. However, they are not necessary mandatory. Participation can be optional for the buyers (e.g. nutrient trading under NPDES permits). Unlike non-regulatory programs, government involvement is the nature of regulatory programs as the basic and common motivation of such programs is to meet the regulatory requirements set by the government on pollution reduction and resource protection. Some of the programs described here have been successfully practiced for many years while others are still in their early stages of being tested.

New market-based concepts are ideas proposed to inject economic incentives to environment protection. They have not been practiced to prove their effectiveness. The EMMs can work to integrate the successful practices into a bigger environmental commodity market and create opportunities for the new market-based concepts to be tested in the market.

I. Non-Regulatory Programs

The Chicago Climate Exchange (see also Appendix C)

The 1997 Kyoto Protocol specifies emission limits for the industrial countries (Annex I countries), prescribed three emissions trading mechanisms, and acknowledged the role of carbon sequestration or “sinks”. As a market for GHG emissions has begun to emerge over the past five years or so (Rosenzweig, 2002), it is highly likely that regardless the fate of the Kyoto Protocol, the demand for GHG emission reductions will grow over time. Taking advance action to limit GHG emissions and creating value for these reductions by supporting the development of an emissions trading system make good business sense. The Chicago Climate Exchange (CCX, http://www.chicagoclimatex.com) is the first voluntary, organized pilot GHG emissions trading market in the United States. Participation will eventually include emission sources and offsets throughout North America. Many of the actions that can cut or capture greenhouse gases – actions which are expected to be stimulated through markets for greenhouse gas mitigation – can also make a significant contribution to water quality enhancement. CCX is also designed to explicitly incorporate and encourage projects that can mitigate greenhouse gases while simultaneously helping to improve water quality. The goal of the CCX pilot CHG trading program is to establish the market for discovering the price of reducing GHG emissions. The core steps are to limit overall consumption of the atmosphere (GHG emissions) and establish trading instruments that allow participants to find the most cost-effective methods for staying within a target emission limit. The market price of those instruments will represent a value signal that should stimulate new and creative emission reduction strategies, technologies and land-use management practices. The emerging markets represent a new source of financial resources that can aid efforts, such as conservation land-use management, that produce both GHG and water quality benefits.

On January 16, 2003, CCX announced its founding members, who made a legally binding commitment to reduce their emissions of GHGs by 4% below their 1998-2001 average baseline by 2006, the last year of the CCX pilot program. These members include large multinational energy and manufacturing companies such as American Electronic Power, Dupont, Ford Motor Company, and Motorola, Inc., and the City of Chicago. The CCX Rulebook was completed in August of 2003 that articulates the structure and governance of a mult-sector and multi-national GHG trading program, including modalities of emission quantification, monitoring, verification, offset definition and trading. On October 1, 2003 CCX conducted its first auction of CCX emission allowances to its members. According to a CCX press release, average successful bid price for vintage year 2003 and 2005 CO_2 emission allowances was $0.98/metric ton and $0.84/metric ton, respectively. The total traded CO_2 allowances were 1000,000 and 25,000 metri tons, respectively. Continuous electronic trading of allowances and offsets also began on October 10, 2003.

Conservation Development

Conservation development is a density neutral design approach that preserves as much as 50% or more of the site area in open space and permanently protects areas of environmental and community values (Rogers et al., 2002). Conservation development achieves the goal of water quality protection/enhancement in a watershed by identifying areas in a watershed targeted for permanent protection and carrying out development in non-priority areas where site-specific conservation practices such as storm water BMPs and impervious surface reducing designs are integrated with development.

Incentives for conservation development can be voluntary programs in which stakeholders participate in protecting watershed resources for multiple sustainable use or regulatory demands such as a TMDL. Because conservation development practices go beyond what regulations require developers to protect the ecosystem, water quality credits can be generated. Trading and banking these credits provide economic incentives for implementing conservation development (Rogers et al., 2002). Feasibility studies and pilot projects have been undergoing in the Kalamazoo River Basin under the phosphorus TMDL and Saginaw River Basins under a voluntary program, both in Michigan.

Green Shopping / Ecotourism

Some consumers are using their everyday spending to express their values concerning environmental protection. The boost in sales of organic and fair trade products are testimonials to this desire. The marketing industry in the late 1980s started to use "the green claim" as a new advertising ploy. For example, approximately 13% of the new products on the market in 1993 made some claim about their environmental characters (International Institute for Sustainable Development [IISD]; http://www.bsdglobal.org/markets/green_marketing.asp). IISD also found that consumers like products that have more than one environmental attributes and a good business strategy is to offer environmental improvements in several categories simultaneously, such as water pollution, solid waste, and manufacturing processes. However, when consumers are faced with a trade-off between product attributes, the environment almost always loses. In terms of price for green products, IISD found that premiums of more than 2% can be charged only if the consumer perceives additional product value. Because in current commodity markets, green products do not earn the producer any premium for their lower environmental impacts, they are in effect competing with regular products without much advantage except consumer preference of goods produced in an environmentally friendly way. This preference, no matter what consumers say, is unpredictable at best. In an EMMs framework, because the reduced environmental impacts are actually sellable commodities, green products would be able to keep price competitive or even gain price advantages with the earnings from the environmental commodities generated from the production of green products.

Because ecotourism is only loosely defined, there is no global estimate on spending for international ecotourism. However, it is estimated by the World Trade Organization that 7% of all international travel is nature based (The International Ecotourism Society, 2002). *Triple E Travel*, an ecotourism agency offers ecotourists the opportunity to invest in carbon offset programs with the world's first climate neutral air travel certification program, announced in November, 2000. A percentage of the spending for each plane ticket is donated to a fund, which finances carbon dioxide reduction projects. In this way, a carbon dioxide trading is done, not by regulations, but voluntarily by green-minded consumers wishing to protect the environment and/or to take responsibility for the discharges they create.

II. Regulatory Driven Programs

The National Acid Rain Program

The 1990 Clean Air Act (CAA) Amendments brought forth the national Acid Rain Program (ARP) to reduce SO_2 emission from electric power generators (Title IV of the Amendment). Starting from 1995, under the program, the US EPA allocates to each participating power plant a fixed number of emission "allowances", the national total number of which is set every year to meet the Amendment's reduction goals. A plant can buy emission allowances from any party who holds them to compensate its excessive emissions or sell its own allowances provided that at the end of the year it surrenders enough allowances to cover its emissions for that year. This "cap and trade" regime gives utilities a direct financial incentive to reduce emissions below required levels (Environmental Defense, 2000). ARP is unprecedented in that it sets limits on the total discharge not the rate of emissions relied on by previously existing command-and-control air pollution regulations; and it uses market power to motivate emission reduction practices. By 1999, the program achieved 100% compliance and utilities reduced SO_2 emissions 22% below the target level. The Central Accounting Office recently confirmed that the program could save as much as $3 billion a year compared with command-and-control programs (US EPA, 2001).

The California Regional Clean Air Incentives Market

In January 1994, California's South Coast Air Quality Management District (SCAQMD) inaugurated the Regional Clean Air Incentives Market (RECLAIM), aiming to reduce the NO_x and SO_2 emissions in the region. The market principles of RECLAIM are similar to the "cap and trade" scheme of the national ARP although the participants of RECLAIM are not limited to utilities. RECLAIM consciously left to the market the formation of a trading system "where brokers and other intermediaries were explicitly allowed to participate and develop futures, options, and other derivative markets (Fromm and Hansjürgens, 1996). Both ARP and RECLAIM emphasize the importance of monitoring and enforcement and have mandatory monitoring and reporting requirements. These requirements are essential in ensuring the success of the programs. RECLAIM also has a unique zoning system designed to prevent the potential "hot-spots" problem (due to a spatial shift of emissions resulting from trading). As a regional program, the challenge for designing the program lay more in the reconciliation of the market-based instruments with the existing command-and-control regulations (Fromm and Hansjürgens, 1996). For example, when setting emission reduction goals, the SCAQMD had to take into account existing regulations such as the 1991 Air Quality Management Plan (AQMP), which was a result of the air quality management requirements specified by the CAA and the California Clean Air Act. As a result, instead of developing its own specific emission targets, RECLAIM took the reduction rates of the 1991 AQMP as the baseline.

Water Quality Trading under Total Maximum Daily Load (TMDL)

TMDL places a cap on the total amount of a certain pollutant a water body can receive. TMDL management plans allocate that amount to the pollutant's sources, point and non-point. This creates a framework in which water quality trading can occur. A farmer in a watershed with a TMDL has the opportunity to make improvements to the land to reduce non-point source inputs to the water body. Any reductions made below that level dictated by the TMDL can become tradable credits. Because credits must be real, surplus and measurable, an NRCS agent or other authorized certifiers must determine that the improvements produce credits meeting these criteria. The credit can then be available for purchase by a point source discharger in the watershed needing to reduce his load. Credits within watershed for which nutrient and/or sediment TMDLs have been set can be generated by changes in agricultural practices, planting of buffer strips or use of erosion control techniques. Trading can also occur between two point sources or two non-point sources. The drive to minimize abatement cost and make profits (produce tradable credits) will also promote the development of innovative nutrient and sediment control techniques. Watershed-based water quality trading under TMDL has been experimented in several demonstration and pilot projects (see http://www.envtn.org) such as the Long Island Sound (Connecticut) nitrogen credit trading program, Cherry Creek Basin (Colorado) phosphorus trading program, and Lower Boise River (Idaho) phosphorus trading program.

Water quality trading has been included in the Lake Allegan/Kalamazoo (Michigan) River phosphorus TMDL implementation plan.

Water Quality Trading under Permits Issued under National Pollution Discharge Elimination System (NPDES)

In the Minnesota River basin, there have been two wastewater effluent trading programs carried out under the provisions of NPDES permits (Section 402 of Clean Water Act; MPCA, 1997 and 1999). In both cases, "no increase" requires the point sources to fully offset the pollution loads to the Minnesota River by obtaining pollutant (phosphorus and $CBOD_5$) credits from non-point sources. Trading ratios equal to or greater than 2:1 are imposed to ensure the trading programs would bring additional environmental benefits. The NPDES permits detail the concentrations and flow rates of the permittee's allowable discharges. Permits also have a time table for the permittees to follow in terms of the quantity of credits purchased. A trust fund is designated by the permit to guarantee sufficient funding to accomplish the goals. The Minnesota Pollution Control Agency has the authority to approve credits and inspect trading project sites. Trading under NPDES offers a great degree of accountability. However, due to the inflexibility of NPDES, it can be cumbersome to implement at times, incurring high transaction costs.

Partnership for Safe Drinking Water

The Safe Drinking Water Act (SDWA), developed in 1974, is the federal law that ensures the quality of Americans' drinking water. Under SDWA, EPA sets standards for drinking water quality and oversees the implementation of these standards by the states, localities and water suppliers. Typically, municipalities comply with the SDWA by treating drinking water as it is pumped from the ground or from a reservoir. The Act was amended in 1986 and 1996, with the 1996 Amendments encouraging source water protection over treatment as the sole remedy. Some forward-thinking municipalities, New York City for example, have decided to invest in watershed conservation in order to prevent drinking water sources from water quality degradation. The City would have had to spend $6 billion for construction and $300 million annually on drinking water filtration. Instead, a voluntary partnership with the agricultural landowners in the Catskills area, called the Whole Farm Program, was developed. The Program, which was operated by the farmer led Watershed Agricultural Council, developed BMP protocols in the watershed. The City agreed to cost-sharing assistance for the implementation of the BMPs. Less money is spent on conserving the watershed and protecting groundwater than on treating drinking water after it is impaired. Again, pollution prevention is favored over remediation. The changes in land use in the watershed create the added benefit of enhancement of ecosystem commodities, like habitat and carbon sequestration.

Wetlands Mitigation Bank

The provisions of Section 404 of the Clean Water Act established a program to provide compensation for any unavoidable impacts to wetlands through activities that restore or create wetlands. Parties who need to fill or dredge a wetland for development or any other reason are required to obtain permits from the US Army Corps of Engineers. They must first demonstrate that everything has been done to avoid the loss of the wetland to construction before proposing replacement to generate lost wetland functions (wetland mitigation). Since 1993, wetlands mitigation has been one the most established environmental markets in the U.S. A wetlands mitigation bank is “a wetland area that has been restored, created, enhanced, or (in exceptional circumstances) preserved, which is then set aside to compensate for future conversions of wetlands for development activities. The value of a bank is determined by quantifying the wetland values restored or created in terms of credits (US EPA, 1999)”. When in demand, these credits can be sold to developers to meet the “no net loss” requirement. “Approximately 100 mitigation banks are in operation or are proposed for construction in 34 States across the country, including the first private entrepreneurial banks (US EPA, 1999)”. Environmentally, mitigation banking can achieve greater ecological benefits by consolidating numerous small, isolated or fragmented mitigation projects into a single large parcel of wetland. Economically, mitigation banking can increase the chances of success by bringing together various financial resources and planning expertise. Mitigation banking also reduces costs for both permit applicants and the regulatory agency with its economies of scale.

Conservation Bank

Habitat conservation banks are a form of trading that can be used to protect sensitive lands and focus development in other areas. In 1995, the State of California established policy outlining the creation of regional conservation banks. The buyers of the California conservation bank credits are developers legally required to offset habitat impacts. Credits are generated for wetlands, threatened and endangered species, environmentally sensitive habitat areas, mud flats, sub-tidal areas, and other less sensitive resources. A bank’s credits are certified by wildlife agencies, who determine whether target species are present and whether habitats are restored correctly. A banked area is preserved in perpetuity, and a management plan, an easement guaranteeing the entry of resource management personnel to the land, and a guarantee of future funding for management of the bank are required. The award of credits is negotiated on a case-by-case basis between the land owner, the proponent in need of the credits, and the regulatory agency (RAC, 1995). While focusing on species habitats, the California conservation bank policy covers other areas with “natural resources values”, including impacted wetlands.

The U.S. Fish and Wildlife Service in 2003 released its official guidance for conservation banks (US FWS, 2003). This policy explicitly distinguishes conservation banks from wetland mitigation banks, primarily by their goals. While wetland mitigation banking aims to replace lost wetland functions, including but not limited to specific habitats, the goal in conservation banking is to offset adverse impacts to a specific species. Therefore, in contrast to the “no net loss” policy of wetland mitigation, “an appropriate function of conservation banks is the preservation of existing habitat with long-term conservation value to mitigate loss of other isolated and fragmented habitat that has no long-term value to the species (US FWS, 2003)”. The US FWS policy also cites Sections 7 and 10 of the Endangered Species Act as the legal authorities for the agency to carry out conservation banking. Clearly, conservation banking, as defined by the US FWS, is primarily for wildlife conservation. Consequently, conservation banks will be evaluated on all issues surrounding banking in the context of the benefits of the intended species, different from the watershed-based approach to wetland mitigation.

Using Water Markets in the American West in Ecosystem Protection

Based on the doctrine of "prior appropriation", water rights law in the western states give senior rights holders the priority to meet their water needs. It does not provide incentives for water users to conserve their water usage. In times, particularly during droughts, in addition to the decreased water supply to junior rights holders (e.g., municipalities), this type of water resource appropriation could lead to water overdrawing that induces stream or riparian habitat degradation and loss of endangered aquatic species. A market-based solution to this problem was developed in the west and has been proved effective. Oregon has developed a market for water intended for environmental needs (Landry, 2002). In 1993, the Oregon Water Trust, a private, nonprofit organization was founded to use water markets for environmental benefits. It pays farmers to use less water for irrigation so more water can be left in the rivers to protect endangered salmon. In Nevada, the city of Reno is buying water from farmers to increase flows and solve some of the water quality problems in the Truckee River, which is the city's primary source of drinking water. Water markets provide economic incentives to water users to conserve water and it is a win-win strategy for both the environment and the farmers.

III. New Market-based Concepts

Flood Storage (see also Appendix A)

Flooding is a very real problem for U.S. cities built on floodplains such as St. Louis. The mean annual national flood losses for the last 30 years reached $3.4 billion. Traditional solutions aim at using hard engineering solutions, e.g., levies, seawalls, rip rap and revetments, to protect land in flood prone areas. In addition to high construction costs and considerable maintenance expenses, hard engineering measures leave two problems unsolved. First, by merely containing the flood water in the river channel, energy in the running flood water cannot be dissipated or released. It accumulates while transported downstream with the water. The results are the rising potential of flood damage to downstream cities and severe in-stream habitat destructions. Second, although rare, the consequences of structural failure are almost always catastrophic.

Flood storage, however, provides a much less expensive and more natural solution to these problems. Agricultural land can recover from flood damage more easily than urban areas. Therefore, farms located upstream of major cities can sell "flood storage credits" to these flood prone cities. When flood conditions are forecasted, city planners can pay agricultural land owners to open upstream levies, allowing flood water to inundate their land, preventing it from reaching downstream cities. This is nothing but a mimicking of the natural processes of flood abatement. Floodplains, especially wetlands on floodplains, are the natural flood storage devices that can reduce flood volume and dissipate flood water energy. Therefore, paying agricultural landowners to store flood waters can make environmental as well as economic sense for cities and flood insurance companies. An agreement such as this could also serve to lower flood insurance premiums for landowners in such cities. The agricultural landowner could farm the land until the need to store flood waters arose. The storage of flood waters would destroy crops. However, the selling of flood storage credits should more than compensate the landowner for this loss.

The geographical location of both the buyers and sellers of flood storage credits generally would fall within the Federal Emergency Management Agency's floodplain limits. Flood prone areas exist virtually everywhere, due to riparian development and increases in impervious surfaces. Consequently, virtually every state in the union would have the need for such a market. Still, markets would need to be reasonably local in that there would be little advantage to St. Louis, which is in the Mississippi River basin, of buying credits from the Sacramento River basin.

The BushTender Program in Victoria, Australia

Recent development in economics theories in auction has enabled the State of Victoria, Australia to develop an innovative market-based program, called BushTender, to conserve and enhance the one million hectares of native vegetation remaining on private land in the state (personal communications with James Todd, State of Victoria, 2003; general information available at http://www.nre.vic.gov.au/web/root/domino/cm_da/nrence.nsf/frameset/NRE+Conservation+and+Environment?OpenDocument). The issues this trial program was designed to address are common concerns regarding public investment in the management of natural resources on private land, namely 1) accounting for each landowner's unique cost structure and willingness to cost-share; 2) more accountable expenditure of public funds, and; 3) non-standard environmental benefits resulting from these investments, diversified by differences in the biodiversity assets, the sites, the landowner services and the costs.

To address these issues, certain critical information needs to be revealed. "Some of the information needed resides with government agencies who have knowledge of different environmental assets and the actions that might be taken to improve these assets – landholders will not necessarily know this information. Landholders, on the other hand, know about the costs involved in changing landuse or management from current practices to ones that improve biodiversity – this information is not known by government. This problem of hidden or asymmetric information is now recognized as a key impediment to creating markets. While the public good and non-priced characteristics of biodiversity explain why markets might not operate efficiently, the asymmetric information problem is the main constraint to establishing missing biodiversity markets. Auctions based on management agreements are a mechanism that enable these issues to be addressed. Auctions require landholders to reveal their information on costs and the government to reveal its preferences for biodiversity assets and actions. The agreements can be designed to accommodate the variable benefits from site to site. Furthermore, competition between bidders in the auction facilitates cost-effective outcomes" (personal communications with James Todd, State of Victoria, Australia, 2003).

The State of Victoria developed the Biodiversity Benefits Index (BBI) to objectively rank the landowner bids. "The BBI for BushTender is constructed as a benefit/cost ratio. The benefit is defined in terms of site condition and size improvements, including maintenance of high quality vegetation or improvement from low quality, modified by the current conservation value of the site. The cost is that nominated by the landholder in their bid.

The BBI for each site is calculated as BBI = BSS ? HSS / $, where HSS is Habitat Services Score, the total amount of service offered by landholder (specified by outcomes); BSS is Biodiversity Significance Score, the measure of current conservation value of the site, and; $ is the landholder's price as shown in the bid" (personal communications with James Todd, State of Victoria, Australia, 2003). The BSS and HSS scores were determined by state conservation field officials upon site assessment visits to participating lands and the landowners provided price bids. An auction system featuring an auction system featuring discriminative-pricing, competitive bidding and sealed bids was used in the trial.

During the trial, about 400,000 Australia dollars (US$ 274,000) were allocated to management agreements selected by the auction process based on the BBI score. It was found that compared to a traditional fixed-rate approach, the BushTender approach 1) attracted significantly more participation and was able to fully utilize its budget, and 2) resulted in not only more 'biodiversity (as reflected by the BSS score)' but also at a lower cost per unit. Another important benefit of the BushTender program's auction scheme is the information revelation on some critical aspects of public investment in natural resources protection on private land. "In the past landholders have been asked to identify the actions they believe will improve the environment (when this information is mainly held by environmental agencies); and agencies have nominated the price that will be paid for these actions (when this information is mainly held by landholders)" (personal communications with James Todd, State of Victoria, Australia, 2003). In the BushTender trial, state conservation officials used their information to determine the relative biodiversity priorities of actions proposed by a landowner and in turn, the landowner revealed the costs of these actions. "This change in the information revelation process resulted in better resource allocation decisions by improving economic efficiency and targeting sites of highest priority". More importantly, under BushTender, landowners were rewarded for disclosing information about rare and threatened species and such populations became assets rather than liabilities.

Forest Banking and Forest Carbon Sequestration

Forest banking is a market-based tool for the conservation of working forests while keeping them economically productive (Cameron and Muller, 2001; The Nature Conservancy, 1998). Landowners permanently deposit the timber rights in a Forest Bank. The bank maintains the right to grow, manage, and harvest trees while the landowner retains the ownership of the land and can use the land for non-destructive recreational activities or other activities that do not reduce the value of the timber. The landowner receives guaranteed annual dividends (4 to 4.5 %) based on the timber's value, and has the option to withdraw the cash value of the timber. A feasibility study of the forest banking concept conducted by the Nature Conservancy (1998) at two sites within the Great Lakes basin generated legal and financial frameworks for a functioning Forest Bank in the pilot stage. The study concluded that the Forest Bank concept had great potential and should be implemented. Piloting the concept at several sites with the very best potential for success will help build the concept into a national program for the conservation of working forests.

The carbon sequestration potential of banked forest land provides another opportunity for funding and making economic returns of forest banking. In Oregon in 1999, the Klamath Cogeneration Project, a natural gas-fired electricity and steam generation plant, invested $1.5 million in CO_2 by reforesting 3,125 acres of underproducing lands (Cathcart, 2000). This investment was part of a larger CO_2 emission offset portfolio required in the site certificate for the plant. This investment is expected to accrue 1.16 million metric tons of CO_2 emission offsets over a 100-year period. While the state retains ownership and marketing right of the carbon offsets, landowners can use their new forests for nay purpose, including timber production. Forest banking fits into the EMMs concept very nicely in that it promotes forest conservation while having the potential for high economic returns on environmental resource investments.

Partnership between Water Front Communities and Upstream Land Owners

Lake property owners are highly dependent upon the water quality and recreational value of the lake to maintain their property values. Water clarity is important for lakes valued for their aesthetic and recreational uses. However, when the lake is an impoundment of a river system, upstream watershed uses can contribute nutrients and sediment to the lake system, impairing its water quality and driving property values down. A lake association typically forms for the purpose of maintaining these property values. Traditionally, this association would invest in practices to correct the symptoms of the nutrient input problem, e.g. excessive weed growth, algal blooms and decreases in water clarity. These remedies can be costly and in most cases, only temporarily effective. The correct approach to a problem of this sort would involve measures aiming to decrease nutrient input, instead of fixing the symptom (algal blooms) of that problem. This could be accomplished by identifying upstream riparian areas where nutrient and sediment output is greatest and paying the landowner to install buffer strips or other BMPs to keep the sediments on the land. This could be seen as a water quality trade in which both parties benefit economically. The landowner is paid for the improvements, which he is not required to make. The improvement may even improve his bottom line, as it prevents erosion from his field. The lake association would presumably spend less on the planting of the buffer strips than it was paying (or would pay) for lake treatments.

A similar agreement to that described above could be created between a harbor community and an upstream land owner. Sediment deposition in harbor areas decreases boat traffic and restricts larger vessels from using the harbor, decreasing the income of the community. Harbors are very important economically for recreational boating uses and for commerce. For example, the Port at New Orleans is the entrance to the world's busiest waterway--the Mississippi River. Over 6,000 vessels annually move through New Orleans on the river. Over 2,400 vessels dock at the port annually. Additionally, the Port of New Orleans is the only port in the U.S. serviced by six class-one rail lines, making the port vital to the economy of the United States (NOPA). Regular harbor and port maintenance involves costly dredging operations. A port authority or harbor community could pay upstream riparian land owners to install BMPs to decrease sedimentation into the waterways, thus preventing sediment buildup in the port. Decreasing sediment inputs to the water body would also elicit water quality improvements. The costs of the BMPs would be less than those incurred for dredging. Additionally, boat traffic would not be disrupted for dredging operations (at least not as often).

Habitat Restorations by Conservation Organizations

Conservation organizations, such as land conservancies, Trout Unlimited, and Ducks Unlimited, are considerably successful in building membership, collecting private donations and receiving grant monies to protect and restore valuable habitats. Hunting and fishing organizations, such as

Trout and Ducks Unlimited, host member events to raise monies for wetlands and stream restoration projects. These projects are conducted voluntarily to increase recreational opportunities or in some cases members of these organizations wish to protect the “non-use” value of these ecosystems. This means that they are willing to pay for the restoration of these ecosystems for potential future uses or for their sheer existence.

If these organizations participate in trading programs under an EMMs framework, they could earn economic returns from these restored natural lands, by sequestering carbon, maintaining water quality, creating a wetlands mitigation bank, or by providing endangered species habitat. These incomes could be reinvested in more habitat restoration projects. The newly created habitats could then earn tradable credits, creating a spiral effect in which the sale of credits allows more land to be restored, which results in the sale of more credits. Participation in credits trading programs under EMMs would allow these organizations to maximize their land restoration activities/resources. Further, a conservation organization (or a concerned individual) could purchase credits for the sole purpose of retiring them. In this way, conservationists are paying investors for land improvements and for decreasing the amount of discharges entering the atmosphere or a watershed. While creating an additional tool for conservation organizations to protect the environment, this would add more players in the ecosystem markets.

Phase II Storm Water NPDES and Trading Stormwater Abatement Credits

The objectives of the Phase II storm water regulations are to: (1) reduce the discharge of pollutants to the "maximum extent practicable" (MEP); and (2) protect water quality. In order to meet these objectives, the establishment of approved BMPs is required. These BMPs can be nonstructural practices that involve planning and other activities that promote and accomplish the goal of cleaning up storm water runoff from urban areas.

In terms of water quality/quantity trading, an impervious area contributing to a storm water discharge pipe can be viewed similarly to a watershed for which a TMDL is established. A concentration is set for the pipe to the surface water body, as a load is set for the watershed draining to the surface water body. Areas in the watershed that can store water, infiltrate water, or use BMPs to remove solids and other pollutants can earn credits purchased by the NPDES storm water permit holder, i.e., the municipality. A concentration could be established for the final discharge point or allocations would be directed within the watershed. These actions could also reduce flooding, lowering flood insurance and flood damage costs. Habitat protection or restoration could also be provided by stormwater BMPs.

A simulation study for Cincinnati’s Shepherd Creek examined the innovative approach of trading responsibilities for stormwater runoff to control excess stormwater runoff associated with development within a watershed (Thurston et al., 2002). Instead of centralized large-scale costly infrastructure, a system of tradable credits that creates economic incentive for building small BMPs distributed throughout a watershed to mitigate stormwater runoff in a way that mimics the water retention in a pre-development watershed. The study found that because the cost of abating stormwater runoff differed substantially by land use and soil type, trading could promote a significant amount of distributed abatement in the watershed and in some cases significantly lower "the cost per cubic of detention in place of, or in concert with, a large-scale engineering solution for control of excess stormwater flow".

Redevelopment and Runoff Management Rules

Wisconsin's Runoff Management Rules are slated to become effective on October 1, 2002 (http://www.dnr.state.wi.us/org/water/wm/nps/admrules.html). Included in these rules are non-agricultural runoff reduction and treatment performance standards, implementation and enforcement provisions for the construction and post-construction phases of new development. Redevelopment, however, is largely exempt from these standards. From an EMMs perspective, this exemption created an opportunity for water quality trading. Redevelopment sites can make the effort to install runoff treatment facilities and/or management practices that are beyond the minimum requirements of the rules. The additional environmental benefits brought by this effort could be sold to new development sites in the same watershed where it is difficult to meet the runoff mitigation requirements.

Nutrient Criteria

Hypoxia is a condition of low dissolved oxygen levels in surface water bodies. The hypoxia in the Gulf of Mexico, which is formed at the mouth of the Mississippi River caused by nutrient enrichment of the river, serves as the most well known example. To reduce nutrient emission to the nation's water bodies, the US EPA promulgated nutrient criteria for the "Cornbelt Ecoregion" in the Mississippi River basin where most of the nitrogen fertilizer is applied, setting maximum nitrate-nitrogen concentrations at 1.6 mg/L. However, reaching these levels by putting restrictions on fertilizer application is not a practical solution, given the current regulation reality on farming practices. Using of wetlands to treat agricultural land drainage could serve to alleviate the problem. Wetland microorganisms can convert nitrate-nitrogen to atmospheric nitrogen. This service, removal of nitrate-nitrogen from the water, could be sold as a credit to those who discharge waters high in nitrogen.

This trading is dissimilar to trading under TMDL or NPDES. With the new US EPA nitrogen criteria, a maximum concentration allowable in the water is set. This concentration must be met at various sampling points along the water body. A wetland meant to intercept farm drainage before it reaches the water body, either in a tributary or along the edge of a field, would assist in achieving reduction goals. However, trades may need to occur along the water body of interest. For example, an upstream farmer could discharge elevated levels of nitrogen with the understanding that a downstream landowner would clean that water through his wetland. In this scenario, concentrations would be exceeded for that stretch of the river between the two participants' farms. Therefore, the concentration criteria would be met downstream of the wetland, but not necessary along the whole river stretch. If the receiving waters, e.g., the Gulf of Mexico, are to be protected, then meeting the concentration criteria at the mouth of the Mississippi River, as opposed to various locations along its stretch, would serve this purpose. Applicable trading rules would allow this type of compliance. To date, no known trades of this type have been conducted.

Natural Resources Damages Assessment

The Superfund Program (the Comprehensive Environmental Response, Compensation and Liability Act [CERCLA]) identifies the most polluted sites in the United States and places them on the National Priorities List (NPL). The fund then finances necessary clean up and source control measures while the Potentially Responsible Parties (PRPs) are identified. Funding from the PRPs is not limited to remedy the contaminated media. Under the Natural Resources Damage Assessment, monies are utilized to restore natural resources affected by the release of hazardous substances at NPL sites or by oil spills. The PRP must compensate the public for natural resources losses and help to restore the damaged resource.

An investor could finance a restoration project that the PRP would then repay the investor for. The PRPs would be the buyer, and any entity owning the property or investing in the restoration would be the seller. In a sense, an NRDA bank could be created. These restoration projects could also earn GHG, endangered species and water quality credits, according to other regulations. This could work anywhere there is a oil spill or Superfund site, which is every state in the United States.

Municipality Cap on Development and Tradable Development Rights

Tradable development rights can be used for land conservation and endangered species preservation, as the two commodities can be produced simultaneously. Tradable development rights can work in two ways. The first scenario is similar to a conservation easement, in which a conservation organization purchases the landowner’s right to develop his property. The second scenario occurs when a cap has been placed on development. A municipality may designate various conservation and development zones. The owner of the land in the conservation zone is then left to finance the protection of the land, and to suffer economic losses from development restrictions placed on the property. The developer can enjoy income from his land, which, ironically, increases in value if it is in close proximity to a conservation zone (Thoreau Institute, 2001). However, if the developer must purchase development credits to compensate for the habitat loss on his land, then the owner of the conserved land can enjoy some of the income from the development. In this way he does not own “waste land”, but is earning income from his land’s resources that are enjoyed by the whole community. This method of compensating owners of sensitive land tends to focus development on habitat-poor land and to conserve land with a high habitat quality.

Endangered Species Act

The main objective of ecosystem trading is to provide economic incentives for maintaining or improving environmental integrity. The Endangered Species Act has been criticized for inflicting penalties on owners of land containing endangered species habitats. These penalties have caused some landowners to intentionally destroy habitats of endangered species before they can be identified by federal biologists. As a result, the species that the act is intended to protect becomes a source of animosity. However, these species and the habitats they depend upon are resources valued by all. Therefore, this landowner should be compensated for protecting this resource. With endangered species habitat trading, the owner could agree to protect and enhance his land for the management of an endangered species that is lost to development in another area.

The Thoreau Institute, a think tank for environmental protection, suggests several economic incentives for protecting endangered species (Schaerer, 1996). One of these methods is called tradable mitigation credits. Sensitive habitats would be identified and be slated for protection. A cap on new development would be placed in which each acre developed would have to be replaced with 2 or 3 acres preserved or restored. Those lands with high habitat value, i.e., those easier to restore or preserve, would be protected, while those with low habitat value would be developed. This trading scheme is similar to tradable development rights, but the emphasis is placed on endangered species habitats. Builders could earn credits for preserving a portion of the lands they own. This has the added benefit of increasing property values of those residences constructed. Conserving these lands for species could bring about the added benefits of carbon sequestration, flood storage and water quality credits, if the land was previously tilled or if it includes wetlands.

IV. Ecosystem Market Institutions and Mechanisms

Besides the inherent market mechanisms working in a market economy (e.g., demand, supply, and profit maximization and cost minimization behaviors, etc.), some innovative market institutions deserve special discussion here. These institutions, based on their counterparts in traditional commodity markets, were particularly designed and tailored for application in environmental markets. They often draw from new technology development, especially the Internet, and have the potential for being adopted in the EMMs.

Environmental Registry

Potential buyers and sellers of any commodity or asset—from ground beef and airline tickets to nutrient trading credits—must execute transactions using some form of market organization. The specific trading rules governing exchange are the core of market organization (Cason and Gangadharan, 1998). Market organization can have a major impact on transaction costs, especially for developing markets such as water quality trading. Two types of potentially significant transaction costs are information costs of entering the markets and search costs of finding a trading partner (Gangadharan, 2000). Theoretical studies and empirical evidence have shown that it is extremely important to minimize these costs in order to obtain the projected savings from environmental markets.

For the national Acid Rain Program (ARP), the US EPA (USEPA, 2002) instituted an electronic record-keeping and notification system called Allowance Tracking System (ATS) to track allowance transactions and the status of allowance accounts. The system is Internet-based and open to any interested party. The primary role of the ATS is to provide an efficient, automated means of monitoring compliance with the allowance trading program. It also provides the allowance market information on who is holding allowances, the date of allowance transfers, and the allowances transferred. The RECLAIM implemented an electronic bulletin board system (BBS) that allows firms to post trading interests electronically. Offers to buy or sell are made public on the BBS. Firms can then contact offering firms to negotiate a transaction.

Experimental research (Cason and Gangadharan, 1998) indicated that in terms of price accuracy and volatility, the RECLAIM BBS performed nearly as well as the traditional continuous double auction

Another example of electronic registry is the Web-based Nutrient Net (www.nutrientnet.org) developed by the World Resources Institute as a prototype on-line registry for nutrient credit trading. Like the RECLAIM BBS, Nutrient Net offers an open access not only a trading registry where interested parties can find market information. Moreover, Nutrient Net has built-in interactive calculation tools enabling both point and nonpoint sources to estimate nutrient loads from their operations and costs associated with various mitigation options. When fully functioning, it essentially provides a free technical service to market participants, which can further reduce transaction costs.

Brokerage Services

Brokerage is a market institution that can reduce transaction costs and increase the liquidity of commodities. Brokers have been playing an important role in both the ARP and RECLAIM. During Phase I of ARP, the volume of trades involving brokers rose from 10% in 1995 to 45% in 1998 (Environmental Defense 2000). An examination of recent transactions (1/16-2/19/02) in RECLAIM shows that 66% of the completed and proposed trades of RECLAIM trading credits (RTC) involved at least one broker, accounting for 20% of the total RTC (34,723,237 lbs of SO_2 and NOx emission). There are six broker agencies with various sizes and backgrounds actively participating in RTC trading in this period. Notable ones are Cantor Fitzgerald Brokerage LP, Edison Mission Marketing & Trading, and Natsource LLC. Clearly, brokerage services have become an indispensable part of the air emissions trading markets and the opportunities to gain economic returns from providing these services are being captured. In addition to the role of trading facilitators, emission brokers have also been actively involved in the process of maturing the environmental commodity markets. An example is the effort by the Emissions Marketing Association in standardizing the SO_2 and NO_x allowance transaction contract, the negotiation of which is the reason for significant delays to the transfer of allowances and cash, adding costs and uncertainty to trading (Most, 2001).

Trading Authority

A trading authority or its equivalent has been a major feature of many watershed-based water quality trading programs. Primarily, trading authorities have played three roles in these programs. Among them, accountability checking is probably the most common one. Because of the novelty of water quality trading, uncertainties exist on the environmental consequences of trading and the proper execution of trading contracts. Trading authorities check the credit quality and quantity of a trade and approve the trade on the basis of sustainable environmental benefits. Second, facing the inevitable challenge of a thin market in a watershed-based trading program, trading authorities also often provide registry and brokerage services to furnish market information, solicit buyers and sellers, and trade directly with both buyers and sellers. Third, trading authorities may be involved in designing a trading program. In the Kalamazoo River Water Quality Trading Demonstration Project, an *ad hoc*, multi-disciplinary Steering Committee was formed to direct the project on issues such as establishment of an equitable trading ratio, non-point source site evaluation and monitoring protocols, and a banking and credit allocation strategy. Existing or newly created entities have served the role of a trading authority. For example, the programs in the Minnesota River Basin (trading under NPDES permits), the trust fund board mandated by the permit and the Minnesota Pollution Control Agency (MPCA) essentially assume the responsibility of a trading authority, with the trust board recommending trades and the MPCA making the final approval.

Green Insurance

As discussed in Section I Chapter 2, insurance policy can be developed in ecosystem markets to reduce the risk of lower crop yields when farmers adopt conservation practices. The Agricultural Conservation Innovation Center (ACIC,2002 [www.agconserv.com]) of the American Farm Trust, has been developing insurance policies for conservation practices to reduce farmers' risks when they apply BMPs for fertilizer and pesticide management. The Manure Crediting Nutrient Management Policy insures the yield difference that may occur if a farmer adopts the nitrogen fertilizer application rate determined by the pre-sidedress nitrogen test (PSNT) based on timely measurement of mineralized soil for nitrogen after the crop is planted and just before the crop starts rapid nitrogen uptake. The Corn Rootworm Integrated Pesticide Management (IPM) Policy and the Potato Late Blight Policy protect farmers from pest-caused crop damage resulting from the adoption of IPM recommendations, hence encouraging risk-averse farmers to reduce pesticide uses. To protect no-till farmers against the risk of cold, wet springs, ACIC developed an insurance policy in cooperation with the National Tilth Lab and the Conservation Technology Information (CTIC). The policy is fully rated, offering coverage against cold, wet weather during the three key weeks of planting and emergence. If temperatures drop to between 90 and 85% of normal heat units for the given three-week period, the farmer will be indemnified up to 100 % of the purchased coverage. The policy is estimated to cost $3-4 per acre for about $40 of coverage.

In a study funded by USDA Small Business Innovative Research, Agren Inc. (www.agren-inc.com), an agricultural and environmental consulting firm in Iowa, compiled a detailed compendium of IPM/BMP tactics used in corn production; identified those most likely to impact input use, yields, and profits; assessed risk as a barrier to adoption; located experts and sources of actuarial data to support probability and severity of failure; and developed feasible scenarios for comprehensive IPM/BMP financial risk management products to protect farmers and their advisors from consequences of failures. The project also includes policy rating by an underwriter and determining optimum product form to maximize benefits to users and rural economies.

REFERENCES

Agricultural Conservation Innovation Center (ACIC). 2002. *Promoting Conservation Innovation through Crop Insurance.* Available online at http://www.agconserv.com/ promote.html.

Alberta Cattle Feeders Association (ACFA). 1998. "Carbon Sequestration and Trading Implications for Canadian Agriculture". Discussion Paper.

American Farmland Trust (AFT). 2001. *Stemming the Tide.* American Farmland. pp. 9-13. Fall 2001.

Anderson, R.C. 1999. *Economic Savings from Using Economic Incentives for Environmental Pollution Control*. Resource Consulting Associates under agreement with the Office of Economy and Environment, USEPA.

Army Corps of Engineers. 2002. *How Projects are Initiated.* http://www.nws.usace.army.mil/ pao/wrd/noframe/2_proj.html

Alliance for the Chesapeake Bay. 2002a. "VA Comes up with Cost for Cleanup; Now It Must Come up with Money". *Bay Journal*. 12(1):5.

Alliance for the Chesapeake Bay. 2002b. "Bay States' Legislatures Enact Land Conservation, Water Measures in 2002". *Bay Journal*. 12(3):16.

Atkinson, S. and T. Tietenberg. 1991. Market Failure in Incentive-Based Regulation: The Case of Emission Trading. *Journal of Environmental Economics and Management*. 21(1):17-31.

Baumol, W. J., and W. E. Oates. 1988. *The Theory of Environmental Policy*. Cambridge University Press.

Better World Travel Company. 2001. *Travel Cool Program*. http://www.tripleE.com

Board of Commissioners of the Port of New Orleans. 2002. *The Port of New Orleans.* http://cattlefeeder.ab.ca/manure/ carbonsequest.html

Board of Certified Safety Professionals (BCSP). 2002. *History of the BCSP.* http://www.bcsp.org/aboutBCSP_fr.html

Boustany, R. G., C. R. Crozier, J. M. Rybczyk, R. R. Twilley, K. Flynn, and W. H. Conner (eds.) "Denitrification in a South Louisiana Wetland Forest Receiving Treated Sewage Effluent". Ecology and Management of Southern Forested Wetlands, SC (USA), 25-27 March 1996. *Wetland Ecology and Management* 4:289

Brookhaven National Laboratory. 2002. Peconic River Remedial Alternatives-Technology Fact Sheet on Wetlands Restoration/Constructed Wetlands. http://www.bnl.gov/erd/peconic/ Wetlands.pdf

Cameron, M. and M. Muller. 2001. *Innovative Financial Mechanisms for Promoting Conservation*. Institute for Agricultural and Trade Policy, Minneapolis, MN. November, 2001.

Cason, T. N. and L. Gangadharan. 1998. "An Experimental Study of Electronic Bulletin Board Trading for Emission Permits" *Journal of Regulatory Economics*. 14:55-73.

Cathcart, J. F. 2000. "Carbon Sequestration" *J. of Forestry* 98:32-37

Chemical and Engineering News. 2002. "Government & Policy Concentrates". p. 24 of the November 4, 2002 issue.

Christen, K. 2002. "Let's Make a Deal: U.S. EPA to Focus on Nutrient Trading" *WE&T.* February:16-20.

Comin, F. A., J. A. Romero, V. Astorga, and C. Garcia. 1997. "Nitrogen Removal and Cycling in Restored Wetlands Used as Filters of Nutrients for Agricultural Runoff". Fifth International Conference on Wetland Systems for Water Pollution, Vienna, Austria, 15-19 September, 1996. *Wetland-Systems-for-Water-Pollution-Control-1996* (conference proceedings, R. Haberl, R. Perfler, J. Laber, and P. Cooper[eds.])

Dahl, T. E. 1990. *Wetlands losses in the United States 1780's to 1980's*. U.S. Department of the Interior, Fish and Wildlife Service, Washington, D.C. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/ wetloss/wetloss.htm (Version 16JUL97).

DeLaune, R.D., C. W. Lindau, R. S. Knox, and C. J. Smith. 1990. "Fate of Nitrogen and Phosphorus Entering a Gulf Coast Freshwater Lake: A Case Study. *Water-Resour.-Bull.* 26:621-632.

Drury, R. T., M. E. Belliveau, J. S. Kuhn, and S. Bansal. 1999. "Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy. *Duke Envtl. L. & Pol'y*. 9:231-290.

Environment Canada and US EPA. 2001. The State of the Great Lakes 2001. ISBN 0-662-30488-8, EPA 905-R-01-003, Cat. No. EN40-11/35-2001E.

Environmental Defense. 2000. *From Obstacle to Opportunity: How acid rain emissions trading is delivering cleaner air*. Global and Regional Atmosphere Program, Environmental Defense, New York.

Faeth, P. 2000. Fertile Ground: *Nutrient Trading's Potential to Cost-Effectively Improve Water Quality*. World Resources Institute, Washington, D.C.

Faeth, P. 2001. *Testimony of Paul Faeth, Director of the Economic Program at the World Resources Institute, before the Senate Committee on Agriculture, Nutrition and Forestry*. March 1, 2001. Washington, D.C.

Fang, F. 2002. *Phosphorus Retention by Soils and Suspended Sediments in the Minnesota River Basin.* Ph.D. dissertation, University of Minnesota at Minneapolis-St. Paul.

Florida Fish and Wildlife Conservation Commission. 2001. http://www.floridaconservation.org/commission/2001/mar/New%20North%20Fl%20Mit%20Park.pdf. Last verified October 5, 2003.

Fromm, O. and B. Hansjürgens. 1996. "Emission Trading in Theory and Practice: An Analysis of RECLAIM in Southern California". *Environmental and Planning C: Government and Policy*. 4:367-384.

Gangadharan, L. 2000. "Transaction Costs in Pollution Markets: An Empirical Study" *Land Economics*. 76:601-614.

General Accounting Office (GAO). 2003. *Great Lakes: An Overall Strategy and Indicators for Measuring Progress Are Needed to Better Achieve Restoration.* U.S. GAO Report number GAO-03-515. Available at http://www.nemw.org/GAO_GLrestor.pdf. Last verified October 5, 2003.

Goodstein, E. 2001. *Economics and the Environment (3rd ed.)* John Wiley & Sons, Inc. New York.

Great Lakes Commission. 2002. *An Analysis of Conservation Districts' Changing Responsibilities: the District Role in Conserving and Protecting Great Lakes Land and Water Resources*. Available at http://www.glc.org/swcdsurvey/pdf/survey.pdf. Last verified October 2, 2003.

Great Lakes Information Network (GLIN). 2002a. *Fish and Fisheries of the Great Lakes Region*. http://www.great-lakes.net/envt/flora-fauna/wildlife/fish.html. Last verified August 21, 2002.

Great Lakes Information Network (GLIN). 2002b. *Tourism in the Great Lakes.* http://www.great-lakes.net/tourism. Last verified August 21, 2002.

Greenhalgh, S. and P. Faeth. 2001. "A Potential Integrated Water Quality Strategy for the Mississippi River Basin and the Gulf of Mexico". In *Optimizing Nitrogen Management in Food and Energy Production and Environmental Protection: Proceedings of the 2nd International Nitrogen Conference on Science and Policy*. *The Scientific World* 1:976-983.

Greenhalgh, S. and A. Sauer. 2003. “Awakening the Dead Zone: An Investment for Agriculture, Water Quality, and Climate Change”. *Issue Brief*, February 2003. The World Resources Institute, Washington DC.

Harper, S. 2002. “States Suffer Sticker Shock on Bay Cleanup”. *The Virginia-Pilot.* November 1, 2002.

Hoen H. F. and B. Solberg. 1994. “Potential and Economic Efficiency of Carbon Sequestration in Forest Biomass through Silvicultural Management”. *For-Sci*. 40:429-451

Kerr, R. A. 1998. “Acid Rain Control, Success on the Cheap” *Science*. 282:1024-27.

Kieser, M. S. 2000. *Phosphorus Credit Trading in the Kalamazoo River Basin: Forging Nontraditional Partnerships.* The Forum for Greater Kalamazoo and the Steering Committee for the Water Quality Trading Demonstration Project. Final Report to Water Environmental Research Fund, Project 97-IRM-5C.

Kieser, M. S., A. F. Fang, and J. A. Spoelstra. 2003. *Role of Urban Stormwater Best Management Practices in Temperature TMDLs.* Water Environment Federation TMDL 2003 Conference. Chicago, Illinois, November 16-19, 2003

Lake Michigan Federation (LMF). 2002. *Sand Dune Ecology*. http://www.lakemichigan.org/ habitat/dune_formation.asp. Last verified September 24, 2003.

Landry, C. 2002. “The Rising Tide of Water Markets” *Impact*. 4:26-29.

Lee, J. J. and R. Dodson. 1996. “Potential Carbon Sequestration by Afforestration of Pasture in the South-Central United States. *Agron-J,* 88:381-384.

Michigan Department of Agriculture. 2001. *The Farmland and Open Space Preservation Program*. Available at http://www.michigan.gov/mda/0,1607,7-125-1567_1599_2558-10301--,00.html. Last verified September 24, 2003.

Michigan Department of Environmental Quality (MDEQ). 2001. *Revised rules for water quality trading.* Available at http://www.deq.state.mi.us/documents/deq-swq-trading-RulesRevised.pdf. Last verified September 24, 2003.

Minnesota Pollution Control Agency (MPCA). 1997. *National Pollutant Discharge Elimination System and State Disposal System Permit MN 0031917*. State of Minnesota, Minnesota Pollution Control Agency, Water Quality Division, Point Source Compliance Section. St. Paul, MN.

Minnesota Pollution control Agency (MPCA). 1999. *National Pollutant Discharge Elimination System and State Disposal System Permit MN 0040665*. State of Minnesota, Minnesota Pollution Control Agency, South District/Major Facilities, St. Paul, MN.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. 2001. *Action Plan for Reducing , Mitigation, and Controlling Hypoxia in the Northern Gulf of Mexico.* January 2001, Washington DC.

Most, M. 2001. “EMA Contracts Committee”. *The Emissions Trader*. 5(4):7-8.

National Geographic Society. 2000. *Louisiana Losing Ground at a Catastrophic Rate*. January 25, 2000. http://www.coastal.uno.edu/news/2000/01/01252000/sinking_9233.html

National Research Council (NRC). 2001. *Compensating for Wetland Losses Under the Clean Water Act*. Committee on Mitigating Wetland Losses, Division of Earth and Life Sciences, National Research Council. National Academy Press, Washington DC.

Resources Agency of California (RAC). 1995. *Official Policy on Conservation Banks (April 7, 1995).* Available at http://ceres.ca.gov/wetlands/policies/mitbank.html. Last verified September 24, 2003.

Restore America’s Estuaries (RAE). 2002. *A National Strategy to Restore Coastal and Estuarine Habitat.* RAE, Washington DC, April 2002.

Richardson, C. J. and S. S. Qian. 1999. “Long-term Phosphorus Assimilative Capacity in Freshwater Wetlands: A New Paradigm for Sustaining Ecosystem Structure and Function”. *Environmental Science & Technology*, 33: 1545-1551

Rogers, J., E. Bacon, A. McElwaine, M. Kieser, and M. Kelly. 2002. “Incentives and Tools for TMDL Implementation and Achievement of Voluntary Goals in Two Michigan Watersheds”. Abstract submitted for WEFTEC 2002, Session F.

Rosenweig, R., M. Varilek, B. Feldman, R. Kuppalli, and J. Janssen. 2002. *The Emerging International Greenhouse Gas Market*. The Pew Center on Global Climate Change. March 2002. Arlington, VA.

Schaerer, B. 1996. *Incentives for Species*. The Thoreau Institute, Oregon. Available at http://www.ti.org/schaerer.html. Last verified September 24, 2003.

State of Victoria, Australia. 2003. *The BushTender Trial*. Department of Sustainability and Environment. Relative information available at: http://www.nre.vic.gov.au/web/root/domino/cm_da/nrence.nsf/frameset/NRE+Conservation+and+Environment?OpenDocument. Last verified June 20, 2003.

Stavins, R. N. 1995. “Transaction Costs and Tradable Permits”. *J. of Environ. Economics and Management*. 29: 133-148

The International Ecotourism Society. 2002. *Ecotourism Explorer*. http://www.ecotourism.org. Last verified October 6, 2003.

The Kalamazoo River/Lake Allegan TMDL Implementation Committee. 2002. *Water Quality Improvement (Implementation) Plan for the Kalamazoo River Watershed and Lake Allegan through a Phosphorus Total Maximum Daily Load (TMDL) Process.* Available on line at http://kalamazooriver.net/implement/index.htm.

The Nature Conservancy. 1998?. *The Forest Bank.* Available at http://ww.epa.gov/glnpo/ ecopage/forestbank/fbankrpt.pdf. Last verified February 19, 2002.

Thurston, H. W., H. C, Goddard, D. Szlag, and B. Lemberg. 2002. "Trading Stormwater Abatement Credits in Cincinnati's Shepherd Creek". *Stormwater*. 3:

US Army Corps of Engineers (US ACOE). 1996. *National Wetland Mitigation Banking Study-Commercial Wetland Mitigation Credit Ventures: 1995 National Survey*. IWR Report 96-WMB-9. Washington DC.

US Army Corps of Engineers (US ACOE). 2002a. *Regulatory Guidance Letter No. 02-2 (December 24, 2002)--Guidance on Compensatory Mitigation Projects for Aquatic Resource Impacts Under the Corps Regulatory Program Pursuant to Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 189.* Available at http://www.usace.army.mil/inet/ functions/cw/hot_topics/RGL_02-2.pdf. Last verified September 24, 2003.

US Army Corps of Engineers (US ACOE). 2002b. *National Wetlands Mitigation Action Plan (December 24, 2002).* Available at http://www.usace.army.mil/inet/functions/cw/ hot_topics/ Mit_Action_Plan_24Dec02.pdf. Last verified September 24, 2003.

US Department of Energy (US DOE). 1997. *The Effects of Title IV of the Clean Air Act Amendments of 1990 on Electric Utilities: An Update*. DOE/EIA-0582(97), Energy Information Administration, Office of Coal, Nuclear, Electric and Alternate Fuels, U.S. Department of Energy, Washington, DC 20585.

US Environmental Protection Agency (US EPA). 1996. Draft Framework for Watershed-Based Trading. Office of Water, US EPA. EPA 800-R-96-001. May 1996.

US EPA. 1999. *Wetlands Mitigation Banks.* Available at http://www.epa.gov/owow/ wetlands/facts/fact16.html (last verified February 20, 2002).

US EPA 1999. *TMDL Program.* Office of Water. http://www.epa.gov/owow/tmdl (last verified October 2, 2003).

US EPA. 2000. *Lake Michigan Lakewide Management Plan*. Great Lakes Program Office.

US EPA. 2001a. *Acid Rain Program: Overview*. Available at http://www.epa.gov/airmarkets/ arp/overview.html (last verified February 19, 2002).

US EPA. 2001b. *The Safe Drinking Water Act.* Office of Ground Water and Drinking Water. http://www.epa.gov/OGWDW/sdwa/sdwa.html (last verified October 2, 2003).

US EPA. 2001c. *The Chesapeake Bay Program*. http://www.epa.gov/ecoplaces/part1/site2.html, Revised: 05/16/2001 07:09:59 (last verified April 2, 2002).

US EPA. 2001d. *Chesapeake Bay Program Nutrient Trading Fundamental Principles and Guidelines*. The Chesapeake Bay Program Nutrient Trading Negotiation Team. EPA 903-B-01-001-CBP/TRS 254/01. March 2001.

US EPA. 2002a. *Proposed Water Quality Trading Policy*. Office of Water. April 25, 2002. Available at http://www.epa.gov/owow/watershed/trading/tradingpolicy.html (last verified August 23, 2002)

US EPA. 2002b. *Great Lakes Strategy 2002-A Plan for the New Millennium*. US Policy Committee for the Great Lakes. Washington DC.

US EPA. 2003a. *Final Water Quality Trading Policy*. Office of Water. January 13, 2003. Available at http://www.epa.gov/owow/watershed/trading/finalpolicy2003.html (last verified June 19, 2003).

US EPA. 2003b. *Economic Analyses of Nutrient and Sediment Reduction Actions to Restore Chesapeake Bay Water Quality*. Chesapeake Bay Program Office, September 2003. Available at http://www.chesapeakebay.net/pubs/doc-ecoanal-PartI.pdf (last verified October 2, 2003).

US Federal Emergency Management Agency. 2001. *National Flood Insurance Program*. http://www.fema.gov/nfip/summary.htm

US Fish and Wildlife Service (US FWS). 2002. *National Preliminary Survey of Fishing, Hunting, and Wildlife Associated Recreation.* Available at http://www.census.gov/prod/2002pubs/FHW01.pdf. Last verified September 24, 2003.

US Fish and Wildlife Service (US FWS). 2003. *Guidance for the Establishment, Use and Operation of Conservation Banks.* Available at http://endangered.fws.gov/frpubs/n030508.pdf. Last verified June 19, 2003

U.S. Water News On-line. 1998. *K-State Scientist Studies River Bank Erosion-growth during 1993 Flood*. http://www.uswaternews.com/archives/arcsupply/8kstsci2.html

Woodward, R. T., R. A. Kaiser, and A. B. Wicks. 2002. "The Structure and Practice of Water Quality Trading Markets". *Journal of the American Water Resources Association.* 38:967.

Zinn, Jeffrey A. 1997. *Conservation Reserve Program--Preliminary Results from the 15th Signup*. Environment and Natural Resources Policy Division, Farm Service

Administration, U.S. Department of Agriculture. Available at http://www.ncseonline.org/nle/crsreports/natural/nrgen-14.cfm. Last verified September 24, 2003.

APPENDIX A.

Developing Markets to Manage Ecosystems

Developing Markets to Manage Ecosystems

(DRAFT)

Donald L. Hey
The Wetland Initiative

Flood Storage as a Commodity

The need for flood storage was never more apparent than during the 1993 floods on the Mississippi River. The floodwalls at St. Louis would have been overtopped if numerous upstream levees had not failed, allowing the pent-up floodwaters to inundate the formerly protected land. At the time, the owners of the failed levees probably gave little thought to the value of their flooded property as a place to store floodwaters, which few others wanted. Had upstream levee districts been organized and downstream owners well informed, a market for floodwater storage certainly would have flourished in the late spring and summer of 1993.

Such a market is not without precedent. In the early 1960s when the Army Corps of Engineers were implementing their "big dam" strategy of flood control on the Kansas River, they acquired easements to allow floodwater to occasionally encroach on lands beyond the immediate reservoir area. Property owners could continue to farm or use the land however they wished, but could not claim damages should floodwaters be temporarily stored on their property. This practice has not been applied to other flooding situations; however, it could serve along leveed reaches, perhaps in a more free-market form, to increase flood storage and reduce flood damages downstream as well as on the property that has generated marketable flood storage.

The idea is simple, a downstream property owner, city, or any other potentially affected entity would offer to buy upstream flood storage. Upstream property owners would sell the right to temporarily store floodwaters on demand from the buyer of the "flood storage credit." The seller of the credits would need to be careful not to preempt the use of his property in the event that the downstream owner calls for the execution of the credit contract. That is to say, the credit seller would need to keep his or her levees in tact and the assigned storage volume available. The credit holder, on the other hand, would need to exercise careful judgment in calling the purchase option. Too early a call during a flood may preempt a later, more critical need. A call too late may be disastrous.

The geographical location of both the buyers and sellers generally would fall within the Federal Emergency Management Agency's floodplain limits. Flood prone areas exist both in the humid East as well as the arid West. Consequently, virtually every state in the union would have need for such a market. Still, markets would need to be reasonably local in that there would be little advantage to St. Louis, which is in the Mississippi basin, of buying credits in the Sacramento River basin. In aggregate, however, the market could be extremely large.

One measure of market size might be taken from the mean annual national flood losses for the last 30 years: $3.4 billion. Consider, however, the flood losses in the upper Mississippi River Basin (upstream of Thebes, Illinois) in 1993: $16 billion. To have avoided these losses, 40 million acre-feet of additional flood storage would have to have been available. Based on the damages, an acre-foot of storage would have been worth $4,000. Assuming that the floodwaters would be stored in shallow (3 foot) wetlands behind the levees, 13 million acres would have been required. The rental rate for the 1993 event would have been $1,200 per acre, a handsome sum since most agricultural land in the Midwest rents for $150 to $200 per acre. If the floodwaters were stored in deeper pools behind the levees, the unit-area rental rate would be even higher. Since the expected value of the 1993 damages (the probability of occurrence being 0.01 in any year) would be approximately $160 million, the annual value of a wetland flood-storage credit would be only $12 per acre. If the floodwater could be stored to a depth of 15 feet, the value would be $60 per acre. But remember, this income would be in addition to the normal income from farming or other activities that would not be interrupted except on rare occasions.

The longevity of the flood storage market is without limit as long as two land use activities continue. The first is that upstream landowners have a need to drain their land for agricultural production, commercial development or any other reason. The second is that downstream owners occupy or us flood prone areas. Under these conditions, flood damage will occur.

Nitrogen Farming

Hypoxia is a phenomenon that occurs throughout the world in locations where rivers discharge into seas or oceans. This problem of low or depleted oxygen resources in the waters of bays and gulfs is most troubling where rivers drain intensely farmed and developed watersheds. Within the United States, such streams as the Mississippi, Hudson, Potomac, and Sacramento Rivers all produce large nitrogen loads, which are the primary causal factor, robbing the oxygen resources of the receiving salt waters. Where the oxygen sources are depleted, fish and more mobile aquatic organisms flee the affected area, but those who cannot move so rapidly, die. Ultimately, hypoxia will damage those people dependent on the fisheries.

In the Mississippi watershed, 31% of the nitrogen load to the Gulf of Mexico comes from the fertilizer applied to agricultural lands. Reducing the nitrogen load to receiving streams has proved to be nearly impossible, for the simple reason that there is considerable economic advantage in using large quantities of nitrogen fertilizer and in quickly draining nitrogen laden water from the field. Fertilizer increases crop yield by two to three times over that produced without fertilizer. Efficient drainage increases crop yield by a factor of two. The effects on farm income are clear to every farmer and fertilizer producer.

In the past, efforts have been made to encourage farmers to voluntarily reduce the use of fertilizer and to limit the amount of runoff from their fields. These efforts have not worked because the farmer has not been adequately compensated. For example, the reduction in yield has not been offset in an increase in price. A new strategy, nitrogen farming, could overcome this economic disincentive. This strategy involves converting lowlands from the production of corn to the production of wetlands. In turn, the wetland would accept and discharge drainage from the tributary watershed and, in the process, remove a high percentage of nitrate-nitrogen conveyed by the water. Depending on the location and size, up to 90% of the nitrogen load passing through the wetland would be removed. The amount removed would be recorded by the farmer and certified by the state. Once the state certification is received, the farmer would be free to sell the certified nitrogen credits on the open market. The buyers of nitrogen credits could be other farmers, municipal and industrial dischargers, and those emitting nitrogen to the atmosphere, which ultimately falls back to the land's surface, such as power plant and automobile owners.

Based on a preliminary investigation, the cost of producing a ton of nitrogen credit would be approximately $600. This covers the capital costs of the land and wetland restoration as well as the labor and materials needed to operate the wetland. Assuming that the cost of nitrogen fertilizer is $400 a ton and that approximately one-third of every ton is removed by drainage, a farmer would have to buy a third of a ton of nitrogen credits for every ton of nitrogen fertilizer applied in order to mitigate his nitrogen emissions. This would result in approximately a $200 per ton surcharge, or tax, on fertilizer, bringing the total cost to $600 per ton.

The market area for nitrogen farming would be restricted to the more humid, eastern portion of the United States and along the Pacific coast where row crops are intensely grown. The western portions of the Missouri River basin produces little in the way of nitrogen-loaded runoff due to low precipitation and the particular crops grown in the region. On the other hand, rivers along coastal California and rivers draining southern Minnesota, Iowa, Missouri and Arkansas and all states eastward would present fertile areas for nitrogen farming. The magnitude of the market could be estimated from fertilizer sales, emissions of power plants and automobiles and by the discharge of municipal and industrial point sources.

Just considering the fertilizer component, the market size is considerable. Given the fertilizer used in the United States in 1999, 12 million tons (2000 pounds/ton) and assuming one third of this amount finds its way into the drainage system, approximately 4 million tons of nitrogen credit would be required to offset the load on a 1:1 basis. The annual value of these credits would be $2.4 billion.

The cornerstone for the nitrogen market has been laid. In January of 2001, the United States Environmental Protection Agency promulgated nutrient criteria, including nitrogen, for the United States. In the "Cornbelt Eco-region" where most of the nitrogen fertilizer is used, the total nitrogen criterion was set at 2.18 mg/l. Of this concentration about 1.6 mg/l would be nitrate-nitrogen. These are fairly high concentrations and they are probably much greater than pre-European settlement conditions for many of the streams. However, they are substantially lower than the nitrogen concentrations now conveyed by the rivers of this region. The total reduction of nitrogen will need to be three- or fourfold. For the Illinois River, approximately 100,000 tons per year will need to be removed. At the estimated cost for credit production quoted above, $600 per ton, the annual market for nitrogen credits would be approximately $60 million.

As with the flood control market, the nitrogen market will need to be locally based. Dischargers of nitrogen would likely be required to buy credits from sellers upstream of their point of discharge. In this way, elevated concentrations of nitrogen in the river system would be minimized. On the other hand, certain streams could be reclassified in order to allow them to convey higher nitrogen concentrations to downstream nitrogen farms. This, however, would require a change in the way the water quality standards are currently administered.

The nitrogen credit market would be viable as long as crops need to be grown on well-drained and fertilized land. A shift to crop species more tolerant of saturated soils or a change in the chemical nature and application of fertilizer could reduce the need for nitrogen credits. Crops requiring less drainage and nitrogen are being actively considered. New forms of nitrogen fertilizer are being developed, ones that attach to the soil and dissolve more slowly. In the meantime, the market opportunities are enormous.

Multiple Markets

Almost all of the markets for managing ecosystems could be supplied from one landscape. Restored wetlands could grow flood storage, nitrogen, phosphorous and atrozine credits. These same wetlands could offset wetland losses due to economic development, whether agricultural, industrial, commercial or residential, and provide quality open space for recreation, wildlife habitat and biodiversity. To establish these markets, only one needs to be initiated. If successful, the others will follow.

One of the easiest ecosystem commodities to generate, monitor and manage is that of aqueous nitrate-nitrogen. Wetlands remove nitrogen, wetlands don't sequester nitrogen. The microbial communities within wetlands readily strip the oxygen off the nitrate molecule sending nitrogen gas back to the atmosphere. Consequently, there is no concern with long-term sequestration or the offending molecule reentering the environment at some other point, potentially causing even greater problems. The release of nitrogen gas to the atmosphere is not a problem since it is relatively inert, and nitrogen comprises 78% of the atmosphere.

If a nitrogen market can be produced it will very readily demonstrate the economic value of land for other purposes than corn production, housing or commercial development. The nitrogen market would monetize the ecosystem service of water quality management. This experience will facilitate monetizing phosphorous and flood control, wildlife management, and many other ecosystem services. The nitrogen market will create a new land-economics paradigm. As such, it will create new opportunities for landowners, particularly farmers, and will lessen the agricultural community's dependence on government subsidies while bringing an equitable resolution to the problem of non-point source pollution.

APPENDIX B.

Managing Nitrogen Flows through Multiple Markets

Managing Nitrogen Flows through Multiple Markets

Mark Landry and Paul Faeth
March 15, 2002

Throughout the United States there is a great need to develop programs to cost-effectively meet existing and new regulatory requirements. Among the most necessary and contentious are regulations to protect water quality. Since passage in 1972, the Clean Water Act has helped the nation make significant progress toward fishable and swimmable waters. Yet, there are still many waterbodies that do not meet their designated uses, the majority of them impaired by nutrient pollution from agricultural nonpoint sources and municipal and industrial point sources (Faeth, 2000).

There are a variety of federal and state programs and regulations aimed at controlling and preventing nutrient pollution—including permitting, taxing, subsidizing, mandating, and creating incentive programs. These diverse and often complex policy instruments are typically not very well integrated and seldom consider the multiple impacts or benefits that can be attributed to a given activity. For example, there is a policy disconnect between wetland restoration projects, NPDES (point source pollution) permitting, mandatory treatment processes at wastewater treatment facilities, agricultural-based incentive programs like the Conservation Reserve Program (CRP), air emission standards, etc. Environmental management is most often limited in scope, though it does not need to be.

Competing objectives, lack of coordination, budget shortfalls, and increased political pressure limit the capacity of decision makers to manage the growing demands placed on environmental services and natural resources. With so many competing demands, outcomes can be made more economically and environmentally effective if environmental protection activities can be integrated across media (air, water, waste) and focus areas. One of the key components to implementing such an extensive approach will be policy development where innovation among stakeholders, the regulated community, and third party entrepreneurs are successfully promoted. Market-based mechanisms and economic incentives may provide institutional and policy infrastructure necessary to meet the multiple demands placed on environmental services at least cost.

Trading programs, where pollutant credits and resource rights are clearly defined, enforceable, tradable, and typically capped within watersheds and airsheds, have successfully been implemented in many regions to reduce pollution efficiently and effectively. Defining a tradable commodity, for example nitrogen reduction credit, is contingent on being able to quantify and enforce the pollutant emission, effluent discharge, and/or the sequestered or utilized amount. In a multi-market trading system, each environmental service or unit of pollution control (e.g., acre of riparian buffer created, number of trees planted, energy efficient measures implemented, etc.) will also need to be clearly defined in order for a market to exist. Enforcement ensures that control measures perform as intended to reduce the desired or required level of pollution. As a result, tradable credits allow two parties to shift allocation of regulatory responsibility in order to lower pollution control costs (Stephenson et al., 1998). Often, pollutant credits are allocated or permitted in a closed or "capped" trading system. A multi-market trading program could result in an open trading program, where emissions credits, environmental services, and/or units of treatment and pollution controls are available for trade across media, programs, and sociopolitical/geographic boundaries; or a closed trading system, where the same activities could generate credits of different types to be sold into separate markets.

Nitrogen management presents the opportunity for such multiple markets, so we have chosen to examine it here. Because the dynamics of nitrogen movement between the biological world and the soil, air, and water is complex, we limit the example in order to illustrate the multiple facets, complexities, and diverse opportunities for trading. The nitrogen cycle is summarized for the purpose of highlighting the multiple processes and states of nitrogen in the environment. The anthropogenic effects on the nitrogen cycle are described to stimulate contemplation of potential nitrogen market opportunities. Finally, multi-market trading to reduce nitrogen is discussed in terms of potential barriers to trade and lessons learned from existing, pilot, or proposed trading systems.

The Nitrogen Cycle

Movement of nitrogen among the atmosphere, soil, water, and organisms constitutes the nitrogen cycle. Nitrogen is a life-giving nutrient to plants and animals, ranking fourth in abundance behind oxygen, carbon, and hydrogen in most organisms. Nitrogen is also a common element found in the environment. Nearly 80 percent of the earth's atmosphere is nitrogen gas (N_2). However, most organisms cannot use nitrogen gas directly. Availability of nitrogen to organisms is limited because plants and animals require nitrogen to be "fixed." Nitrogen *fixation* is the process whereby gaseous nitrogen is bonded to hydrogen to form ammonia (NH_3) and then to organic forms usable by plants.

Nitrogen Cycle Components

1) *fixation* – N gas to organic N
2) *mineralization* – organic N to ammonia or ammonium
3) *nitrification* – ammonium to nitrite then to nitrate
4) *immobilization* – nitrate or ammonium to organic N
5) *denitrification* – nitrate to nitrite then to N gas

Fixation occurs naturally by lightning and biological processes mediated by enzymes found in the rhizomes (underground stems) of legumes such as soybeans. Biological fixation is a relatively slow, oxygen-dependent process and represents only a small component of the nitrogen cycle. Fixation induces *mineralization* and *nitrification* in soil and is accelerated under aerobic conditions. Applying nitrogen fertilizer, usually nitrate (NO_3^-) nitrogen, to the soil rapidly increases the plant-available pool of nitrogen in the soil.

For example, farmers in the Midwest usually apply nitrogen fertilizer to croplands to increase yield by as much as 200 percent. However, the National Research Council (1993) reports that as much as 40 percent of the nitrogen applied to fields is not taken up by plants and can be lost to the air and water. Rotating crops with legumes such as soybeans is another common cropping practice implemented in the region in order to maintain the symbiotic relationships with bacteria that make soil nitrogen readily available to plants.

Soil nitrate is soluble and easily mobilized into surface and ground water. *Immobilization* of nitrogen via the hydrologic cycle is critical to the natural distribution of nitrogen.

Volatilization and *denitrification* of nitrogen species from soil and water into the atmosphere occurs spontaneously everywhere and balances nitrogen loss due to deposition and fixation. Atmospheric deposition of nitrogen species is well documented and is an integral driver affecting the ecological balance of aquatic and terrestrial systems. Flux in all nitrogen cycling processes occurs naturally and is enhanced by human activities.

Causes and Consequences of Increased Nitrogen in the Environment

Nitrogen cycling has been accelerated by human activities such as increased production and use of nitrogen fertilizers and the burning of fossil fuels by power plants, automobiles, and factories, which creates NOx emissions in the combustion process. As a result, local and global ecosystems have been disrupted, with multiple short- and long-term effects. The box to the right illustrates some of the effects humans have had on the nitrogen cycle (Vitousek et al., 2002).

Agriculture in the United States has been enormously productive in part because of the use of nitrogen fertilizer. According to Figure 1, nitrogen fertilizer use has increased by about 150 percent over the period 1965 to the mid-1990s, from 4.6 million tons per year to 12 million (USDA, 1997).

<u>What has human domination of the nitrogen cycle done?</u>

- Doubled the rate of nitrogen inputs on land.
- Increased acidification of soil, streams, lakes, and rivers in many regions.
- Induced hypoxia—such as the annually occurring “Dead Zone” in the Gulf of Mexico.
- Altered biodiversity, particularly species that depend on low nitrogen scenarios.
- Added to the pool of greenhouse gases, particularly nitrous oxide (N2O).
- Reduced net soil fertility by accelerating losses of potassium and calcium.
- Caused blue-baby syndrome from nitrogen pollution in groundwater.

Nutrient loading is the principal cause of hypoxia, a condition that occurs when the amount of dissolved oxygen in water reaches levels of 2 mg l^{-1}, while normal levels of dissolved oxygen are about 5 mg l^{-1}. Areas of hypoxia (or “dead zones”) are present in more than half of the estuaries of the United States (Bricker et al., 1999). High concentrations of nitrogen in streams and rivers contributes to the development of hypoxic zones in the ocean—which regularly occur in the Gulf of Mexico, Long Island Sound, and elsewhere. One of the largest hypoxic zones off the U.S. coast occurs near the outflows of the Mississippi and Atchafalaya Rivers in the northern Gulf of Mexico. This zone, which was 8,000 to 9,000 km^2 in the summers of 1985-1992, has now doubled to between about 18,000 km^2 (Rabalais et al., 1999). Relatively high levels of nitrate nitrogen are detected annually in the Mississippi River between April and July and are attributable to agricultural sources (Hatfield, 2002).

Hypoxia occurs when excess nutrients in water spawn the accelerated growth of microbial species suspended in water resulting in a depletion of dissolved oxygen. Waters lacking oxygen results in a “dead zone,” where fish and aquatic life cannot exist. The size, timing, and location of the regularly forming hypoxic zones depend on the rate and amount of nutrient loading (Rabalais et al., 1999).

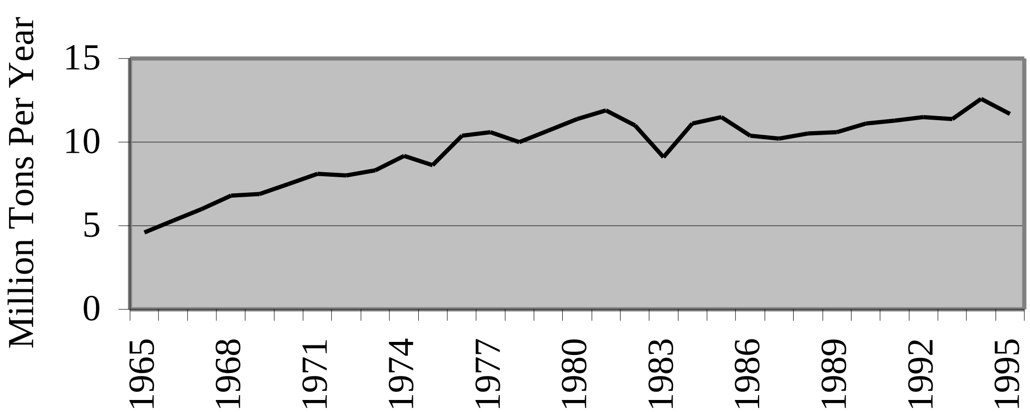
The 1997 outbreak of the toxic algae, *Pfiesteria*, in the Chesapeake Bay shed public attention on the problems associated with high concentrations of nitrogen in the Bay. As early as the mid-1980s, scientists warned that nitrogen in fertilizer and chicken manure was altering the Bay ecosystem dramatically (Dewar and Horton, 2000). It is now estimated that air deposition of nitrogen contributes to one fourth of the total nitrogen loading to the Bay (ECARA, 1996). In addition, modeling efforts indicate that NOx emission reductions, in compliance with the Clean Air Act, reduces nitrogen loading to the Bay by 13 percent (ECARA, 1996).

This section only begins to demonstrate the effects humans have on the nitrogen cycle and the resulting consequences. Researchers continue to discover relationships between human activities and nitrogen cycling. Scientist also predict the effects of current and anticipated use of nitrogen fertilizers, fossil fuel burning, and other nitrogen inputs will continue to take their toll on local and global systems.

Opportunities for Multiple Market Trading of Nitrogen Credits

The debate surrounding nutrient loading at the local and national level is stuck on traditional solutions, namely conservation subsidies to farmers, the use of best management practices (BMPs), and tighter controls on point sources. It is apparent that these conventional approaches will not be adequate because they are too expensive and address too small a segment of the problem. The challenge is to identify and implement policies that are fair and cost-efficiently distribute responsibility for appropriate nitrogen management. These policies should also take advantage of the synergies among water quality, drinking water protection, wetland habitat, and climate protection that nitrogen control can provide.

Figure 1: Nitrogen Fertilizer Use 1965-1995



Emissions trading schemes have been used to control air emissions, water pollution, land development, lead in gasoline, and even grass burning and the number of woodstoves in communities with air quality problems. Nutrient trading, where firms (or farms) that can reduce nutrients cheaply do so and sell the credits to others for whom reductions are more expensive, has been promoted because of its potential to reduce the costs of improving water quality.

Nonpoint sources, particularly agriculture, contribute significantly to water pollution and remain largely unregulated. They represent a vast opportunity for significant but relatively inexpensive reductions in polluted runoff. The National Research Council estimates that approximately half of the national nitrogen and phosphorus residual results from excess nutrient use. Other researchers have shown that as much as three-quarters of this excess can be avoided through fairly simple and inexpensive techniques such as soil testing and fertilizer banding.

These general trends hold true for the Mississippi River basin. A preliminary analysis of the potential for nutrient trading in the basin indicates that there are great differences in the control costs of point and agricultural nonpoint sources of nitrogen in the basin. The study shows that, if the performance goal was set at a discharge level of 3 milligrams of nitrogen per liter, point sources could save $14 billion by purchasing reduction credits from agriculture rather than installing advanced control technologies themselves (Ribaudo, 1998). This analysis indicates that trading is a promising approach for addressing nutrient pollution to the Gulf. Nonpoint sources are thought to contribute as much as 90 percent of the nitrogen flowing into the Gulf of Mexico, with much of it originating in the upper regions of the Mississippi basin (Alexander, 1995). About 80 percent of the total is believed to come from commercial fertilizer and manure (Goolsby and Battaglin. 1997).

As mentioned above, nitrogen not only contributes to fresh and estuarine water quality problems, it is also a contributor to climate change. Agricultural production is responsible for about 12% of U.S. greenhouse gas emissions (see Table 1). Nitrous oxide, N_2O, is one of the most powerful greenhouse gases, with the ability to trap 310 times as much heat as carbon dioxide. About 88 million metric tons (carbon equivalent) or three-quarters of total U.S. emissions of nitrous oxide emissions, come from agricultural production each year, with 49 MMTCE coming from direct emissions. The largest components of this category are the application of synthetic fertilizers and nitrogen fixation by crops. The application of sewage sludge and animal manures and the cultivation of organic soils are much smaller. When nitrogen is lost through volatilization, leaching and runoff, some share of it is in the form of nitrous oxide or enhances its production (U.S. EPA 2000).

Many of the same activities can improve water quality and reduce or prevent greenhouse gas emissions. For example, nutrient management plans reduce the surplus nitrogen available to be lost to water as well as to the atmosphere. Protected or restored wetlands can remove nitrogen from the water and prevent it from transforming to a nitrous oxide.

Research by WRI shows that a well-targeted water quality program aimed at reducing nutrients and using market-based mechanisms to provide flexibility and reduce the costs of meeting the nation’s water-quality goals, could also provide climate co-benefits (Faeth and Greenhalgh, 2000; 2001). Figures 2 and 3 show how this sort of policy would affect nitrogen losses and greenhouse gas emissions from agriculture in the sub-basins of the Mississippi River. The figures show that a program aimed at cutting nitrogen losses also would substantially reduce greenhouse gas emissions and provide a major multiple market opportunity.

Table 1: U.S. greenhouse gas emissions. U.S. total, emissions from agricultural production, and the share of agricultural production in the U.S. total (U.S. EPA 2000; Lal et al., 1998).

	U.S. Total (MMTCE)	**Agricultural Production** Emissions (MMTCE)	Agricultural Production's Share of Total (%)
Carbon Dioxide	1,494	43	3
Methane	181	60	33
Nitrous Oxide	119	88	74
HFCs, PFCs, and SF_6	40	~0	0
Land Use Change and Forest Sinks	(211)	?[a]	?
Total (Net)	1,623	191	12

a: Estimates vary from about –15 to + MMTC per year.

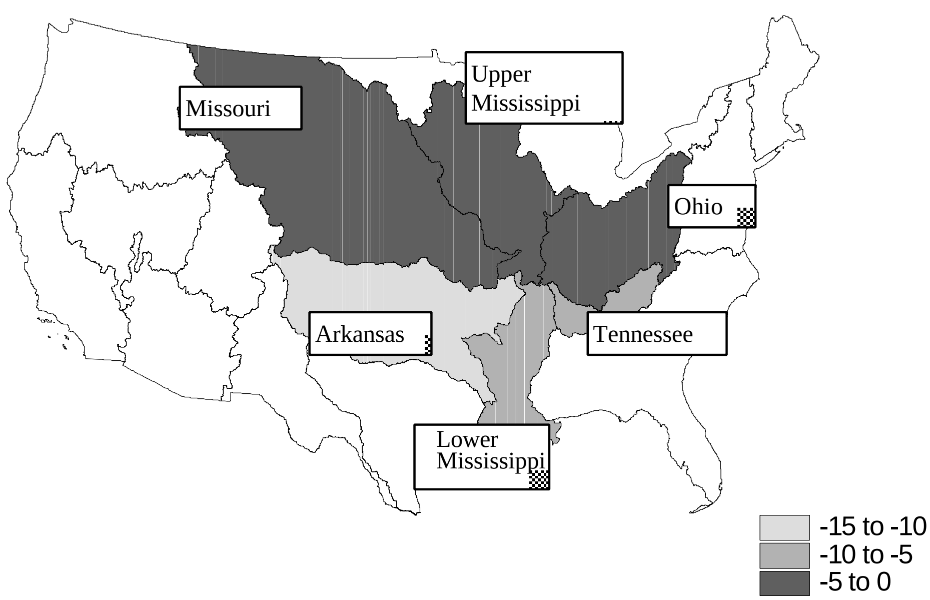


Figure 2: Percent Change in Nitrogen Losses from a Potential Policy to Reduce the "Dead Zone"
(In this scenario the market clearing price for a nitrogen credit representing one pound on N kept out of the water is assumed to be one dollar).

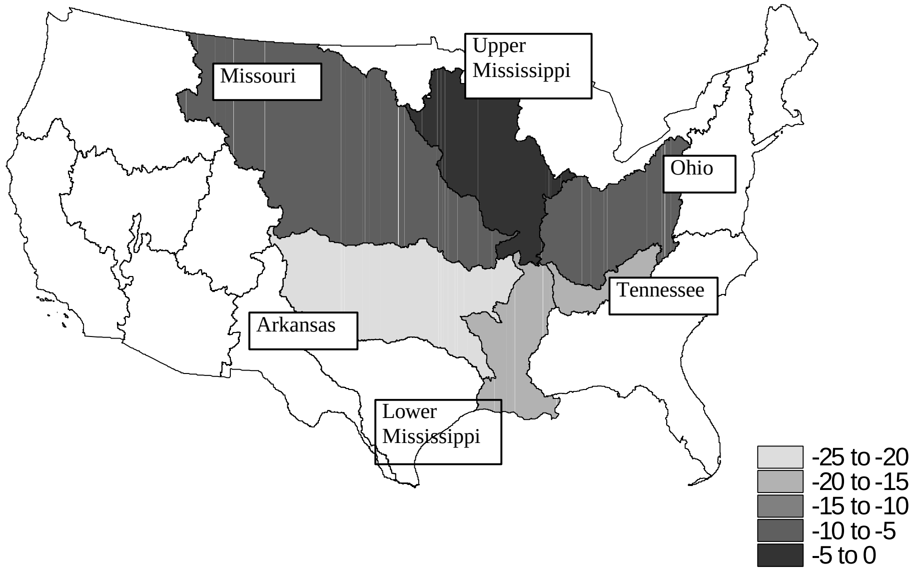


Figure 3: Percent Change in Greenhouse Emissions from a Nutrient Trading Program to Reduce the "Dead Zone"

Challenges in Developing Multiple Markets for Nitrogen

The complexity of the nitrogen cycle reflects the difficulty of accurately assessing the amount of nitrogen in the soil, available for plant uptake, mobilized in surface runoff or leachate, or volatilized into the atmosphere. The causational effects of human activities on the nitrogen cycle are more readily identifiable than understanding the dynamic, far-reaching consequences. For example, what is the impact of one Midwest farmer's reduction in nitrogen fertilizer use on the hypoxic zone in the Gulf? How is ozone level affected by sequestering nitrogen in a wetland or forest of a designated size? How does critical habitat respond to implementation of tertiary treatment at a wastewater facility? What about measuring the corollary benefits such as the impacts of phosphorus reductions generated by a nitrogen management technique? The extent to which nitrogen management practices affect multiple ecological functions and services remains to be researched in greater detail.

Nitrogen Accounting. One approach to managing sliding scale impacts of nitrogen management practices is through the use of trading ratios. Nitrogen from multiple sources is the same but may have varying effects depending location. In the Long Island Nitrogen Credit Exchange Program, the entire watershed has been divided into sectors with a corresponding trading ratio created to account for the relative impact of nitrogen loading on the hypoxic zone in the Sound (Rocque, 2001). A pound of nitrogen reduced in one section of the watershed may be equivalent to a partial pound of nitrogen reduced in another. Trading ratios are considered critical in order to equalize the relative value of a nitrogen credit among various sources (U.S. EPA, 1996).

The Chesapeake Bay Program promotes the use of trading to meet water quality standards and has developed guidelines for all Bay jurisdictions that choose to establish nutrient trading programs (U.S. EPA, 2001). The Chesapeake Bay Program's fundamental principles support coordination among states to accommodate trading consistent with Federal, state and local laws and regulations. The Chesapeake Bay trading program highlights the need to consider natural boundaries (major Bay tributaries) and not only sociopolitical boundaries. Nitrogen cycling does not respond to state boundaries.

Another way to deal with the problem is through the use of attenuation coefficients. The Chesapeake Bay Program Office has modeled the degree to which nitrogen in different parts of the watershed is denitrified as it moves along the tributaries to the bay. The results show that there are significant differences depending upon the time spent in travel. The same work has been dome by USGS for the Mississippi River Basin. These sorts of tools can be used to supplement trading ratios.

Valuing Nitrogen. *The value of nitrogen involves the conversion of a right derived from restoring, enhancing, or preserving an environmental asset into a marketable credit (EBX, 2001). In all cases, a credit must be defined as a unit of nitrogen (e.g., pound or concentration) or nitrogen management (e.g., acre of wetland, trees planted, distance of stream bank restored, etc.) that can be measured or quantified.*

Stephenson et al. (1998) point out that physical properties of nonpoint source (NPS) pollution do not offer the significant barrier to trading as is often presumed. Measuring NPS pollution has been done directly (monitoring concentration and flow) and indirectly (using simulation models and/or engineering performance specifications), allowing NPS dischargers to successfully participate in trading programs. The authors also argue that sensitivity to individual incentives can stimulate innovations in NPS measuring capabilities and NPS management performance assurance.

Common markets that have been identified that directly or indirectly affect nitrogen, include: watershed-based pollutant trading, SO_2 allowance trading, wetland mitigation banking, and greenhouse gas emission trading. Other unique markets have been or could be developed for nitrogen as well. Below is a list of other current markets that do or would likely have an impact on nitrogen cycling.

- Habitat mitigation banking (currently under pilot testing by EPA in California);
- Sediment trading, such as the Piasa Creek Project in Illinois (Great Rivers Land Trust, 2002);
- Marketing floodplain restoration to derive nitrate removal credits (TWI, 2001); and
- Poultry litter trading (Jones and D'Souza, 2001).

Evaluating existing and potential markets for nitrogen is the first step towards valuing nitrogen and understanding how multiple benefits derived from these various markets can be bundled or stacked.

Risk and Uncertainty. Certainly there are multiple risks and uncertainty associated with participating in nitrogen credit markets—as there are in any type of market. Some types of risk and uncertainty are obvious, such as weather and other ecosystem dynamics.

Farmers, the primary group of contributors to NPS pollution, are generally risk averse. This is due in part to the low rates of return (3 percent on average) expected by farmers. There are currently few regulatory incentives for most farmers to adopt best management practices. For example, lack of restrictions on fertilizer use results in over application of nitrogen in order to ensure that nitrogen does not limit crop production. Farmers know that nitrogen demand across their fields varies spatially, however, they are accustomed to applying nitrogen at a conventional rate across entire fields rather than variable rates based on existing soil nutrient concentrations.

According to the Agricultural Conservation Innovation Center (2002), farmers face three types of risk associated with adopting BMPs that may potentially generate nutrient credits for trade, including:

- Innovation Risk – Early adopters of the BMP are using a system that has not been tested in a wide variety of commercial farming conditions and therefore is not trusted;
- Test-Trust Risk – Basically, it is difficult to "bet the farm" on a procedure or practice, no matter how well established or proven it may be; and
- Operating Risk – Consider that farmers often over-apply manure and fertilizer in order to avoid losing nutrients in years of extreme, heavy rains. As a result, most years when above-normal rainfall does not occur, the excess manure and fertilizer doesn't get used and may affect receiving water bodies. For example, split application of nitrogen is not widely accepted because farmers run the risk of not being able to get into the field a second time to apply nitrogen in wet years.

Farmers would expect to receive a price for nitrogen credits that reflected these risks and the degree to which the individual faced them

One way to overcome farmers' BMP adoption risk is through the use of crop insurance. The Agricultural Conservation Innovation Center (ACIC) works with a variety of farm-related organizations to develop BMP risk insurance and crop insurance policies (2002). Example crop insurance policies they have helped to develop include: Legume and Manure Crediting, Performance Warranties, Corn Rootworm IPM Policy, Potato Late Blight Policy, Cold Soils No-Till Policy, and a Rainfall Policy. All of these types of insurance policies are discussed in further detail at the ACIC website (see references).

Another type of uncertainty is BMP or treatment effectiveness. For example, conventional tertiary treatment of wastewater to remove nitrate is expensive and typically not required by law. Dilution of nitrate-rich effluent in nitrate-poor water bodies has apparently solved the problem. Establishing wetlands for tertiary treatment of waste poses unquantifiable risk to wildlife and humans and generates concern regarding reliability, knowledge and understanding of the ecological processes, and containing effluent during high flow events.

Creating wetlands for nitrogen management may provide advantages that offset risk. For one thing, wetlands are significantly less expensive to construct than installing conventional tertiary treatment such as reverse osmosis. Nitrate reduction effectiveness may exceed conventional methods while improving water quality and biological integrity. There are consequences to cost-effectively reducing nitrate using wetlands that should be considered. For example, wastewater in Houghton, Michigan is effectively treated by pumping effluent into a series of holding ponds and ultimately a peatland wetland. As a result, a monoculture of cattails has grown in the wetland by taking competitive advantage of the elevated levels of nitrate. This result was not anticipated and to some is considered undesirable.

Risk and uncertainty may deter resource managers from implementing potentially cost effective nitrogen pollution controls. Market clearing prices would have to be above the perceived value of these risks for farmers to participate in the market. A market-based program would encourage ways to reduce risk. Multi-market trading may allow for a reallocation of risk based on the development of new technologies, nitrogen management practices, and additional parties willing to take on liability.

Conclusions

Multi marketing of nutrient credits and environmental services is possible and may adequately address cross-media, cross-regulatory, and cross-boundary concerns regarding improving environmental quality cost effectively. The case for nitrogen demonstrates the some of the complexity, dynamics, and barriers facing successful implementation of a multi market trading program for a particular environmental bad actor. Clearly, high levels of nitrogen in one media or location have numerous ecological impacts throughout the environment. Understanding these relationships, where nitrogen is located and it's movement, are first steps towards developing multi markets for trading of nitrogen credits and/or environmental services. Valuing nitrogen and nitrogen management practices involves converting these derived "rights" into "credits." There remain certain levels of risk and uncertainty that should also be considered in the development of multi markets for nitrogen. Creating multi markets takes awareness of the stackable values derived from cost differential means to manage nitrogen.

References

Agricultural Conservation Innovation Center. 2002. “Promoting conservation innovation through crop insurance.” Available online at www.agconserv.com/promote.html.

Alexander, Richard B. et al. 1995."Regional Transport of Point and Nonpoint-Source Nitrogen to the Gulf of Mexico," prepared for the First Gulf of Mexico Hypoxia Management Conference. Kenner, Louisiana.

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, D.R.G. Farrow. 1999. National Estuarine Eutrophication Assessment: A Summary of Conditions, Historical Trends, and Future Outlook. Special Projects Office in cooperation with National Centers for Coastal and Ocean Science, National Ocean Service, National Oceanic and Atmospheric Administration, Silver Spring, MD. ~50 pp. + Appendices A - D.

Dewar, H. and T. Horton. 2000. “Seeds of solution to nitrogen glut.” *The Baltimore Sun*. September 28.

East Coast Atmospheric Resource Alliance (ECARA). 1995. “Airsheds and watersheds: The role of atmospheric nitrogen deposition.” A report of the *Shared Resources Workshop*. October 11-12.

EBX. 2001. “Nutrient trading: A private perspective.” A presentation made by the Environmental Banc and Exchange, LLC at the EPA Watershed Trading Workshop. June.

Faeth, Paul. 2000. *Fertile Ground: The Potential of Nutrient Trading to Cost-Effectively Improve Water Quality*. World Resources Institute: Washington, D.C.

Faeth, Paul and Suzie Greenhalgh. 2000. *A Climate and Environmental Strategy for U.S. Agriculture*. Washington DC: World Resources Institute.

Faeth, Paul and Suzie Greenhalgh. (2001). Policy Synergies Between Nutrient Over-enrichment and Climate Change, *Estuaries* (in press).

Goolsby, Donald A. and William A. Battaglin. 1997. "Sources and Transport of Nitrogen in the Mississippi River Basin." Presented at the American Farm Bureau Federation Workshop, "From the Corn Belt to the Gulf… Agriculture and Hypoxia in the Mississippi River Watershed," St. Louis, Missouri.

Great Rivers Land Trust. 2002. *Piasa Creed Watershed Project.* Available online at www.greatriverslandtrust.org/articles.htm.

Hatfield, J. 2002. “Agriculture and water quality: A national perspective.” Available online at www.ctic.purdue.edu/KYW/Abtracts/Hatfield.html.

Jones, K. and G. D'Souza. 2001. "Trading poultry litter at the watershed level: a goal focusing application ." *Agricultural and Resource Economics Review* 301:1, 56-65.

Lal, R., J.M. Kimble, R.F. Follett, and C.V. Cole. 1998. *The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect*. Ann Arbor Press, Chelsea, Michigan.

National Research Council. 1993. Committee on Long-range Soil and Water Conservation, Board on Agriculture. *Soil and Water Quality: An Agenda for Agriculture*. Washington, DC: National Academy Press.

Rabalais. N. R.E Turner, D. Justic, Q. Dortch and W.J. Wiseman Jr. 1999. Characterization of Hypoxia: Topic 1 Report for the Integrated Assessment of Hypoxia in the Gulf of Mexico. NOAA Coastal Ocean Program Decision Analysis Series No. 15. NOAA Coastal Ocean Program, Silver Spring, Maryland.

Ribaudo, Marc, et al. 1998. "Nitrogen Sources and Gulf Hypoxia: Potential for Point-Nonpoint Trading," presented at the annual meeting of the American Agricultural Economics Association. Salt Lake City, UT. August,

Rocque, A. 2001. "Facilitating hypoxia control in Long Island Sound through a nitrogen credit exchange program." Connecticut Department of Environmental Protection, April.

Stephenson, K., P. Norris, and L. Shabman. 1998. "Watershed-based effluent trading: the nonpoint source challenge." *Contemporary Economic Policy* 16:4, 412-21.

TWI. 2001. *The Wetlands Initiative 2001 Annual Report*. Available at http://www.wetlands-initiative.org/pdf/ar2001.pdf. Last verified September 24, 2003.

USDA. 1997. *Agricultural Resources and Environmental Indicators, 1996-97*. Washington, DC: Economic Research Service, Natural Resources and Environment Division. Agricultural Handbook No. 712.

U.S. EPA. 1996. *Draft Framework for Watershed-Based Trading*. EPA 800-R-96-001. May.

U.S. EPA. 2000*. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1998.* Office of Policy, Washington, D.C.

U.S. EPA. 2001. *Nutrient Trading Fundamental Principles and Guidelines.* EPA 903-B-01-001. March.

Vitousek, P., J. Aber, R. Howarth, G. Likens, P. Matson, D. Schindler, W. Schlesinger, and G. Tilman. 2002. "Human alteration of the global nitrogen cycle: causes and consequences." *Issues in Ecology*. Available online at esa.sdsc.edu/tilman.htm.

Welte, M. 2001. "Farm officials blame 'dead zone' on nature." The Associated Press and Local Wire. December 10.

APPENDIX C.

Improving Water Quality by Capitalizing on Multiple Environmental Service Markets

Improving Water Quality by Capitalizing on Multiple Environmental Service Markets

(Initial Discussion Draft)

by
Environmental Financial Products LLC

There is a growing appreciation that the value of many of the "services" provided by healthy ecosystems, including all forms of aquatic systems, are not fully recognized in the existing marketplaces for goods and services. The conventional view is that this form of market failure results in less protection for ecosystems than is socially optimal, as it allows pollution and other degradation to occur without consideration of the loss of benefits to others. One conventional response to this problem is to rely on elected officials and government agencies to adopt and enforce regulations intended to protect ecosystems. Several decades of environmental regulation in the more advanced industrial economies has yielded major improvements on many environmental problems, but has also revealed the need for new and creative approaches. It is now widely agreed that use of flexible, market-based methods for achieving environmental protection and improvement offer a powerful tool for effectively advancing these goals. The emergence of various market-based environmental protection programs introduces the prospect of harnessing additional financial resources that can help simultaneously produce multiple forms of environmental improvement. The Chicago Climate Exchange (CCX), which is now being developed for launch in 2002, is being designed to explicitly incorporate and encourage projects that can mitigate greenhouse gases while simultaneously helping to improve water quality.

One of the most widely cited successes in market-based environmental protection initiatives is the U.S. sulfur dioxide (SO_2) emission allowance trading program. The program was established under the Clean Air Act Amendments of 1990, with the goal of cutting electric utility emissions of sulfur dioxide, the principal cause of acid rain. The program has been highly successful: emission cuts have exceeded the legal mandate, compliance has been 100%, and active trading in the allowance market has helped drive down compliance costs to levels far below most predictions. While the long-term human health benefits of the program are believed to be worth up to $40 billion, it is sometimes forgotten that a primary objective of the program is to improve water quality by reducing acidity in streams and lakes. This particular program is but one of many examples of the multi-media relationship that is characteristic of many pollutants. Due to evaporative processes, and precipitation-borne and dry deposition or air pollutants, a large number pollutants are transferred between the air and water bodies. The SO_2 program is an explicit attempt to improve aquatic ecosystems by reducing pollutants that are released into the air.

The opportunities for improving water quality through actions intended to reduce atmospheric concentrations of greenhouse gases (such as carbon dioxide) arise from some fortuitous environmental relationships. Many of the actions that can cut or capture greenhouse gases – actions which are expected to be stimulated through markets for greenhouse gas mitigation – can also make a significant contribution to enhanced water quality. This section reviews some of these new opportunities that can harnessed in the emerging markets for greenhouse gas mitigation.

The negative effects caused by the release of greenhouse gases (GHGs) are currently not priced. Consumers and businesses do not fully take account of such effects in their economic decision-making because there is no price on the use of the atmosphere. The goal of the CCX pilot greenhouse gas trading program is to establish the market for discovering the price for reducing emissions. The core steps are to limit overall consumption of the atmosphere (GHG emissions) and establish trading in instruments that allow participants to find the most cost-effective methods for staying within a target emission limit. The market price of those instruments will represent a value signal that should stimulate new and creative emission reduction strategies, technologies and land-use management practices. The emerging carbon credit markets represent a new source of financial resources that can aid efforts, such as conservation land-use management, that produce both greenhouse gas and water quality benefits.

Background: the emerging global market for GHG emission reductions

Emissions trading programs are emerging worldwide as a leading tool for addressing the threat of climate change. In the United Nations Framework Convention on Climate Change (FCCC), ratified by most of the nations of the world, industrialized countries agreed "to aim to reduce" greenhouse gas (GHG) emissions to 1990 levels by the year 2000. The Kyoto Protocol further specified emission limits for developed countries, prescribed three emissions trading mechanisms, and acknowledged the role of carbon sequestration or "sinks".

While the Kyoto Protocol provides a general framework for a global GHG emission reduction program, its entry-into-force is not essential to creating a global market for carbon emissions. Indeed, the market is emerging quite strongly in the absence of ratification. This "bottom up" approach is demonstrated by the numerous initiatives and activities that promote emissions trading and GHG reductions, even in the absence of compelling rules or regulations.

The UK, Denmark and Norway have plans to commence GHG emissions trading at various levels, and the European Union is planning for a comprehensive emissions trading market before 2005. Any U.S. program can be expected to rely heavily on emissions trading and carbon sequestration. Individual companies, such as British Petroleum and Royal Dutch Shell, have instituted internal trading programs. Several U.S., Canadian, European and Japanese companies including Suncor, Ontario Power, a group of US utilities, Peugeot, Sumitomo, among others have conducted pilot trades or made investments in sequestration or other offset projects. The private sector's response probably reflects the perception that GHG emission limitations of some sort will emerge and will drive fundamental changes in business activity.

If the Kyoto Protocol does not enter into force, another international framework will likely emerge to link the various initiatives that are emerging. For example, an international trading system might evolve based on domestic trading systems in the U.S., Canada and some other developed countries, or it might begin in the framework of the North American Free Trade Agreement. National or domestic trading systems could be connected through bilateral or "plurilateral"[2] trading agreements among nations. These systems can be expected to include crediting for GHG-reduction initiatives undertaken in developing countries.

[2] Plurilateral refers to small to mid-size groups of countries—for example, more than three but less than twenty.

Whatever the fate of the Kyoto Protocol, it is highly likely that the demand for GHG emission reductions will grow over time. Taking advance action to limit GHG emissions and to create value for these reductions by supporting the development of an emissions trading system makes good business sense.

Overview of the Chicago Climate Exchange

The Chicago Climate Exchange is the first voluntary, organized pilot greenhouse gas (GHG) emissions trading market in the United States. Participation will eventually include emission sources and offsets throughout North America. The design and implementation of the CCX is funded by the Joyce Foundation, a Chicago-based philanthropic foundation, through a grant to Northwestern University and Environmental Financial Products, LLC.

The goals of the CCX are to:

- Prove the concept of GHG emissions trading system that incorporates allowances and offsets generated in carbon sequestration and other projects in developed and developing countries.
- Discover a price of CO_2 reductions in a program with diverse participants and offsets.
- Develop the infrastructure, skills and standardization required for a successful GHG emissions market.
- Provide a predictable emission reduction schedule, phased-in over time.

To date, thirty-six companies and other entities have agreed to participate in the CCX market design phase, and to participate in trading if the final design is consistent with their strategic objectives. In addition to major industrial concerns such as Ford, DuPont, Cinergy, Alliant, Wisconsin Energy, and Midwest Generation, leading representatives of the agricultural, forestry and conservation sectors have agreed to participate. The latter, which include the Iowa Farm Bureau Federation, Agriliance, Growmark, International Paper, Mead and The Nature Conservancy, bring an important capability to execute land management improvements that can aid water quality.

Detailed description of the Chicago Climate Exchange

A guiding principle of the CCX is “start small and grow over time.” This applies in terms of both geography and the number of participants. Even on a relatively small scale, however, the CCX aims to be representative of the U.S. economy. It can provide a model program suitable for expansion to the entire U.S. economy.

Initially, the CCX will focus on a seven-state region in the Midwest, consisting of the states of Michigan, Minnesota, Indiana, Illinois, Iowa, Ohio and Wisconsin. This region includes approximately 20% of U.S. economic output (GDP), GHG emissions and population. Its economy is representative of the U.S., and hosts a diverse industrial base, auto manufacturing, electric power generation, refining and production of fossil fuels, agriculture and forestry.

Phase 1 participants will be companies with operations in the seven-state region, while companies within the U.S., Canada and Mexico will be eligible for participation in Phase 2. Participating companies must agree to quantify and report company-wide GHG emissions for a baseline year, currently proposed to be 1999. This will serve as the baseline emission level. The core parameters of the CCX will be finalized based on input from a Technical Committee with representation from participating companies. Ongoing advisory groups will help oversee rule modifications and operational decisions.

Participating companies will assume a voluntary emission target based on a proposed reduction schedule of 2% below the baseline in 2002 and 1% further reductions per year thereafter. During 2005, the last year currently planned for the pilot program, the proposed target is 5% below the baseline level. Allowances equal to the targeted emission level will be distributed every year, similar to the USEPA SO_2 emissions trading program. The CCX Registry will record actual emissions, track allowances, offsets, and trading activity. Standardized emissions monitoring and verification protocols and trade documentation will be employed. At year-end allowances equal to actual emissions will be relinquished. Companies that have emitted more tons of CO_2-equivalent emissions than the allowances they hold may purchase offsets or allowances to achieve compliance. Companies with excess allowances or owners of offsets may sell these.

Offsets from projects undertaken by non-participants, including a limited number of offsets generated in a developing country (Brazil), may also be registered. Certified offsets may be used for compliance. Allowable offset projects include forestry and soil carbon sinks, capture and destruction of landfill methane and coal bed methane and certain renewable energy projects.

The CCX will expand over several phases. Phase 1 is planned to become operational during the second half of 2002. Participants and offset projects will be limited to the seven-state Midwest region during this phase, except for credits generated in emission reduction or sequestration projects in Brazil. Phase 2 will begin in 2003. Participating companies and offset projects may be based anywhere in the U.S., Canada and Mexico. During Phase 3, commencing in 2004, the CCX will expand to include links with international markets.

The CCX is being designed to provide specific opportunities for generating greenhouse gas emission offsets through practices that can simultaneously enhance water quality. The next section discusses this important opportunity to attract financial resources into activities that provide multiple environmental benefits.

Interface Between Greenhouse Gas Mitigation Activities and Water Quality Improvements

Several types of greenhouse gas mitigation activities can have a direct positive impact on water quality. These practices, which include land-use and land management changes such as no-till farming and reduced fertilizer application, can help reduce soil erosion and chemical run-off into water bodies. The direct benefits are distinct from the contribution such efforts can make in the long-term effort to reduce greenhouse gas accumulations, which also has massive linkages to water quality.

Three categories of GHG mitigation projects that have potential to help improve water quality are being targeted for inclusion in the Chicago Climate Exchange. The activities, which have gained explicit recognition in the international negotiations to develop a coordinated response to the threat of climate change, are included in part because of the importance in demonstrating the feasibility of trading for specific projects. The three GHG mitigation project types that can help improve water quality are:

- capture and sequestration of atmospheric carbon through enhancement of carbon reservoirs – "sinks" in agricultural soils, grasslands and tree stands;
- reduced emissions of nitrous oxide (a high-potency greenhouse gas) realized through reduced application of nitrogen fertilizers;
- reduced emissions of methane through utilization of animal waste as an energy source.

Enhancement of soil carbon "sinks" can contribute to improved water quality by reducing soil erosion. Establishment of grasses and tree stands can also reduce the flow of soils and fertilizer run-off into water bodies. Greenhouse gas reduction credits for reduced nitrous oxide emissions (realized by cutting application of nitrogen fertilizer) can also represent an important method for cutting nutrient flows into water. The opportunity to obtain carbon credits through use of animal waste as an energy source offers one incentive for managing animal wastes in ways that reduce the risk of releases into water bodies.

The remainder of this chapter provides additional detail on the nature and mechanics of the opportunities to harness the opportunities in the emerging greenhouse gas mitigation markets in ways that provide direct benefits for water quality.