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Natural Resources Credit Trading Reference

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Foreword

This is an exciting time for all of us who are concerned about making measurable environmental improvements in the management of our Nation's sensitive ecosystems. USDA has long been a leader in implementing conservation on the ground in partnership with landowners. An extension of this leadership is the critical stewardship activities we accomplish daily through market based incentives. The *Natural Resources Credit Trading Reference* is a great resource to help us build our institutional knowledge and foster the creation of environmental market opportunities to accelerate private land conservation and integrate market based approaches into our suite of tools.

Valuing environmental services encourages conservation stewardship and supports innovative financing solutions for continued agricultural and forest production. One of my primary goals in this regard is to help build a more unified, transparent market system in which landowners, who are the sellers of ecosystem services, can actively participate in emerging environmental markets, and in which investors – as the buyers – can trust that they are purchasing a real conservation benefit.

The *Natural Resource Credit Trading Reference* is written for USDA field staff and our partners as a means to facilitate understanding market based conservation as an opportunity for landowners to receive additional financial returns on their working lands. These revenue streams will help cover the costs of owning and managing land, and provide new incentives for landowners to retain their holdings as productive, working land.

The 2008 Farm Bill included a new section in the Conservation Title called "Environmental Services Markets." In it, Congress expressed a broad vision for how America's landowners – farmers, forestland owners and ranchers – can participate in these new emerging markets for conservation on private lands. The *Natural Resource Credit Trading Reference* will help USDA field staff and our partners work with landowners to identify these new opportunities.

USDA will play a critical role in designing ways to overcome the many constraints facing the emergence of environmental markets. The new USDA Office of Environmental Markets (OEM) will lead the development of national standards and registries that will help instill confidence in these new markets, and the technical guidelines and science-based methods to assess environmental service benefits, which will help instill confidence in these new markets.

The Environmental Credit Trading Reference is a great introductory tool for us to build capacity and raise awareness as we continue in our leadership role developing the infrastructure for robust environmental markets. I encourage you to read this reference and share it with our partners. I look forward to working with you in expanding agriculture's role in solving some of our nation's most critical environmental issues through these new markets.

/s/

Dave White
Chief

Acknowledgments

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Executive Summary

Environmental credit trading programs are receiving considerable attention in agriculture. Such programs have been used successfully to improve environmental quality in other sectors, and they have the potential to harness market forces in a fundamentally new and innovative way to cost-effectively improve environmental quality in agriculture.

The purpose of the NRCS Natural Resource Credit Trading Reference is to provide an understanding of how environmental credit trading can be used to increase the provision of conservation and ecosystem services by agriculture. To do this, the reference defines key terms, explains the benefits of credit-trading in general, and the role credit trading can play delivering real environmental performance at a reasonable costs to producers and the public. It characterizes the most important features for the formation of efficient and effective credit markets, and outlines the major challenges to making environmental credit markets work effectively in agriculture. It discusses these factors as they apply specifically to four important types of potential and existing environmental credit markets: water quality, carbon, wetlands, and wildlife habitat.

Environmental credit trading (ECT) is a general term that refers to a range of market-like transactions where an entity undertakes an activity that provides environmental benefits in exchange for payment from another. ECT does not necessarily need the participation of a public entity, and it can (and does) occur between private parties, such as a farmer and an industrial pollution discharger. However, it can only be effective in improving the environment if there is some firm requirement for environmental improvement (a cap or a standard). Such a requirement is generally the result of government regulation. This is one of the reasons why it is best to think of ECT as complementary to rather than as a substitute for other policy mechanisms, such as regulation. ECT works by adding flexibility and cost-effectiveness in achieving the desired level of environmental performance embodied in the other policy mechanisms.

Generally, markets are a good way for society to decide what and how much to produce and consume. We all - consumers and producers - enjoy the returns from a market system. Market forces provide strong motivation for firms to provide the many goods and services desired by consumers at low cost. Markets in general, though, do not provide incentives for the production of environmental goods and ecosystem services even though many people value them highly. This is because it is difficult for providers of environmental goods to earn a profit on them. This happens in part because many environmental goods can be enjoyed by everyone whether they paid for them or not. Air quality is an example of a public good—a good that once provided can be enjoyed by many people, including those that did not help pay for it. Another reason is that it is difficult for farmers to absorb the costs of reducing the offsite environmental effects of their activities (their externalities) and remain profitable in very competitive markets for crops and livestock. ECT, by creating a price for credits provides a way for farmers to receive compensation for the costs they incur when they undertake socially beneficial and valuable activities which improve environmental quality. By creating a price, ECT also spurs long term technological improvement, since innovations that allow for cheaper, more effective ways to enhance environmental performance can get rewarded in the marketplace. Other approaches commonly used in conjunction with ECT are regulation, historically used to deal with environmental problems created by the production of a commodity, and conservation technical assistance programs, which help farmers and ranchers with a variety of decisions regarding conservation and land use decisions.

However, several conditions must be met for environmental markets to achieve cost-effective results. These conditions include having buyers and sellers willing to participate in the market with no single buyer or seller having too much influence over how prices are set. Without willing buyers and sellers no market can form. If a buyer or seller has too much influence, they can use it to affect the price they pay or receive, ultimately leading to less of the product being produced or consumed than would occur otherwise. One important way this can be prevented is ensuring that those who want to enter the market are not prevented from doing so. Another condition is that the ownership of the environmental goods being bought and sold must be clear. In the case of environmental goods, ownership is not always readily apparent, and may require legislation or a court ruling to be determined. This issue is linked to the condition that there must be agreement by both buyer and seller on the commodity being traded. Finally, efficient markets require two conditions linked to information. The first is that prices must be broadly known and the second is that the cost of participating in the market, the transactions costs—finding a buyer or a seller and agreeing to a deal—must be low. All these conditions when met help ensure that the best, most cost-effective trades take place.

Another important feature of a market is the manner in which the transactions take place, referred to here as the "market mechanism." There are three common mechanisms under which most credit trades occur: exchanges, direct trading between two entities, and clearinghouses which negotiate separately with buyers and sellers. In some credit markets, more than one mechanism may be used simultaneously. For example, clearinghouses can negotiate separately with sellers and then participate in exchanges in order to find buyers.

To be effectively applied in agriculture, credit trading programs will have to overcome several challenges. This includes the difficulty of measuring and monitoring the environmental good being produced. This can be a thorny issue because it makes it difficult to distinguish the contribution of a specific market participant to the provision of the environmental good. To get around this problem, proxies for the actual environmental good are often used. In agriculture, conservation practices applied are often used as proxies for measured reductions in soil erosion and nutrients. Using practice based proxies create their own additional challenge –that of accounting for the variation in the effectiveness of the same practice in delivering the desired environmental outcomes from the same practice over space and time.

A third challenge is related to enforcement and the establishment of contract liability, since the environmental service may be provided over a period of time or only after a period of time has elapsed. Specific provisions must be included in the agreements to ensure clear responsibility and liability rules. Another difficulty is the establishment of a baseline of environmental goods, that is, the starting level of environmental performance beyond which environmental credits can accrue, and the time at which such activities were undertaken. Asking for a basic minimum performance level might have the effect of making a credit trading program more difficult to initiate, raising the price of the credits since each credit is effectively more valuable than if a credit were earned on all improvements. Conversely, rewarding early adopters drives down the price of credits. A fifth challenge is leakage, that is, the possible changes in amount of the environmental goods produced elsewhere, perhaps outside of the trading region resulting market adjustments to the provision of credits. If significant leakage occurs, the gains from the environmental trading program will be offset by worsening of the environment elsewhere.

Another set of difficulties occurs when producers can pool returns from more than one program for the same environmental gain. This situation can occur because there are many agricultural programs that support conservation at the Federal and State level. The decision to allow or not allow pooling may have serious consequences for the cost effectiveness of credit trading programs. On the one hand, pooling by increasing the amount received for a credit may increase trading activity in existing markets and induce adoption of more environmentally friendly technologies throughout the sector. On the other hand it makes the cost of credits appear cheaper to the user of the credit than it really is. This represents a particular concern when one of the sources of payment for the credit, such as the government, is not going to take ownership of its share of the credit, but allow the other purchasers of the credit to use it. In this case, the payment can create the situation where credits are used to comply with regulations even they do not represent the cheaper way to comply with the regulations, defeating the ultimate purpose for establishing a credit trading market in the first place. If the purpose of the payment is for something broader, like sustainability or good stewardship, or for other attributes then the impact of pooling on the efficiency of credit trading programs is less clear.

A final difficulty in setting up ECT relates to the existence of high transaction costs. Since ECT is a new venture, associated with some uncertainty, there are learning costs. Many agricultural producers will be hesitant to commit themselves to actions for which they do not fully understand the ramifications for their operations and their liability, and it may be difficult to find interested buyers. Any market transaction requires effort and, especially when markets are newly developing, the costs of learning and searching out potential trading partners can slow the development of efficient markets. Some of the transaction costs can be reduced via the use of aggregators, that is, individuals or group that collects credits from a large number of sources and sells those credits to a large number of buyers. The aggregator may purchase and sell credits on its own behalf or on behalf of a nongovernmental organization, private group, or individual.

The shape of credit trading programs and the issues that need to be addressed in order for agriculture to participate will depend on the type of environmental issue being addressed. Four types of environmental issues to which agriculture could contribute or participate are water quality, air quality, wetlands mitigation and wildlife habitat.

Water quality trading. Many water quality trading programs already exist in the U.S. While many support trading only between emitters whose pollution can be easily identified like point sources, which are often permitted, many more support trading between point sources and non-point sources, such as agriculture land. Most of the existing ECT programs for water quality have been spurred by State regulations or by the implementation of a total maximum daily load (TMDL) for an impaired water body. This is because the Federal government forbids point sources from using credits to meet the much more widely applicable technology-based effluent limits (TBEL), requiring them instead to meet their TBEL by using approved technologies.

One of the major challenges to the establishment of a cost effective trading program is determining how much of a reduction in pollution achieved by a farmer or rancher can be used to offset pollution from a point source. These are commonly referred to as trading ratios. Trading ratios for agriculture in credit trading programs may not equal one because of the natural reduction of the pollutant contained in water at it moves down the stream. This means that a reduction in pollutant upstream is not equivalent to a reduction in pollutant downstream. Another reason – again specific to water - for not setting the trading ratios at one-to-one is to account for differences in the effect different forms of a pollutant have on water quality. Uncertainty about the actual amount of pollution reduction achieved performed by credit sellers is another reason, as are adjustments for cost-share received by the non point sources, which artificially reduces (distorts) the cost of improving water quality.

The focus of most water quality trading programs is on the control of nutrients, particularly phosphorus and nitrogen, but they can be used to cover a wide variety of pollutants and effluents. Other pollutants covered under trading programs include selenium, mercury, heavy metals, sediment, suspended solids, and biological oxygen demand (BOD). In addition, instream flow and temperature have also been stipulated as tradable commodities. It is important to realize that not all pollutants are appropriate for trading. The EPA indicates that the trading of pollutants that "exert acute effects over small areas and in relatively low concentrations" would not be suitable for trading. This includes persistent bioaccumulative toxics for which EPA maintains a list at *http://www.epa.gov/pbt/index.htm*.

Carbon trading. The reduction of carbon dioxide and other GHG concentrations in the atmosphere can be achieved by reducing emissions, or by sequestering carbon in soils, above ground biomass and the oceans. Agriculture and forestry can sequester carbon by storing it in agricultural soils or in plants themselves, such as trees or perennials. Carbon can be sequestered in agricultural soils through changes in management practices such as the adoption of conservation tillage or through land use changes, such as switching from annual plants to perennial crops. The potential for agricultural sources to earn credits for sequestering carbon and then selling them to firms that generate carbon emissions through energy use or other actions represents an important way for agricultural producers to participate in carbon trading programs. In carbon trading, the buyers are likely to be energy firms and industrial producers using significant energy resources. These firms will only demand carbon credits to offset their emissions if they face a limit on how much carbon they will be allowed to emit and then allowed to meet that limit either by reducing their GHG emissions internally or by purchasing offsets from another source, in a cap-and-trade approach. While a cap and trade program does not exist at present, there are proposals for national programs and regional trading programs. There may be significant opportunities for agricultural sources to participate in these markets, particularly as they become more established. An important issue in carbon trading is the impermanence of carbon sequestered in soil or biomass. While reducing emissions will permanently reduce the amount of carbon dioxide in the atmosphere carbon sequestered in biomass can still be lost to the atmosphere by burning, and carbon sequestered in soils from the adoption of low or no-till methods can be lost by re-tilling the soil. This may require that credits given for carbon sequestering activities have a trading ratio lower than one. Alternatively, a credit could be earned only if the supplier guarantees that the carbon stored is permanent. If it is released, an equivalent amount of carbon must then be sequestered by other means, or credits purchased. A third option is to have contracts where the payment is placed in an annuity account whereby the credit seller receives the interest annually as long as the carbon remains sequestered.

Wetland trading. There are two main drivers to wetland trading (banking). The first is Section 404 of the Clean Water Act (CWA), which mandates that the U.S. Army Corps of Engineers (USACE) issue a permit that requires the restoration or creation of wetlands to offset the wetlands that will be destroyed. This can be achieved either by the permit holder undertaking the restoration directly or by contracting with others to restore or create an equivalent amount of wetland acreage or services or both. The second driver is the Swampbuster provision of the Farm Bill, which mandates that farmers obtain valid wetland offsets for any wetland acreage they begin to farm in order to retain eligibility for agricultural program payments. Producers that require wetland offsets are potential buyers of wetland credits. These drivers along with the national goal of “no net loss” of wetlands effectively impose a cap on wetland loss. Wetland banks represent the main market mechanism for providing wetland offsets in both situations. Wetland banks restore, create or enhance wetlands to be used to compensate for unavoidable wetland losses in advance of farming or development, when such compensation cannot be achieved at the development site or would not be as environmentally beneficial. The main issue related to wetland banking is what metric to use in to determining the number of credits generated by its restoration or creation of a wetland. Ideally, an offset wetland should provide the same set of ecosystem services and functions as the one that is lost, so it is generally preferable to have credits defined in terms of wetland functioning. A simpler approach for assigning credits to wetland banks is the most common and is based simply on the size of the wetland. This approach assumes that one acre of wetland established in the wetland bank provides the same amount of wetland functioning or value or both as the original wetland.

Habitat Credit Trading. Traditionally, market-based approaches have not been seen as a major tool for species conservation efforts. Habitat credit trading, which allows the conservation of habitat in one location to offset or trade for the loss of habitat elsewhere, is emerging as a novel approach. These credit programs are being spurred by provisions of the Endangered Species Act, which directs Federal agencies to ensure that listed species are not jeopardized and their critical habitat is not affected. This requirement has the potential to act as an effective cap for the establishment of a credit trading program. The potential buyers of conservation credits are firms or government entities wishing to develop land for commercial or residential use or alter land use in ways that will adversely affect threatened or endangered species. One major source of supply of conservation credits is via conservation banks, which permanently preserve and manage lands to mitigate the loss of listed species and their habitats at some other location. As in the case of wetlands, no single criterion for determining the amount of credits to provide for a given amount of habitat is likely to work in all cases. Criteria may include quantity, quality, species covered, conservation benefits and available or prospective resource values. Ideally, habitat that is used to mitigate lost habitat for an endangered species should provide the same, or superior, set of ecosystem services and functions and should support all of the same species as the mitigated site. In practice, credits have typically been assigned based on the amount of acreage of appropriate habitat and the presence of a nest site or family group of the species of interest.

Chapter 1 Introduction

Many people engaged in conservation have heard the excited claims made by advocates of **market-based incentives** and **credit trading programs** and the fearful criticisms made by skeptics. Advocates point to their potential to harness market forces in a fundamentally new and innovative way to improve environmental quality cost-effectively, while skeptics point to their potential to be ineffective and act as smokescreens that ultimately generate little actual environmental improvement (box 1). The purpose of this reference is to help separate the unsubstantiated claims from the actual situation in this sometimes contentious discussion and to help the reader to understand the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service's (NRCS) likely role in these programs.

Once the reader has reviewed this reference, he or she should understand what environmental credit markets can do, what they cannot do, and what role credit markets can play in delivering real environmental gains at reasonable costs to producers and the public. The reader should understand the necessary components of environmental credit markets that must be put in place before such gains can be obtained and the major challenges to making environmental credit markets work efficiently in the agricultural sector. The reader also should understand why environmental credit markets can, when implemented properly, be a valuable component in the overall toolkit for improving environmental performance of agriculture and industry. Finally, the reader should understand why, even after all the efficiencies of the market-based methods are employed, environmental quality gains will not be achieved easily or cheaply in many segments of agriculture and why credit markets are likely to be only one component of the needed set of environmental policies in agriculture.

In this introductory chapter, some key terms are defined and some overall questions concerning the basis and role for environmental credit trading are answered. The basics of environmental credit trading and market-based approaches are discussed in chapters 2 through 4. The remaining chapters discuss issues related to specific areas of environmental credit trading. These areas include water quality credit trading, carbon credit trading, wetland banking, and wildlife habitat or conservation banking. There are some terms related to credit trading that are used in the reference that may not be known by all readers. When such a term is first introduced, it will appear in bold typeface and it will usually be accompanied by a definition. These definitions are also included in the glossary.

What is environmental credit trading?

Environmental credit trading is a general term that refers to a range of market-like transactions where an entity undertakes an activity that provides environmental benefits in exchange for payment from another. For example, an agricultural producer who constructs a buffer around his corn field could be credited with generating water quality improvements. If a water treatment plant located in the same watershed as the farm field is allowed to meet its regulatory obligations by purchasing water quality improvements from an upstream farmer, then the treatment plant might find it cheaper to pay the farmer for his credits than to install onsite treatment technologies. This is an example of one type of environmental credit trading approach, sometimes referred to as **base-line-and-credit** trading, where the credit for environmental improvement is from a firm that is not otherwise required to meet environmental performance improvements, but the buyer of the credit (the municipal treatment plant in this case) is required to make improvements or contract for them from the outside.

There are many examples of baseline-and-credit trading programs, such as in water quality trading markets in which municipal waste treatment plants are the primary buyers and agricultural producers are the primary sellers. These markets will be the topic described in chapter 5 dealing with water credit trading. An example from the international area involves the Clean Development Mechanism (CDM) of the Kyoto Protocol. In the CDM, firms located in countries that have signed off on the Kyoto Protocol can meet their emission reduction obligations by reducing their emissions or buying emission reduction credits domestically or from sources in countries that are outside of the Kyoto Protocol and therefore not subject to the requirements of the treaty.

Another commonly described credit trading approach is a **cap-and-trade** program where both the buyer and seller of credits are under an obligation to improve their environmental performance. An example of this form of credit trading is the sulfur dioxide (SO_2) trading program that allows certain sulfur dioxide emitters to meet statutory requirements of reduced emissions either by reducing emissions from their own factories or by purchasing additional reductions from other companies whose factories have reduced their emissions below their individual requirement or allowance.

While there are other forms of environmental credit trading and other definitions, for the task at hand, it is sufficient to consider credit trading as a mechanism that allows firms that have undertaken environmental improvements to exchange them for payment by another private entity, either a firm subject to environmental restrictions or a nonprofit entity interested in improving environmental performance.[1]

Why is there so much interest in trading?

Many policymakers and environmental advocates have come to the realization that achieving further gains in environmental improvement through direct regulation will be increasingly costly. This has led them to look for new tools to reduce the costs of further environmental improvements.

Economists and others have long understood that markets can be very powerful in providing goods and services at the lowest costs possible. The challenge in harnessing market forces to work in favor of environmental provision is to establish the necessary components for the market to develop.

In short, credit trading has the potential to lower the cost of reducing pollution to the point that policy makers and society are more comfortable requiring greater environmental improvement than they would

[1] In some cases, these third parties may purchase the credits to reduce the supply of credits available to firms subject to environmental restrictions. Their purpose for doing this is to raise the price of offsite credits to spur greater implementation of onsite treatment or abatement.

if the costs of obtaining those improvements were higher. Since environmental credit markets can often be developed to complement existing approaches and since they focus on providing environmental gains at low cost, it is hoped that if these markets can be developed then it will be possible to achieve further environmental gains.

Who should read this reference?

This reference was developed with NRCS employees in mind, but there is a wide range of conservation specialists for whom this information can be beneficial including employees of Conservation Districts, Resource Conservation and Development organizations, various technical service providers, as well as members of watershed conservation groups, the environmental community, and a host of other individuals interested in understanding market-based approaches for improving environmental performance in agriculture.

What kinds of trading does this reference cover?

While the focus of this reference is on environmental credit trading markets that are of the cap-and-trade or baseline-and-credit variety, the reference also covers a variety of topics that are relevant for other market-based approaches. For example, many of the same issues that must be addressed to make a credit trading program work must also be addressed by green labeling or certification programs for them to prove an effective means of improving the environment. While such programs are not covered in depth in this reference, by learning about the necessary components of an effective trading program, the reader will gain knowledge that will help in understanding these other market-based approaches.

How does trading integrate with the agricultural conservation programs?

Many conservation programs are funded by Federal and State budgets, as well as by initiatives undertaken by nonprofit organizations. Credits can be generated by activities and practices undertaken in conjunction with these programs, but the degree to which credits from these previously funded practices will be allowed to be utilized in credit trading programs will vary by the rules of the conservation and trading programs involved. Major issues of concern will be:

- Who owns the credits—the farmer/rancher or the conservation agency or nonprofit organization
- Whether the activities or practices represent a gain within the context of the credit trading program
- Whether the total cost of the credits (i.e., the financial assistance provided through the conservation program plus the price of the credit) is greater or less than the cost of the alternatives for achieving the reductions represented by the credits

Greater description of these issues can be found in the chapters related to specific credit trading areas such as water quality and carbon trading.

Is trading a substitute for other environmental programs?

Environmental credit trading is a tool that can be used to support efforts that improve the environment by making those efforts less costly than they would be otherwise. But, environmental credit trading can only be effective in improving the environment if there is some firm requirement for environmental improvement (a cap or a standard) that needs to be met. This cap or standard will generally be provided through government regulation; although, a strong demand from the nonprofit sector could provide this, as well. Without a cap or a standard in place, credit trading alone will generally be inadequate to induce enough environmental change to meet society's goals for clean air and water, improved wildlife habitat, and the provision of other ecosystem services. Instead of considering these approaches as a standalone solution, it is best to think of them as approaches that smooth the way for environmental gains by providing more flexible solutions and allowing market forces to identify the least costly ways to achieve gains.

Box 1: Why do opinions differ so strongly about whether credit trading is a good idea?

Whether an environmental credit trading program is viewed as good policy often depends on the desired goals of the person making the assessment. Most environmental economists view an environmental credit trading program as a "success" if, after it has been in place for an adequate period of time, the overall costs of meeting an environmental objective are lower than they would be without the trading program. It is important to emphasize that not only must the costs be lower, but also the quality of the environment must still meet the goals of the program. Reduced cost at the expense of the environment would be a failure. However, for someone who does not view cost savings as a legitimate or important goal, this means that credit trading programs hold little appeal. If a program that merely "lowers cost" without improving the environment is not viewed as valuable, then credit trading may seem to be nothing more than a smoke and mirrors trick. In fact, environmental credit trading programs are often adopted at the same time as the development or tightening of an environmental standard. This makes a lot of sense as environmental improvements can be quite costly and credit trading can reduce the resistance to the tougher standard by helping to reduce the costs of meeting it. Credit trading programs can support improved environmental quality by allowing society to achieve higher standards at less overall cost.

Chapter 2 Credit Trading Basics: What's So Great About Markets?

Introduction

Market forces provide strong motivation for firms and industry to provide the many goods and services that citizens desire at low cost. Consider the far-ranging choices consumers have when purchasing a new pair of athletic shoes: low cost options in an elaborate range of styles and colors available at discount and outlet stores, an equally elaborate array of somewhat higher priced and possibly longer lasting shoes designed for specific sports found at sporting goods and department stores, or expensive top-of-the-line shoes sold at specialty sports shops. In the case of athletic shoes, market forces allow shoe makers to profit from producing shoes that satisfy the preferences of the many classes of consumers with very disparate tastes and incomes. Consumers and producers both enjoy the returns from a market system. All purchases are voluntary implying that each participant must be more satisfied by buying or selling the product than not doing so.

While market forces can work very well for a large category of goods, there are others, like **environmental goods** and **ecosystem services**, for which markets do not provide an incentive for their production. In fact, in many cases, market forces have led to the degradation of the environment. So, why are market-based approaches to providing environmental goods receiving so much attention and being touted as a useful way to provide these very services? The answer is that while a free, uncontrolled market cannot generally be relied upon to protect and enhance the environment; there are cases when actions by the government or nongovernmental entities can correct the shortcomings with markets that cause the underlying problems. If so, then the power of the market can be employed to provide environmental goods.

It is important to understand, however, that the power of markets can only be harnessed in this way under the right set of conditions and that to generate this set of conditions, there will often need to be government involvement. In the next section, the reasons for this are discussed in more detail.

Why don't markets for environmental goods occur naturally?

Athletic shoes and environmental goods, like improved air quality, differ in several important respects that make competitive markets very good at satisfying consumer preferences for shoes, but not very good at satisfying consumer preferences for environmental goods. First, when a company decides to make and sell a new brand of shoes, it can profit from the sale of each pair: a consumer cannot wear a pair of shoes that he has not purchased. In contrast, if an agricultural producer decides to produce improved air quality, in the absence of a government payment program, there is no way for the producers to get paid for producing that good. This situation occurs in part because environmental goods, such as improved air quality, can be enjoyed by everyone whether they paid for it or not. In economic terms, air quality is an example of a **public good—**a good that once provided can be enjoyed by many people, including those that did not help pay for it. Note that agricultural commodities are like athletic shoes. When a producer decides to grow and sell corn, he or she anticipates that there will be willing buyers for the product so that he or she can profit appropriately from resources invested in producing it. Agricultural commodities, like shoes, are examples of **private goods—**goods that when purchased by an individual are enjoyed primarily by that individual.

There are some cases in which individual producers can collect the returns from their investments in environmental goods production. One example is the provision of hunting habitat by landowners via the establishment of hunting clubs or payment for access to hunt on private lands. In this situation, landowners, by taking advantage of their property rights, can exclude those who do not pay them for using the habitat (hunting or fishing) from receiving the benefits. However, in cases in which there is no low-cost way to exclude those who do not pay for the environmental good from enjoying its benefits, there is little reason to believe that private markets will generate sufficient incentives to produce an adequate level of environmental goods.

The inability of agricultural producers to collect profits by providing environmental goods is one reason why unfettered market forces cannot be expected to provide an adequate amount of environmental goods. To further complicate matters, there is a second problem that often arises in agricultural markets (as well as in markets for many industrial goods) that tends to encourage market participants to degrade the environment. This is not done intentionally or with malice, but is simply an outcome of individual producers doing their best to maximize their net returns.

Agriculture markets, like markets for many other goods, are highly competitive, meaning that an individual agricultural producer must compete with many other producers to get the best price possible for his or her product at harvest time. In the course of using land to produce agricultural commodities, there can be offsite environmental consequences. For example, row crop agriculture in the central United States is dependent on fertilization to produce high yields. While much of the fertilizer is used by the plants, some of it may leave the soil and end up in the nations' rivers and waterways causing environmental problems associated with over nourishment of plant life that in turn can reduce water quality and adversely affect the ecosystem. Soil erosion is another example of an offsite problem that can be a by-product of agricultural production.

These offsite effects, or **externalities**, can be difficult for individual producers to avoid and still remain profitable in a competitive market. Why? Because if a producer were to decide to undertake the expense of building a conservation buffer or employing a more costly, but more environmentally friendly agricultural practice, his or her costs would be higher than the rest of his or her competitors. These competitors would then be able to sell their product at a lower price preventing our environmentally conscious producer from charging a price high enough to cover the added costs of installing and maintaining the buffer or other conservation practice. Thus, an individual producer cannot be expected to undertake costly conservation practices to avoid offsite effects on his or her own.

How would environmental credit trading work?

By now, the reader should understand that there are characteristics of environmental goods which make adequate provision of them by free and unfettered market forces problematic. However, many people highly value environmental goods and policy makers—in and outside of government—are looking at credit trading programs as a way to address the problems that make the provision of environmental goods through markets problematic.

As a simple example, imagine that the land in a watershed is heavily used to produce agricultural crops and that the crops are fertilized with nitrogen-based fertilizer according to recommendations. Despite the careful application of fertilizer, there may be significant loss of fertilizer from leaching into ground water or runoff into the local waterways. Suppose further that there is a drinking water treatment plant located near the outlet of the watershed and that it must treat water with an expensive process to denitrify it when the nitrate concentrations are above the regulatory standard of 10 parts per million (ppm). Also, suppose that if crop producers were to stop fertilizing their crops in the fall and commit to undertaking all of their fertilization in the spring, this would cause nitrate concentrations to fall be well below the standard in most years. However, undertaking all of their fertilization in the spring will cost crop producers more than fertilizing in the fall.

Since it costs producers time and effort to change from the more convenient fertilization time (fall) to spring, they have no incentive to make the change on their own. However, consider a situation that allows the operators of the drinking water plant to contract with the upstream crop producers to make this change in return for regular payments. These payments would provide them the incentive they need to switch from fall to spring fertilization. This set of conditions could set in motion the formation of a market for environmental credits. Crop producers who made the switch in fertilization practices could receive an environmental credit for the change which they could then sell to the drinking water treatment plant. If the treatment plant could acquire enough such credits it could avoid the cost of running the denitrifying process.

There are many details that would have to be worked out for such an exchange to work well. There would need to be assurances by the crop producers that they would continue to fertilize only in the spring and at the agreed upon fertilization levels (this suggests a role for an independent entity to certify that all parties are following the agreement). Also, there would also have to be agreement to handle contingencies such as unfavorable climatic conditions such as hot or wet conditions that cause the nitrogen standards to be violated despite the change to spring fertilization or the substitution of crops with significantly different nutrient requirements, or residuals, into the rotation to accommodate market or weather circumstances.

What would be the gains from this credit trading arrangement? An initial conclusion might be that there are few gains. If the credits had not been produced by the crop producers, the treatment plant would simply have run its denitrification process and the drinking water standard would have been met. But there are other sources of gains. First, the treatment plant would only be willing to participate in this exchange if the cost of obtaining the necessary credits was less than the cost of running the treatment plant so there would be cost savings in attaining the desired environmental outcome. Secondly, while an important reason for reducing nitrate concentrations in the water has to do with meeting drinking water standards, reduced nitrates would also likely improve local ground or surface water quality throughout the watershed, implying net environmental gains from credit trading. Thirdly, the credit trading arrangement could spur greater technological innovation than could be spurred by only permitting the regulatory standard to be met by treating water with the denitrification process. Under trading both crop producers and the developers of treatment plant equipment will attempt through innovation to reduce the costs of their services.

Credit trading and standard approaches for providing environmental goods

State, Federal, and some local governments have used a variety of approaches to overcome the problems preventing markets from providing environmental goods. Many of these approaches work well on their own, but in some cases, credit trading can be used in conjunction with them to improve their performance. In some cases, nongovernmental entities are developing or have developed voluntary programs with a credit trading component. Following are examples of these approaches and how credit trading can be used in conjunction with them.

Regulation

One historically common approach to dealing with environmental problems created by the production of a commodity is regulation. Many industrial sources of pollution are regulated directly. For example, placing limits on the amount of industrial waste water that can be released into open rivers and streams is a common way to regulate water quality and its degradation from industrial point sources. Other forms of regulation prescribe the type of technology that can be used to produce a product or prescribe the type of pollution control device a product must have when sold. An example of the latter form of regulation is the requirement that car manufacturers install catalytic converters.

Regulations that take the form of a limit on how much pollutant can be generated and introduced into the environment, and do not specify how that can be done, lend themselves to credit trading. The regulation, by limiting emissions, provides the basis for generating a demand for credits. However, while such a regulation can be an important component in establishing a credit trading program, there are many other requirements and conditions that need to be in place before an effective trading program can emerge. These issues are discussed more completely in Chapter 3.

A number of successful environmental credit trading programs have been implemented in the United States, mostly spurred on by some form of regulation. Chief among these success stories is the sulfur dioxide trading program initiated under the 1990 Clean Air Act Amendments which limited the amount of sulfur dioxide that electricity generating power plants emit. To make the limitations less costly, firms were allowed to trade environmental credits within a cap-and-trade scheme. If a firm more than met its emissions limit, it was credited with emission improvements that could be sold to another firm that emitted more than its limit. In this way, the total amount of emissions was capped, but different firms were allowed to produce more or less of the emission reductions depending on their cost of doing so.

Another example (a baseline-and-credit scheme that will be described at length in chapter 5) is the point and nonpoint water quality trading programs being developed and implemented in a number of States and watersheds. While the **point sources** of emissions in water quality trading programs are often subject to limits on the amount of wastewater or effluent they can put into a waterway, **nonpoint sources** such as agricultural farms and urban runoff, are not subject to limits. Nonetheless, in point/nonpoint trading programs, point sources may be allowed to contract with nonpoint sources, such as agricultural producers, to change their land use practices. Actual (or estimated) improvements in water quality from these nonpoint source actions are then credited towards the required emission reductions of the point sources. In theory, the fact that the sources that are governed by a cap (the point sources in the water quality example) are allowed to trade with those that are not (the agricultural nonpoint sources) does not represent a problem. As long as the total amount of effluent entering the water is controlled to the desired level in the desired locations, it makes no difference which source is reducing its effluent the most.

Financial assistance programs

There are many State and Federal **cost-share programs** that provide financial assistance to agricultural producers for their conservation actions on working and nonworking lands. The NRCS' major working lands programs include the Environmental Quality Incentive Program (EQIP), which pays some share of the costs of **adopting** and implementing conservation practices, and the Conservation Stewardship Program (CSP). CSP differs slightly from EQIP in that CSP provides enhancement payments (sometimes called **green payments**) to agricultural producers meeting exceptional land stewardship standards. There is also a slate of programs that cover the cost of removing land from active agricultural production entirely. The largest of these programs includes the Conservation Reserve Program (CRP), administrated by the Farm Service Agency (FSA), and a host of NRCS programs such as the Wetlands Reserve Program (WRP).

By paying directly for all or a share of the costs of conservation practices, these approaches are market-like in the sense that a financial incentive is offered. Agricultural producers then choose whether or not to "sell" conservation practices. However, there are some important differences between these programs and a typical market. First, in these programs the government is typically the only buyer. Second, the government typically provides a great deal of guidance concerning which conservation practices are eligible for payment. Nonetheless, by offering to pay someone to provide the conservation practice, these government programs are market-like in that they affect behavior voluntarily.

As a result, both the government and the agriculture producer gain. Depending on how these programs are structured, they can also make use of market mechanisms, like auctions, to induce providers of conservation practices to offer these practices at the lowest price they are willing to take (typically what it costs them to provide the practices).

Environmental credit trading programs could potentially complement these financial assistance programs. If an agricultural producer participates in a financial assistance program and adopts one or more conservation practices and is allowed to "own" those credits (rather than the agency that paid the cost-share), then these programs could make credit trading more profitable for them. This may spur interest in credit trading programs, but also raises some concerns about the effectiveness of credit trading programs that permit the use of credits paid for by financial assistance programs (discussed in chapter 4).

USDA policy has explicitly stated that all returns to agricultural producers from the sale of environmental credits generated by the adoption of conservation practices, whether or not they are paid for in total or part by USDA conservation programs, accrue to them solely. NRCS retains the authority to ensure that operation and maintenance requirements for USDA funded improvements are met. Where activities required under an agreement to produce environmental credits may affect land covered under a USDA program contract, participants are encouraged to request a compatibility assessment from NRCS.

Technical assistance programs

Most States and the Federal government have a range of technical assistance programs that can help producers and growers with a variety of decisions regarding conservation and land use decisions. The NRCS Conservation Technical Assistance Program provides a wide range of services to support voluntary planning, conservation design, and implementation to improve environmental outcomes (*http://www.nrcs.usda.gov/programs/cta/*). The breadth of local and community knowledge that NRCS personnel have can contribute significantly to the success of environmental credit trading programs by explaining the programs and their potential benefits and pitfalls to participants and by supporting certification efforts and conservation practice assessments that might be used to quantify credits. This topic will be discussed in detail later in chapters related to specific environmental services for which credit markets pertain.

Voluntary trading programs

While government initiated trading programs are the most visible and largest, there are a number of trading programs that have been set up by nongovernmental entities, such as consortiums of industry groups. Typically, industry groups act in anticipation of future governmentally initiated programs, and nonprofit environmental groups attempt to jump-start environmental initiatives that can improve environmental quality at low cost. An excellent example of an industry-lead initiative is the Chicago Climate Exchange (CCX). Members of the exchange are firms that generate greenhouse gas emissions. These firms committed to reduce their emissions by 1 percent per year from 2003 to 2006 for a total of a 4-percent reduction. Firms that reduced their emissions by more than this amount earned credits, which they could then sell to firms that did not reduce their emissions to meet their commitment. In addition, firms could purchase credits from Brazilian or U.S. offset producers. In this way, the market has both “cap-and-trade” and “baseline-and-trade” features. The cap-and-trade portion is the original agreement to reduce emissions by 1 percent a year and allowed trading to meet that goal. The baseline-and-trade portion is represented by the ability to purchase credits from outside suppliers, in this case, the U.S. and Brazilian agriculture producers. The stated purpose of the CCX was to provide a proof of concept of an offset market, to build the necessary institutions and expertise for such markets, and to inform the public and policymakers about trading programs (*http://www.chicagoclimatex.com/about/pdf/CCX_Corp_Overview_2005.pdf*). In 2010, the CCX was sold to the Inter Continental Exchange. In 2011, the CCX was shut down as it became apparent that the United States was not going to institute a cap and trade mechanism. This illustrates the importance of expectations about Federal policies in driving the development of voluntary programs.

Another example of a nonprofit led initiative is the nutrient net tool being developed by the World Resources Institute (*http://www.nutrientnet.org/*) with support from a variety of funding organizations. This Web-based tool provides guidance to landowners and potential buyers of conservation practice within two focus watersheds: the Kalamazoo Watershed in Michigan and the Chesapeake Bay Watershed in the Eastern United States.

Box 2 Checklist on the Basics of Credit Trading

Why should we not expect environmental credit trading to develop on its own?

How does a cap-and-trade mechanism work?

How can credit trading complement traditional approaches in improving our environment?

What are some examples of how credit trading can complement current regulations, NRCS financial and technical assistance programs and voluntary actions by nongovernmental entities?

Chapter 3 Markets for Environmental Services: What makes a market?

For the full benefits of credit markets to be realized, the necessary features must be in place. If these features are in place, then credit trading will be the most cost-effective means of achieving the desired level of environmental services. Not all of them need to be in place for trading to occur, but their absence will decrease the effectiveness of credit trading. Once the reader understands the features needed for an environmental market to flourish, he or she may be able to see what is missing in a particular situation and help to fill in the gaps so that an effective market can develop. Alternatively, the reader may realize that the necessary features of a market cannot be realized in a particular setting, suggesting that a different approach will be needed to provide the environmental services sought.

A list of a number of the features essential to an effective market is at the end of this chapter. In later chapters, each of these components will be discussed with respect to particular environmental services.

Features of an efficient market

There must be willing buyers and sellers.

There must be both buyers and sellers for a market to work. Just because someone produces something does not mean that it is of value to someone else and can therefore be sold to them. For example, while parents might think that their daughter's art work is the most valuable item in the world, there may be little demand for this "product" outside of the immediate family. In environmental credit markets, while many producers might like to sell carbon credits, if there is no reason for anyone to buy them, there will be few or no transactions. Even if transactions did occur, they would occur at very low prices.

The ownership of environmental goods must be clear.

Unless it is clear which entity holds the property rights to a good, a market cannot develop. In the case of environmental goods, ownership is not always readily apparent. For example, consider the case of a large factory that pollutes the air through emissions from its smokestacks and has done so for many years. If the growing population living around the factory begins to complain and requests that the emissions be controlled, the firm might respond by offering to shut down one of the smokestacks located nearest to the town center in exchange for a fee. This might raise a rather angry response from local townspeople who might counter that they would be willing to consider accepting a payment for putting up with a bit of smoke from this factory, but they would not pay the firm to shut down its smokestack.

At issue here is who owns an environmental commodity such as air and therefore who has the right to use it as they see fit. Does the factory own it and therefore have the right to pollute the air, or do local residents own it and have the right to prevent the factory from polluting it? Once it is clear who owns the air, then a market can form. If the factory owns the air, then it has the right to sell reductions in its air pollution to local residents. If the local residents own the air, then they have the right to ask the factory to pay for being permitted to pollute the air.

There must be agreement on the commodity being traded.

To have an effective market, both the buyers and sellers must agree on the product that is being traded. In the case of a pair of shoes or a bushel of green beans, this is straightforward. For environmental goods, however, there can be situations in which this is less clear. An energy firm may wish to purchase **carbon credits** to offset its carbon emissions. The motivation for the energy company to buy such credits might be to advertise to its consumers that they are committed to improving the environment and that they are signaling this by purchasing a given amount of carbon credits each year to help offset their carbon emissions. Suppose that the energy firm enters into an agreement with a landowner willing to plant additional trees on his or her acreage in exchange for compensation. Since these trees will sequester carbon, there may be a commodity that both sides can agree upon and a trade could occur. A problem can arise if the amount of carbon actually sequestered by those trees is not equivalent to the expected and agreed upon amount. For example, what happens if there is a fire 2 years after planting that wipes out the stand of trees? Who is responsible for replacing the carbon represented by the stand of trees, the landowner or the energy company?

The answer will be determined by whether the commodity being sold is a guaranteed level of **carbon sequestration** or the action that generates sequestered carbon. If the commodity being sold is a guaranteed level of carbon sequestration, then when the expected amount of carbon is not sequestered, the landowner having failed to provide the commodity would presumably have to repay the energy company or find some way to replace the commodity. In contrast, if the commodity sold is the action that generates sequestered carbon, the landowner would have provided the agreed upon commodity and it would be left to the energy company to replace the carbon represented by the lost stand of trees.

While this example illustrates how the lack of an agreed upon commodity can create problems, there are ways to avoid these concerns such as the careful construction of terms and conditions associated the commodity being exchanged.

Prices must be broadly known.

One of the most valuable features of markets is the clear and quick information they provide to both buyers and sellers of products. If the price of shoes increases rapidly, this sends a strong message to athletic shoe producers that there is unmet demand for shoes. An individual firm, anticipating higher profits, will then increase its production in order to sell more shoes at the higher price. As other firms follow, the increase in the supply of shoes will cause the price of shoes to go down. Firms will continue to increase their production until the price falls to the point where they can no longer earn a profit. When the price falls to this point, it signals to shoe producers that there is no more unmet demand that they can fill.

The purpose of developing environmental credit trading markets is to establish a price for credits in order to provide this same type of information to buyers and sellers of credits. Currently, the lack of this information makes it difficult for potential participants in credit markets to know what opportunities there are and to respond to them. This is an area in which knowledgeable field staff can play an important role by taking the information they have on potential opportunities for supplying credits and making this information available to those who can most benefit from it.

No single buyer or seller should have too much control over the market.

Markets work best when no single buyer or seller (or groups of buyers or sellers) have too much control over the market. When a buyer or seller does have too much control, they can use it to influence the price they pay or receive. If, for example, there is only one energy company interested in buying carbon credits, that company can effectively set the price it pays for credits by the number of credits it decides to buy. The fewer credits it buys the lower price it has to pay for each credit. Because of its ability to influence the price it pays for credits, the energy company determines how many carbon credits it will purchase based on how the resulting change in price affects its profits. When this situation occurs in markets for private goods, say athletic shoes, the company buying the shoes will end up purchasing fewer shoes at a lower price for each shoe than it would have if it did not have the ability to influence the price.

Many buyers and many sellers in a market ensure no one on either side of the market can control the market through their production or purchasing decisions. This does not mean that there must be hundreds or even dozens of buyers and sellers. In fact, many markets can thrive with just a few buyers and sellers, as long as the potential for rivals to enter the market exists.

Markets work best when transaction costs are low.

It should be simple for buyers and sellers to find one another and relatively inexpensive to conduct a transaction. When a buyer wants to purchase a pair of athletic shoes, he or she probably knows exactly where to go, either online, or to their favorite local store. Thus, the cost of transacting the exchange is not very great. Where does one go to purchase a wetland offset or 10 tons of phosphorous reductions in the local river? While those engaged in conservation activities may know the answer to these questions, other potential buyers may not.

In credit trading markets, buyers and sellers often need help to develop these connections. In some cases, a single entity or group might act as an **aggregator** of an environmental service. An excellent example of this approach was the action undertaken by the Iowa Farm Bureau in 2004 when they contracted with a group of agricultural producers to sell the carbon sequestered from the adoption of low tillage on 100,000 acres of cropland. This aggregate commodity was then sold on the Chicago Climate Exchange (CCX), an exchange developed explicitly to support the development of carbon trading markets in agriculture.

The CCX is itself an example of another response to the problems that buyers and sellers can have in locating one another. The CCX provides an easily accessible exchange for both buyers and sellers to determine the commodity for sale, the current price, past price, futures, and how many units of the commodity have been bought and sold. More information on the CCX is provided in chapter 6.

NRCS employees and field staff can play a powerful role in the development of an effective market by helping potential buyers and potential sellers find one another.

New firms should have little or no barriers to entry.

A final feature of an efficient market is that those who want to enter the market be allowed to do so. This is because the ability of others to freely enter and exit a market tends to prevent participants, even when the number is small, from using their market power to influence the price they charge or pay. This feature is, in fact, related to two requirements previously stated: that there should be an adequate number of willing buyers and sellers (point 1) and that no one individual buyer or seller have too much market control (point 5). For example, if there is a single seller in a market who uses its market power to keep the price it receives for supplying credits above the cost of providing them, then another seller can come into the market and offer to sell the commodity a bit below the original seller's price. By offering a price below the first seller, the second seller would still earn a good profit while providing the credit to the buyer at less cost. The only way for the first seller to prevent this from happening is for it to lower its price to what it costs to produce the commodity. While this prevents the first seller from being undersold it also effectively prevents the seller from using its market power to influence the price.

Another important feature of a market is the manner in which the transactions take place, referred to here as the "market mechanism." There are three common mechanisms under which most credit trades occur: exchanges, direct trading between two entities, and clearinghouses which negotiate separately with buyers and sellers. In some credit markets, more than one mechanism may be used simultaneously.

Exchanges

Exchanges are markets where a relatively uniform product is exchanged, pricing information is publicly available, and transactions are fluid and easily completed. The stock market and the commodity futures markets are examples of exchanges. Exchanges reduce transactions cost by making the going price known and permitting interested buyers and sellers to easily enter and exit the market. Costs of establishing and maintaining an exchange are high and consequently they usually require a high volume of sales of a uniform commodity to be successful. The CCX and the market for sulfur dioxide are examples of exchanges that have developed for environmental goods.

Direct trading

Direct trading may also be referred to as "bilateral" trading and simply means that a buyer of a credit and the seller negotiate directly with each other or through a broker, come to an agreement, and present their credit agreement for approval by the appropriate trading authority. This is much the same type of transactions that occur with respect to real estate and used cars. While at first blush, this seems to be the most direct and easiest way to perform a trade, the main disadvantage is that it can be costly in terms of time and effort for buyers and sellers to seek out partners for the exchange. These "transaction" costs can discourage trading and result in thin trading in situations that would otherwise be beneficial to both parties. Nonetheless, this can be an effective way for a market to proceed, especially when the potential buyers and sellers are small in number and clearly identifiable.

A particularly effective example of this form of trading occurs in the Grassland Area Farmers Tradable Loads Program in California (*http://www.epa.gov/nps/Section319III/CA.htm*). In this program, selenium content in water for a group of seven irrigation districts is controlled through a cap and trade program. Individual trade agreements were negotiated and certified by the Regional Drainage Coordinator. In this case, the existing infrastructure of drainage districts and organization of those districts provided a natural platform for trading between districts. The transaction costs associated with the trades were estimated to be quite low.

Box 3 Checklist on important features of an effective environmental market

Are there adequate numbers of willing buyers and sellers for environmental credits?
Is ownership of environmental credit clear?
Is the environmental credit that is being traded well defined?
Will prices for environmental credits be broadly known?
Will any one buyer or seller have excessive control in the market?
Are the transaction costs for environmental credits reasonable?
Can anyone who wants to enter the market do so?

Clearinghouses

Under a clearinghouse, the direct contractual linkage between the buyer and seller is broken. In this arrangement, there is an intermediary that negotiates separately with buyers and sellers and assumes ownership of the credit until a buyer if found. The intermediary, by negotiating with numerous suppliers, is able to reduce the search and transactions costs for buyers often by transforming credits of varying price and quality into a more uniform credit. Suppliers' contractual responsibilities are to the intermediary, not to the buyer. Likewise, the buyers' contractual responsibilities are with the intermediary, not the supplier. The intermediary can receive authorization from the regulatory agency to purchase credits and sell them to buyers, thereby assuring suppliers and buyers that credits being bought and sold are acceptable to the regulatory agency. Clearinghouses can reduce transactions costs by reducing costs to both buyers and sellers of identifying customers. It also reduces transactions costs caused by uncertainty about the acceptability of the credits for meeting regulatory obligations. Finally, it reduces transactions costs by publishing prices providing readily available information to suppliers and buyers on credit prices. The clearinghouse arrangement will work best in situations when buyers are looking for a fairly uniform product relative to the variability available from suppliers. Much of the buying and selling of cotton occurs through a clearinghouse mechanism. Cotton producers sell their cotton to merchants or marketing cooperatives who then sell the cotton to textile mills.

Other types of market-based approaches relevant to environmental services

The reader should now have a general understanding of the features needed for an effective market to operate smoothly. Well-functioning competitive markets will exhibit all of these characteristics, but as already noted, there are reasons to expect that well-functioning, competitive markets will not develop on their own for many environmental goods and services.

As discussed previously, many agricultural environmental services have been generated through government support of conservation programs. Examples of these programs include the Conservation

Reserve Program (CRP), the Environmental Quality Incentive Program (EQIP), and the Wetlands Reserve Program (WRP). Nonprofit groups sometimes support environmental conservation in the agricultural sector also.

Sometimes aspects of government conservation programs and nonprofit activities are referred to as **market-based**. In the case of the USDA's conservation programs, this terminology is used to reflect the fact these programs are specifically designed to mimic aspects of a competitive market, such as encouraging producers to compete to provide the best environmental services at the lowest cost.

Besides USDA's conservation programs, there are several other existing and potential market-based conservation and environmental quality approaches. Some of them are government sponsored, and some of them are implemented by the private sector.

Insurance markets

Specialized insurance or quasi insurance products are being developed, which allow farmers to reduce the risk of implementing a conservation practice. For example, in the case of nutrient insurance, farmers who apply the recommended rates and lose the possible yield boost benefit of fertilizer application over the recommended rate are compensated in case there is a yield loss (see for example *http://www.mda.state.mn.us/protecting/waterprotection/~/media/Files/protecting/waterprotection/dwps4.ashx*).

These products may or may not involve a role for the public sector. There is a rationale for using public funds to subsidize such insurance products, since the reduction in fertilizer use can reduce a negative externality.

Green labeling

A second type of market-based system that may be supported by government programs is one that provides information to buyers—either the consumers of agricultural products or the intermediate producers of final products. Both the labeling of products to convey information on their content or method of production and the certification of products as meeting particular standards are examples. These programs are market-based in that they help consumers to better understand the products available to them and allow consumers to satisfy their demand for environmental or other product attributes by choosing to purchase those with the properties they most desire.

Perhaps the best known example of the uniform labeling of agricultural products is the nutritional information required on packaged foods sold directly to consumers. This uniform information helps the consumer to quickly and accurately compare the nutritional content of competing brands. No such broad-based labeling of environmental attributes for agricultural products currently exists. However, there continues to be labeling discussions for products containing various characteristics such as genetically modified foods or environmentally sustainable practices.

Complementing the information generated from labeling are certification programs. These programs can be undertaken by the State or Federal government and might be mandatory. In addition, private industry sometimes self organizes to undertake certification programs. Since the Organic Foods Production Act

(OFPA) of 1990, the USDA administers the National Organics Program, which superseded a variety of state- approved certifications. Organic production "respond[s] to site-specific conditions by integrating cultural, biological, and mechanical practices that foster cycling of resources, promote ecological balance, and conserve biodiversity (*http://www.ams.usda.gov/AMSv1.0/nop*)." The Food Alliance (*http://www.foodalliance.org/*) is a nonprofit organization that "creates market incentives for sustainable agricultural practices, and educates business leaders and other food system stakeholders on the benefits of sustainable agriculture." The Alliance has established a set of standards related to safe working conditions, animal welfare, food safety, and conservation and certifies farms and ranches that meet their standards.

Other very widespread certification schemes, which do not involve the public sector, are the Marine Stewardship Council (MSC) fisheries certification (*http://www.msc.org/*), the Forest Stewardship Council (FSC) forest product certification (*http://www.fsc.org/certification.html*), and Fair Trade certification (*http://www.fairtrade.net/*). Though the historical rationale of Fair Trade was to provide living wages to workers in developing countries, there has been a growing interest in combining Fair Trade with sustainable practices, for example in the case of shade-grown Fair Trade coffee.

Green labeling programs, such as the Food Alliance, are often broader in scope than environmental credit trading programs. They typically have a multiplicity of goals related both to the environment and other social concerns. There are, however, some important similarities between green labeling and trading programs. In both cases, there must be agreed upon methods for identifying and measuring the environmental service of interest. These methods could in fact be the same for labeling programs as for credit trading programs.

Debt Instruments

Debt-for-nature swaps, in which nonprofit organizations buy debt from the governments of developing countries in exchange for conservation activities of those governments' (*http://www.fao.org/docrep/w3247e/w3247e06.htm*), have so far mostly been used on an ad hoc basis and in poor countries. However, they could be also used in the US. For example, defaulted municipal bonds could be swapped for conservation activities.

Equity

Another growing, non-government sanctioned tool to promote conservation is the creation of private equity funds that use environmental attributes or performance as investment criteria. Such funds select investments that incorporate a good environmental profile via green labeling (see above), participation in mitigation markets and other conservation tools such as easements. For example, Beartooth Capital (*http://www.beartoothcap.com/*) invests in land in the U.S. West and then sells conservation easements on it, participates in carbon sequestration markets, certified timber operations and mitigation banks.

Chapter 4 Implementing Credit Trading in Agriculture: What challenges lie ahead?

In the previous chapters, the general features of an efficient credit trading market were discussed, and a few examples of problems that can arise when these features were not in place were described. In this chapter, a number of common problems associated with establishing credit trading programs that are particularly germane to agricultural markets are discussed. While none of these problems is insurmountable, the establishment of effective credit trading programs in some areas of agriculture may be especially difficult (box 4 provides a summary of these considerations).

Difficulty in monitoring and measuring the environmental good

Environmentally friendly agricultural practices can create many different types of environmental goods. Some environmental goods are easy to recognize and quantify, others are more difficult. In the previous chapter, carbon sequestered by planting trees was discussed as an example of a commodity that is difficult to quantify. While it is relatively straightforward to verify that a stand of trees has been planted, it is not clear how much carbon will be sequestered annually by those trees since that will depend upon their growth rate and a variety of other factors including the weather, pest populations, and fire.

Another example relates to agricultural practices that potentially improve water quality within a watershed. By adopting erosion control practices on a field, there are likely to be water quality benefits to local streams and lakes from reduced sedimentation and reduced nutrients. However, the precise pathway between reduced erosion from a field and lower sedimentation within nearby waterways is not always clearly discernable. While some data are available and models exist that can estimate the lower erosion losses in these systems, there is no precise way to know exactly how much less sediment is reaching a waterway from the adoption of a conservation practice on any given field. Does this mean that a tradable commodity that will lead to an efficient environmental credit trading program cannot be developed? Not necessarily, although, it may be more difficult.

In cases where the environmental good is difficult to measure or monitor, it may be possible to identify proxies for those goods that can be more readily quantified and will still support the goals of a credit trading program, for example, maintaining or improving environmental quality at lower total cost. If the buyers and sellers in the market and any regulatory authority involved can agree to use this proxy and if the agreed upon measure is adequately related to the true environmental measure of interest, then an environmental credit trading program based on the proxy can be quite successful.

Consider the water quality example above. Suppose that while it may be impractical to precisely measure how much less soil erodes into a river from a field after a buffer is built at the field’s edge, a reasonable estimate of the reduced erosion leaving the field can be made. This estimate might come from a computer simulation model or from a simple rule of thumb. Can this imperfect measure of water quality improvement be traded between buyers and sellers and still achieve the goals of the program? Yes, under the right circumstances.

If a point source, such as a wastewater treatment plant, wants to buy credits that can be used to offset its own requirements to reduce phosphorous loadings and if erosion reductions are tied closely to phosphorous reductions and if the regulatory authority will allow the upstream erosion reductions to be credited toward the point source emission reduction requirements, then this system can indeed work. Even though no one can be sure exactly how much less erosion and phosphorous will enter the river downstream because of a single conservation buffer built on an upstream farm, if the regulatory authority agrees to give credit for soil erosion reductions from the construction of buffers in the upstream watershed, then trades can occur.

Will such a trading system yield cost savings? Yes, if the cost of installing and maintaining the needed number of buffers upstream is less than the cost of the wastewater treatment plant directly reducing its emissions. Will it preserve or enhance environmental quality? Yes, but only if the phosphorous reduction used to construct the credit amount is correct, averaged for all of the fields during years with both wet and dry periods. In some years, phosphorous loading may be lower than the estimated average. In that case, water quality may exceed the minimum regulatory requirement for the treatment plant. In other years, the phosphorous loadings will exceed the average, resulting in poorer water quality.

An important component of this scenario is that the regulatory authority be willing to accept average phosphorous loadings, implying that loadings may exceed the permitted requirements in some years, but be less than requirements in other years. For some pollutants, such as phosphorous or sediment, this may be a reasonable policy. For others pollutants, such as nitrates, this may not be acceptable when applied to a drinking water source. Thus, the regulatory authority might not be willing to accept a trading program for nitrates if the nitrate reductions from agricultural sources cannot be guaranteed at all times.

An analogous illustration of environmental credit estimation for the establishment of potential markets is that of carbon sequestration. Models of various degrees of complexity have been developed to estimate the amount of additional carbon that will be stored in the soil and in biomass due to changes in land management. A useful Web tool for estimating the carbon sequestration of various management changes (for cropland, rangeland, and agroforestry) is the CarbOn Management Evaluation Tool for Voluntary Reporting of greenhouse gases (COMET-VR: *http://www.cometvr.colostate.edu*). Similarly, the U.S. Forest Service Carbon Online Estimator (COLE) can be used to estimate carbon changes in forestry settings (*http://ncasi.uml.edu/COLE/*). Such tools could provide the necessary link between an uncertain natural process and the development of a tradable commodity.

This discussion reiterates the important role that government requirements will have in many environmental credit trading programs. By setting and enforcing environmental standards, government actions provide the basis of demand for environmental credits. In the water quality case above, if the wastewater treatment plant did not face a requirement to reduce its phosphorous loadings, it would not be motivated to look for less expensive ways to meet this requirement. However, government requirements can also limit the possibilities of trading if the restrictions put in place on what constitute an effective trade are significant. Of course, such restrictions may often be completely necessary to protect the health and well being of people and ecosystems.

There is a lot of discussion of **performance-based** approaches to environmental improvement relative to **practice-based** approaches. While this distinction applies to many conservation programs as well as credit trading, it is central to the discussion of measures used for assessment. The difference between the two relates, in part, to the measures used to indicate success of the program. In a performance-based approach, the measure of success is some measure of the environmental performance of a set of conservation actions taken. In a practice-based approach, the measures of success might be the number of producers adopting the practice or the number of acres treated with the practice. While the environmental performance is a better measure of the goals of the effort, a measure of the adoption levels of the practice are much easier to quantify. Proxy measures, such as the reduced soil erosion estimates used in the water quality example, represent a middle ground between practice- and performance-based approaches. While these approaches do not directly measure the water quality goal of immediate interest (e.g., reduced phosphorous levels at the outlet), they can provide a good indicator of the desired measure and they have the advantage of being easier to measure.

Difficulty in enforcement and establishing contract liability

As the previous discussion highlighted, one of the challenges in environmental credit markets is that the environmental service may be provided over a period of time or only after a period of time has elapsed. For example, the maximum carbon sequestered in agricultural soils following an appropriate land management change may require decades to accumulate, but the reduced nutrient loading from installing a riparian buffer would be expected to occur annually for as long as the buffer is in working condition.

The fact that such time delays can occur may create problems for the efficient functioning of a trading market as changes may occur over time, which reduce or eliminate the provision of the environmental good. What happens if the producer who has contracted to install a buffer finds that it is much more costly to maintain that buffer than anticipated and wishes to break the contract? If the municipal wastewater treatment plant downstream is relying on the effects of that buffer to keep water quality at permitted levels, who would be liable for the shortfall? Would it be the municipal treatment plant to whom permits are issued, or would it be the producer who committed to a credit trade?

The answer will depend on the legal basis of the credit trade and the degree to which each party is explicitly responsible. This will vary with the specific trading program and from State to State. In addition to clearly articulating such liability when trades are first made, there are a number of ways in which agreements can be written to avoid these problems.

One approach would be to make payments for the credits on an annual basis, rather than to make a full payment for the expected duration of the life of the credits. Structured in this way, the water treatment plant would make a payment each year predicated on the upstream farmer having a functioning buffer in place. If the time comes when the buffer is no longer maintained, then the payments would stop. While such an arrangement might be initially less appealing to the producer since it would result in a series of smaller payments each year rather than the producer receiving one large lump sum payment at the beginning of the contract, it would have the benefit of avoiding potential problems in later years. Other ways of structuring contracts to avoid problems with intentional (or unintentional) cessation of services may be possible.

Difficulty in establishing a baseline of environmental goods

One important issue that the developers of credit trading programs must address is the problem of what **baseline** to set for the accrual of environmental credits. The basis of an environmental credit comes from the producer or landowner improving his or her environmental performance beyond some level called a baseline. But, what is the appropriate level at which to set this baseline? Should a producer be expected to have attained some level of land stewardship first and only receive environmental credits for beneficial practices above and beyond this level, or should the producer receive credit for all activities that produce a benefit?

Some people argue that an agricultural producer should not be able to profit from environmental improvements unless he or she has demonstrated a basic minimum performance level. There is a sense of fairness to this argument as all producers must first achieve the same level of environmental improvement before they can earn credits. Ironically, such a requirement might have the effect of making a credit trading program more difficult to initiate. If an agricultural producer must first bear the expenses to attain such a level and then earn credits that can be sold only for additional conservation practices, an agricultural producer may be less willing to undertake any of the conservation practices. On the other hand, if all credit trading buyers and sellers in a region face this same requirement, it is likely to raise the price of the credits since each credit is effectively more valuable than if a credit were earned on all improvements.

A related issue is whether credit should be received for activities instituted only after a certain date, perhaps the starting date of the credit trading program. This latter question is particularly important when some agricultural producers in a region have attained the minimum level of stewardship on their own accord and others have not. If only activities undertaken after a specified date are allowed to earn credits, then these agricultural producers would not be able to receive compensation for conservation practices they undertook on their own accord. Thus, these early adopters would not receive as many credits for the same actions as their neighbors who had not previously undertaken conservation practices. This issue often resonates strongly with those who feel it would not be fair to treat those who have been actively involved in conservation for a long period of time differently than those who have just begun efforts. It is important to note that if credit is given for all conservation practices, regardless of when they were initiated, then more credits will become available. This situation would drive down the price of credits as was described in chapter 2.

As this discussion shows, defining a baseline beyond which credits can be earned is a difficult issue with no clear answer. As credit markets evolve, rules will be developed that address these issues, possibly differently in markets for different environmental services. These rules will affect the value of the credits and ease with which the markets develop and become active.

Difficulty in attaining an overall level of environmental goods

Another issue that the designers of a trading program must address is termed leakage. **Leakage** refers to the fact that when a credit trading program (or any other conservation program for that matter) is instituted, there may be repercussions from market adjustments that affect the amount of the environmental goods produced elsewhere, perhaps outside of the trading region. The problem with leakage is that if it occurs to a significant degree, the gains from the environmental trading program that occur within the area that the program covers will be offset by worsening of the environment elsewhere.

As an example, suppose that a large wetland restoration program is begun in which large tracts of land in the central Corn Belt are restored to wetlands with the intent of improving water quality in the region. If much of this land was previously planted to corn, there should be reduced nutrient runoff from the retirement of this land as cropland. In addition, the development of wetlands will contribute further to improved water quality. If the price of corn rises due to the reduction in corn acreage, agricultural producers will be induced to plant corn on land that was previously in pasture or planted to other more nutrient-efficient crops. Leakage occurs if nutrient runoff increases from this newly corn-planted acreage. In essence, some of the environmental gains "leaked" out of the program due to this acreage response. In the worst case, leakage is complete, meaning that for every environmental improvement that occurs within the program, there is an offsetting loss elsewhere.

As in the example just provided, leakage is more likely to be a problem associated with trading programs or other environmental programs that affect a large region or have the potential to significantly affect market prices for commodities or land. Generally, leakage is an issue that must be dealt with by State or Federal authorities, rather than individual buyers or sellers of credits.

Difficulty in accounting for multiple environmental outcomes from the same practice

One aspect that can make environmental credit trading in agriculture particularly appealing is the possibility that by adopting a practice on one or more fields, an agricultural producer may produce multiple environmental goods and be eligible for multiple environmental credits. If so, the agricultural producer might be able to earn revenue from several sources to cover the costs of a single environmental practice. Agricultural producers who adopt conservation tillage might find that they earn and can sell credits for carbon sequestration and water quality credits in two separate markets. Structural practices such as buffers are likely to provide carbon sequestration, water quality, and wildlife habitat benefits. In fact, the majority of conservation practices in agriculture are likely to generate multiple environmental end-point improvements.

Of course, if it becomes known that agricultural producers can sell credits from one practice in multiple markets, the market price for each credit can be expected to adjust accordingly. If an agricultural producer can cover the cost of adopting conservation tillage entirely from the sale of carbon credits, then the producers could sell the water quality credits earned from this same practice at lower prices than agricultural producers who did not receive payment for carbon credits. If widespread, this could lead to lower prices for water quality credits than would exist if producers were not receiving payment for carbon credits.

A second issue associated with the bundled nature of environmental goods from agriculture practices may come from the timing of the development of credit trading programs. Suppose a credit trading program is initiated for carbon credits and a rancher responds by undertaking range management practices to sequester carbon thereby earning carbon credits. If some years later a wildlife credit market becomes available, the rancher may not be eligible for earning the wildlife credit because the adoption of range management practices may have been accounted for in the baseline used to construct the wildlife credit market. These issues will generally be resolved on a program by program or a market by market basis.

Difficulties raised by pooling of producer returns for the same environmental gain

Pooling of returns occurs when producers receive two or more payments for provision of the same environmental gain. An example of when pooling can occur is when an agricultural producer sells the environmental credits he or she earned for using an environmentally friendly practice while receiving a cost-share or other conservation payment from the government. This is pooling because the agricultural producer is being compensated in part, or in whole, for supplying the environmental gain by the purchaser of the environmental credits and by his participation in the government conservation program.

The many agricultural programs that support conservation at the Federal and State levels makes this situation likely to occur in practice. Some programs, including those supported by the NRCS and other Federal agencies within the USDA, explicitly state that all program participants retain ownership over any environmental credits that might be earned by an agricultural producer's participation in the program and thus, explicitly allows pooling. However, for other government conservation programs, it remains unclear who owns any environmental credits accruing from the adoption of practices. This will likely be resolved on a case by case basis. Also, the USDA's position with respect to pooling does not mean that regulatory agencies responsible for establishing credit trading programs will allow it.

The decision to allow or not allow pooling may have serious consequences for the cost effectiveness of credit trading programs. Some argue that pooling stimulates initial interest in credit trading and increases trading activity in existing markets. In addition, the prospect of additional returns generated by pooling could induce adoption of more environmentally friendly technologies throughout the sector. The combination of higher levels of credit trading and possible increased interest in adopting new technology could lead to a higher level of environmental improvement.

Others argue that pooling provides an opportunity for producers of environmental gains to be paid "too much." In this view, pooling permits the providers of the pooled credits to be paid more than they would have been willing to accept. To the extent that pooling provides credit producers with a surplus, pooling reduces the amount that could be spent on acquiring more environmental gains.

Pooling only represents a concern when one of the sources of revenue is a government payment. This is because the government payment distorts the market price for credits, making credits seem cheaper than they really are. This is because "over payment" permits the providers of pooled credits to supply credits below cost, driving the price of credits down. The lower prices will reduce the ability of providers that do not receive a government payment to participate in the credit trading program and reduce the incentive for credit purchasers to adopt emission reducing technologies. Pooling can cause the cost of credits to appear cheaper than the cost of adopting the environmentally friendly technology when, in fact, they are not. This is because the buyer does not have to account for the cost of the government payments in its calculations of the cost of the credits. To the extent that pooling causes the cost of credits to appear cheaper than they really are, it will reduce the cost-effectiveness of credit trading program. In cases where the cost of the credits plus the government payment exceed the costs of adopting emission reducing technologies by the credit purchasers, it will cause the overall cost of the credit trading program to be greater than if the pure regulatory approach had been used.

It is uncertain as to which view of pooling is more accurate than the other. However, caution should always be taken when a situation arises where agricultural producers can receive a second payment for a practice that they had already undertaken or would have undertaken without the second payment. In that case, the producer is clearly better off, but there is a high probability that little or no additional gain to the environment will be realized. In such a case, allowing pooling could result in greater economic losses than would have occurred without the trading program. On the other hand, there may be cases where the addition of a second source of compensation may still leave the cost of the credit lower than the alternative method for reducing emissions. In this case, allowing pooling would yield true economic benefit.

Some express concern that pooling will actually reduce the level of potential environmental gain. It is hard to see how this would happen as long as the regulations guiding the credit program require each unit of emission reduction represented by the credit utilized by a purchaser represents an actual unit of emission reduction.

Often the concern that pooling will reduce environmental gains stems from the belief that pooling provides a way for suppliers to be paid for practices that were already or would have been in place without the program. There is no question that either one of these types of transactions would reduce the environmental gain from the credit trading program. The reduction in environmental gain caused by these types of transactions, however, is not a result of pooling, but rather a result of improperly defining the baseline.

Finally, the increased costs resulting from pooling are less clear when the purpose of the government payment is for something broader, like sustainability or good stewardship, than the production of the emission reduction which is the focus of the credit trading program. Then the question becomes how much of that payment should we attribute to production of the credit? The answer is we do not know. Any decision made will be arbitrary. The only way to determine whether the trading program is cost effective would be to evaluate the cost-effectiveness of the conservation program and the credit trading program together.

Difficulties arising from high transaction costs

New ventures, especially those with some uncertainty surrounding them, will have a learning curve associated with them. Many agricultural producers and other possible participants in credit trading markets will be leery of committing themselves to actions for which they do not fully understand the ramifications for their operations and their liability. The learning curve for agricultural producers might be steep. Similarly, even if an agricultural producer wants to participate in credit trading markets, it may be difficult to find interested buyers. Like any market transaction, each potential buyer or seller will want to get the best deal and will therefore want to collect information on possible trading options. All of this activity requires effort and, especially when markets are newly developing, the costs of learning and searching out potential trading partners can slow the development of efficient markets.

A number of activities can help overcome some of these transaction costs or the learning cost associated with nascent markets. Aggregators may be of help. An aggregator is an individual or a group that collects credits from a large number of sources and sells those credits to a large number of buyers. The aggregator may purchase and sell credits on its own behalf or on behalf of a nongovernmental organization, private group, or individual.

Box 4 Checklist on potential obstacles in implementing an effective environmental credit trading program

Are there significant problems in monitoring and measuring environmental outcomes?

Can one monitor contract performance and establish who is liable for contract failure?

Can a baseline of conservation practices and their resulting environmental outcomes be established?

Does the credit trading program generate environmental gains which are offset by environmental losses in other areas?

Does the credit trading program spur on conservation practices that provide multiple environmental outcomes?

Is pooling of credits allowed?

Are there high transaction costs?

Chapter 5 Water Quality Credit Trading

The first four chapters in this reference described in general terms how environmental credit markets may work and some of the greatest challenges. In this chapter and the remaining chapters, the focus is turned to specific environmental commodities for which markets have begun to develop, starting with the market for water quality, followed by carbon, wetlands, and habitat. In each of these chapters, the discussion begins with some of the existing programs that provide credit trading in the area. Each chapter concludes with discussion of the specific role that NRCS staffs and partner institutions could have in supporting the potential development of expanded markets.

To keep things simple, this chapter discusses the issues specific to water quality trading by focusing on three overarching questions:

• Who are the buyers and sellers of water quality credits?

• How is the commodity defined?

• How well does the market function?

Buyers and sellers

There are more than 40 water quality trading initiatives and at least half a dozen statewide policies specifically related to water quality trading in the United States. A group of researchers from Dartmouth College (Breetz et al., 2004) collected and summarized basic information about each of these initiatives and programs. This comprehensive look at the programs and policies in place at that time provides a useful starting place for understanding how water quality trading is currently being conducted in the United States, its growing pains, and where improvements may be needed to enhance the functioning of these markets.

The survey by Breetz et al. (2004) reports that 20 States have some kind of water quality trading program in a watershed within their State (several States, such as Colorado and Massachusetts, have multiple watersheds with trading programs). Many of these programs support trading between two point sources, but even more are designed to support trading between **point sources** and nonpoint sources. A point source refers to an emission source such as a municipal wastewater treatment plant where the source of pollution entering the waterway can be easily identified. In contrast, **nonpoint sources** refer to emission sources where the precise source of the pollution and its pathway to waterways are not clear, such as many agricultural sources. Trading that includes nonpoint sources (the cap-and-baseline type) is likely to be the most difficult market to develop and effectively implement.

In the case of water quality credit trading, it is worth spending some time considering whether there will really be enough participants, particularly buyers, to make a water quality market viable. A buyer of a water quality credit is likely to do so to reduce their costs of meeting regulatory requirements. This means that there must be a regulatory requirement that the buyer cannot meet without some expense, and the buyer must be allowed by the regulatory authority to meet its obligation by purchasing credits from another source.

While there are many point sources of water pollution that are subject to regulatory requirements on emissions under CWA and are regulated with permits, this is not true of the majority of agricultural nonpoint sources. A reauthorization of CWA could change this. However, in the near term, the majority of potential buyers of water quality credits are likely to be point sources that are subject to **National Pollution Discharge Elimination System (NPDES)** permits. One advantage of building trading programs into the NPDES permit system is that the permit requirements can create buyers for pollutant reduction credits, and the permits written to point sources can explicitly recognize trades.

For credits to be valuable to a buyer, the buyer (say a municipal wastewater treatment plant) must also be allowed legally to use those credits to offset pollution that it would otherwise be required to clean up. If this condition does not exist, the credits would have no value and there would be no point in spending money to obtain them. The U.S. Environmental Protection Agency's (EPA) trading guidance for NPDES permit writers introduced in 2007 (*http://www.epa.gov/npdes/pubs/wqtradingtoolkit_fundamentals.pdf*) makes clear that point sources cannot purchase credits to meet their entire regulatory requirement to reduce emissions. Point sources have to meet their **technology-based effluent limits (TBEL)** through the implementation of the technology requirements. They cannot use credits to meet this level of improvement. Thus, the water quality credits can only be used to achieve improvements above the level of improvement represented by the TBEL. These improvements can arise from more stringent State regulations or when a water body is impaired and requires the State to develop a **total maximum daily load (TMDL)**. The translation of a TMDL waste load allocation into a water quality-based effluent limit in the NPDES permit for a point source requires that a NPDES permit holder reduce emissions beyond their TBEL. Since EPA carries out most of its water quality programs through delegation of these programs to States, there are a wide array of State laws regulating water quality. Because of this, the potential for water quality credit trading varies from area to area.

In sum, the potential buyers of water quality credits, at least in the near term, are likely to be point sources that are subject to legal mandates that they remove nutrients, other biologically oxygen demanding pollutants, or sediment from their wastewater. Buyers will not be able to use credits to meet all of their pollution treatment requirements; technology-based legal requirements will still require point sources to control a portion of their emissions. When a water body is impaired and there are control requirements beyond those achieved by the required technology, there may be an opportunity for trading. Trading will only occur, however, if there are sources that can provide the needed emission reductions at lower cost than what it would cost for the point source to directly control them and if the buyer is reasonably certain that the credits purchased will meet its statutory obligations.

To gain a better understanding of who the potential buyers and sellers in a market might be, it is useful to consider a few actual trades that have occurred. One example of actual trading between two point sources occurred in the Bear Creek Reservoir (*http://www.bearcreekwatershed.org*) under Colorado regulations that allow wastewater treatment plants to discharge phosphorus levels above a set standard (total phosphorus concentration of 1.0 mg/L as of 2007) if they can offset their phosphorus emissions with an agreement from another source to reduce their emissions by at least as much. The Bear Creek Watershed Association is set up to review and approve credits to guarantee their legitimacy for buyers. As of 2004, one small treatment plant had taken advantage of this opportunity, purchasing credits from a large point source. This trade resulted in cost savings to the buying firm (the small point source) without affecting water quality since the increase in phosphorus loadings were offset by reductions at the selling source (the larger point source). Nonpoint source trades are also allowed under the trading guidance.

In contrast to the Bear Creek trade which occurred between two point sources, the Red Cedar River Nutrient Trading Pilot Program in Wisconsin generated trading between nonpoint agricultural sources and the City of Cumberland in the operation of their treatment works. Cumberland paid 22 agricultural landowners to adopt conservation practices to reduce the amount of phosphorus leaving farm fields. Cumberland estimates that this trading option saves the city about $15,000 yearly while maintaining water quality standards (Breetz et al. 2004). As in the Bear Creek case, a relatively stringent water quality standard induced a point source to look for a cheaper alternative to meet its water quality obligations.

The commodity

As in the two trading programs just described, the focus of most water quality trading programs is the control of nutrients, particularly phosphorus or nitrogen or both. Other pollutants covered under trading programs include selenium, mercury, heavy metals, sediment, suspended solids, and biological oxygen demand (BOD). In addition, instream flow or temperature or both are stipulated as tradable commodities in two trading programs in Massachusetts and one in Oregon. While this covers a wide variety of effluent, it is important to realize that not all pollutants would be appropriate for trading. The EPA indicates that the trading of pollutants that "exert acute effects over small areas and in relatively low concentrations" (*http://www.epa.gov/npdes/pubs/wqtradingtoolkit_fundamentals.pdf*) would not be suitable for trading. This includes persistent bioaccumulative toxics for which EPA maintains a list at *http://www.epa.gov/pbt/index.htm*. This makes sense—if a pollutant is toxic in small amounts or it makes a very big difference exactly where the pollution occurs geographically, it would not be wise to allow trades between two sources that are not located near one another.

While generally only pollutants that are identical or quite similar will be sensible to consider for trading programs, there are cases where it might be reasonable to trade reductions in one type of pollutant for another type of pollutant. If the effect of the two different pollutants on the environment is the same, then a reduction in one can be viewed as equivalent to a reduction in another. An example where such "cross pollutant" trading makes sense and has occurred is in Minnesota where the Rahr Malting company offset carbonaceous biochemical oxygen demand (CBOD) discharged from its facility for upstream reductions in phosphorus (Breetz et al. 2004). Since the phosphorus load reductions were seen as equivalent to the CBOD increases and could be achieved at a lower cost, this trade made sense from both a cost saving and environmental perspective.

In addition to the pollutant itself that is eligible for trading, there are several other dimensions of the commodity that must be agreed upon before credits can be established and traded. In the case of water quality trading, these issues include how the credits are measured and verified and whether a 1-pound reduction in pollution discharge at one source is viewed as equivalent as a 1-pound reduction at another source (i.e., whether the trading ratio is one or something different from one).

Measurement and certification

For a commodity to be bought and sold there must be agreement between the parties (buyers, sellers, and regulators) as to how the commodity (credit) will be measured. When a point source is interested in trading with another point source, the measurement of the value of a credit is likely to be straightforward since most of these sources will already be permitted under the NPDES process and have their discharges monitored. In such cases, keeping track of trades between point sources will be no more difficult than doing the monitoring that is already ongoing through the permitting process.

In contrast, the measurement and enforcement of credits generated from nonpoint sources is likely to raise significantly more difficulties. Many agricultural conservation practices are known to have water quality benefits. Nutrient management methods, the adoption of conservation tillage, and the installation of buffer strips are just three examples of common conservation practices (often referred to as **best management practices** by EPA and others outside the USDA) that reduce soil erosion and nutrient runoff. However, the exact amount of those reductions from any particular farm field to the local waterway may be difficult or impossible to exactly quantify.

Researchers have done studies to assess the magnitude of water quality benefits for a number of practices and, in many cases, it will be possible to assign a reasonable estimate of the average reduction in pollution that will come from the adoption of a practice. But, it is generally believed that the actual reductions at any point in time can vary, sometimes considerably, depending on the weather in a particular year, the crops grown, and various other management practices and land characteristics. How can an agricultural producer earn credits for adopting a conservation practice even if there is no way to measure exactly how much reduction in nutrients and sediment this practice achieves in the local water way at any particular point in time?

One method in which credits have been given to farmers and ranchers is by the use of mathematically based computer models that mimic the best available scientific information. For example, NRCS provides a wide range of modeling and engineering support in its engineering manuals (http://www.nrcs.usda.gov ***Home / Technical Resources / Alphabetical Listing / Engineering***) that relate to the design and effectiveness of conservation practices. Other computer support models are provided on line or are supported by university researchers or nonprofit agencies (*http://www.nutrientnet.org/*).

One can think of the estimates that come from these models as educated guesses about the amount of pollution reduction that will occur by the adoption of the conservation practice at a particular location in a watershed. As long as the regulatory authority is willing to give credit to the buyer of a credit (by the amount assigned by this educated guess), a trade can take place and the buyers and sellers can be satisfied with the process and the result. Further, as long as the credit given to the conservation practice is about right, the environment will not suffer either. Of course, if this is not true and the credit given to the nonpoint source practice overstates or understates the actual pollution reductions from the practice, the resulting water quality after the trade will be either higher or lower than it would have been if the trade were not allowed and each source had to meet its statutory requirements by reducing its pollution. In many cases, it may be that the amount of the credit accurately predicts the typical level of pollution reduction that comes from a conservation practice, but that at some point in the growing season or during some weather event (such as heavy rain or drought), the pollution prediction will not be accurate.

There are other ways that the value of credits from nonpoint sources could be generated such as best judgment from local extension agents or other experts in the area. Limited experimental field trials could be used in conjunction with modeling and expert judgment. Regardless of how the exact value of the credit is determined, what is most important from the efficacy of the market is that both buyers and sellers can be certain that the trade will be viewed as legal and that the use of the credit by the buyer will count towards the buyer's statutory requirements.

The amount of the credit given to a nonpoint source does not have to exactly equal the change in pollution associated with a nonpoint source practice as long as the regulatory authorities verify ahead of time that the credits can be used by buyers to meet their legal obligation for water pollution control. However, if the credit given to the nonpoint practice does not accurately reflect its reduction in pollution to the waterway, water quality could be affected, either positively if the credit understates the true value, or negatively if it overstates the value. If the credit misstates the reduction in pollution, this will also mean that the credit price does not reflect the true value of the credit. In the case of understatement of the reduction, the price will be too low, and, correspondingly, it will be too high in the case of an overstatement. If monitoring reveals this to be the case, the amount of credit given in the future may need to be adjusted to reflect the latest data.

Baseline and timing

The appropriate baseline level of conservation that must be met before credits can be earned is one of the more contentious issues surrounding water quality trading involving nonpoint sources. Some argue that agricultural nonpoint sources should be able to earn credits only after they have undertaken sound conservation practices (perhaps a set of best management practices identified by the NRCS or some other independent authority) on their farming and ranching enterprises, implying that a set of conservation practices should be implemented prior to any credits being earned. If so, then credits could be earned and sold only for water pollution gains that come from the adoption of practices above and beyond this minimum set of practices. Others argue that the appropriate baseline to use is the existing land use and conservation practices on a field, which may be none. If a baseline set of conservation practices must first be implemented before any credits can be earned, this effectively makes the cost of producing the credit higher than if no such requirement existed since the agricultural producer will have to undertake more conservation practices to earn a credit. The higher costs could preclude these agricultural producers from participating in the credit trading program, potentially increasing the costs to the buyers and of the credit program.

For example, in a watershed that has an established TMDL, credit trading programs would most likely only allow nonpoint sources to earn credits for reductions above and beyond the set of best management practices needed to achieve the TMDL load allocation for nonpoint sources. In this case, the effective baseline for earning credits is the level of conservation activity associated with achieving the TMDL load allocation, not the existing level of activity. In contrast, a watershed that is not currently under a TMDL may use the existing level of water quality as the baseline or if there are local or State conservation requirements, then the level achieved when those local or State requirements are in place.

A final issue related to water quality trading is the length of time that trades will last. Since NPDES permits are typically 5 years in duration, the length of time that trades are likely to last is also 5 years. Thus, an agricultural producer might commit to undertaking conservation tillage for a 5-year period in exchange for compensation from a point source downstream. During this period, monitoring of water quality would indicate whether the nutrient and/or sediment reductions expected to occur did in fact occur. This monitoring information is very important for at least two reasons. First, if weather and other natural events have been typical during this period, but the expected nutrient reductions did not occur, it may be necessary to undertake additional conservation practices upstream or for the point source to undertake additional controls. Any adjustments of this sort would need to be clearly stipulated up front in the terms of the contract. Second, this information can be used to improve the predictions from models so that future estimates of nutrient reductions are more accurate.

Trading ratios

The **trading ratio** determines how much of a reduction in pollution achieved by a seller can be used to offset pollution by a buyer. For example, if a municipal wastewater treatment plant can reduce its phosphorus by 1,000 pounds, can another treatment plant purchase 1,000 pounds of credit and thereby not have to reduce its phosphorus contributions by 1,000 pounds without penalty? If so, then the trading ratio is one (or one-to-one). If instead, the seller (the plant that is reducing its phosphorus to earn credits) must reduce its phosphorus load by 2,000 pounds for the buyer to forgo its required reductions in phosphorus levels of 1,000 pounds, then the trading ratio is two (or two-to-one) since 2 pounds of reduction by the seller are equivalent to 1 pound of increase by the buyer.

Why aren’t trading ratios between any two sources always one-to-one?

Location/distance trade ratio

One simple reason why trading ratios between a seller (a point or nonpoint source) and a buyer (point source) may not equal to one is due to **attenuation**. Attenuation refers to the diminishing of the pollutant through natural forces at it moves down the stream. This means that a reduction in pollutant upstream is not equivalent to a reduction in the pollutant further downstream. The further a seller of the credit is located upstream from the buyer the greater the attenuation. For example, a 1-pound reduction in phosphorus discharge from a field located upstream could attenuate to a half pound of phosphorus by the time it reaches the buyer located downstream. A trading program needs to take this natural diminishing of the pollutant over distance into account to protect the environment. In this example, if the trading ratio is one-to-one, then the trade will result in a net reduction in pollution of a half pound rather than the required pound. To counteract this, the buyer has to purchase 2 pounds of credits for 1 pound of pollution reduction it seeks to forgo. This means that in order for the trade to be able to completely off-set, the trading ratio needs to be two-to-one.

Equivalence trade ratio

Another reason for not setting trading ratios at one-to-one might be to account for differences in the effect different forms of a pollutant have on water quality. In the case of nutrients, water quality concerns focus on biological availability of the nutrient. The more biologically available the form of the nutrient, the greater will be its effect on water quality. Phosphorus contained in effluent from wastewater treatment plants generally comes in soluble form and is readily available for biological uptake. On the other hand, phosphorus contained in agricultural runoff generally comes in insoluble form and is not readily available for biological uptake. As a result, the phosphorous contained in wastewater treatment plant effluent will cause more environmental damage than a similar amount of phosphorous contained in agricultural runoff. This difference in the effect of these two forms of phosphorus on water quality needs to be taken into account when using reductions in phosphorous from agriculture runoff to offset emissions of phosphorous in the effluent from wastewater treatment plants. Trading ratios that account for the differences in the environmental effects of the different forms of a pollutant are referred to by EPA as **equivalence ratios**.

Uncertainty ratio

A third argument for setting trading ratios greater than one is that some sources of pollution control are likely to be less certain in their effect on the environment than others. This is closely related to the discussion of measurement and monitoring in the earlier section and is thought to be one of the largest problems with respect to nonpoint source control methods for agriculture. To deal with this concern, many trading programs require a safety margin rather than simply crediting the agricultural producer with the best estimate of the reduced pollution resulting from the adoption of the practice. This **margin of safety** generally translates into a trading ratio that is greater than one. To provide a necessary margin of safety, many trading programs require that more than one pound of pollution reduction achieved by a nonpoint source be used to offset a one-pound increase in emissions from a point source. The EPA refers to this basis for establishing a trading ratio as an uncertainty discount. In this case, the terminology recognizes that the reason for the use of a trading ratio comes from the uncertainty associated with the actual water quality improvements that agricultural nonpoint sources generate.

While this requirement is reasonable, it does increase the cost of meeting pollution control targets since, on average, more control is being implemented than would otherwise be required. A common trading ratio used to create a margin of safety when nonpoint source reductions are being traded is two-to-one. Clean Water Services in Oregon and The Bear Creek Trading program in Colorado are examples of programs that use a two-to-one uncertainty ratio to provide a suitable margin of safety. The Lower Boise Effluent Trading Demonstration Project in Idaho, on the other hand, applies only a 10 percent best management practice uncertainty discount to the calculation of phosphorous credits.

Cost-share trade ratio

A fourth situation where trading ratios may be reasonable is to adjust for pooling by suppliers. In the case of agricultural producers who have received cost-share payments to adopt conservation practices, one could visualize a system where participants in cost-share programs would have higher trading ratios than nonparticipants to account for the portion of the credit the agriculture producer already received payment for. This adjustment recognizes that program payments distort the market for credits by lowering the cost to suppliers of adopting conservation technology and, consequently, the suppliers who receive conservation program payments should be expected to supply more environmental improvement for each credit to correct for this.

There is no easy answer to the question of what is the best trading ratio to use. Trading ratios will be explicitly defined by the trading program and may differ between different sources within the program. To highlight the range of possibilities, boxes 5 and 6 provide a number of examples of trading programs and the trading ratios used.

Box 5: Examples of Trading Ratios used in Water Quality Credit Trading Programs (drawn primarily from Breetz et al. survey)

Program	Trading Partners	Pollutant	Trading Ratio	Comments
Grassland Area Farmers, CA	Nonpoint/nonpoint	Selenium	1 to 1	
Bear Creek, CO	Point/point	Phosphorus	1 to 1	
Chatfield Reservoir, CO	Nonpoint/point	Phosphorus	2 to 1	
Cherry Creek Basin, CO	Nonpoint/point	Phosphorus	2 to 1 or 3 to 1	Higher ratio is used when the sources are far apart
Dillon Reservoir, CO	Point/nonpoint Point/point	Phosphorus	2 to 1 or 1 to 1	For nonpoint/point For point/point
Long Island Sound, CT	Point/point	Nitrogen	Equivalency factors	Used to account for location differences these factors vary by trade
Lower Boise River, ID	Point/nonpoint	Phosphorus	Differs by practice	Values used to account for both uncertainty and location effects
Piasa Creek Watershed Project, IL	Point/nonpoint	Sediment	2 to 1	
Specialty Minerals Inc., MA	Point/nonpoint	Temperature	1 to 1	
Wayland Business Center, MA	Point/nonpoint	Phosphorus	3 to 1	
Kalamazoo River Water Quality Project, MI	Point/nonpoint Point/point	Phosphorus	2 to 1 or 1 to 1	For nonpoint/point For point/point
Southern Minnesota Beet Sugar Cooperative Permit, MN	Point/nonpoint	Phosphorus	2.6 to 1	
Passaic Valley Sewerage Commissions Pretreatment Trading Project, NJ	Point/point	Heavy metals	1.25 to 1	Extra reductions are required reduce total pollutant loading
New York City Watershed, NY	Point/point Point/nonpoint	Phosphorus	3 to 1	
Tar-Pamlico Basin, NC	Point/nonpoint	Nitrogen and Phosphorus	2.1 to 1	
Greater Miami River Watershed Trading Pilot Program, OH	Point/nonpoint	Nitrogen and Phosphorus	1 to 1 2 to 1 3 to 1	For attainment areas Nonattainment areas and predicted credits Predicted credits in impaired waters
Red Cedar River Nutrient Trading Pilot Program, WI	Point/nonpoint	Phosphorus	2 to 1	

Box 6 Cost savings from point/nonpoint source trading: the Great Miami River Watershed Program

To consider a possible water credit trading program for the Great Miami River Watershed, Kieser and Associates undertook an analysis of its potential efficacy. To do so, they estimated the costs that point sources would face to meet the new, higher water quality standard of 1 milligram per liter total phosphorus and 10 milligram per liter total nitrogen. Then, using a water quality model, they estimated the potential reductions in phosphorus and nitrogen loadings that could be achieved if agricultural producers were to adopt no-till methods. The costs to agricultural producers of adopting no-till were combined with this modeling exercise to estimate the costs of achieving nitrogen and phosphorus reductions via the adoption of no-till. The authors of the report estimated that the nitrogen and phosphorus standards could be met at a cost savings of over $380 million if trading between the point sources and nonpoint sources was allowed over a situation where firms had to meet the new requirements internally. These cost savings come from the fact that it costs less for the nonpoint sources to undertake nutrient loading reduction activities than for the point sources in this instance to do so. The following information provides an overview of the key costs and components of the market to help the reader understand how costs savings came about.

Buyers: The buyers in this market are the regulated point source dischargers. Based on the data provided in Kieser's report, there are 334 point sources in the watershed comprised of wastewater treatment plants and various industry sources. Using information on the costs for these sources to upgrade their facilities the authors computed the cost per pound of nutrient reduction for each point source and found that these costs vary widely depending on the size of the point source. The costs of reducing total phosphorus ranged from $6.45 per pound to $1,500 per pound and the costs of reducing total nitrogen ranged from $2.20 per pound to $313 per pound.

Trading ratios: Different trading ratios were applied to trades depending on whether the point source discharges into "attaining" waters or impaired waters and on whether the trade is undertaken before the new standards are required for the point source or after. In the case of a point source in at attaining area who undertakes a trade prior to the requirement, a trading ratio of 1 to 1 was used. If the point source is located in a no attaining region and undertakes the trade before the requirement or if the point source is located in an attaining region and undertakes the trade after the requirement, the trading ratio of 2 to 1 is used. Finally, a source in an impaired region trading after the requirement faces a 3 to 1 trading ratio. These ratios were set by program design.

Sellers: While the trading program allows a number of agricultural conservation practices to earn credits, the focus of the Kieser analysis was on no-till, nutrient management (reduced fertilization) and conversion from a corn-soybean rotation to a hay only operation. The average cost per pound of nitrogen (phosphorus) reduction ranged from $0.45 ($1.08) for no-till only to $1.23 ($2.70) for combined no-till and fertilizer reduction to $3.99 ($8.48) when all changes were combined. By comparing these costs to those reported for the buyers, one can see that the buyers would save money by paying agricultural producers to adopt these practices rather than having to undertake the expense of upgrading their facilities.

Other market features: Buyers of credits are allowed to purchase credits only from upstream sources to be fully protective of all downstream water quality. This means that point sources located further up in the watershed have less opportunity for trading and that there is a higher chance for market "thinness." A trading ratio of 1 to 1 was used. If the point source is located in a no attaining region and undertakes the trade before the requirement or if the point source is located in an attaining region and undertakes the trade after the requirement, the trading ratio of 2 to 1 is used. Finally, a source in an impaired region trading after the requirement faces a 3 to 1 trading ratio. These ratios were set by program design.

For more information: *http://miamiconservancy.org/water/quality_credit.asp*

Market functioning

Many of the trading programs being developed are contained within a single State and are specific to a single watershed or water body. There is increasing interest and movement toward expanding the scope of water quality trading to cover multiple States and large regions. The main consideration in whether trading is a good idea across State lines or any other geographic distinction is the degree to which the environmental impact of the pollution can be considered similar and, if not, whether the use of trading ratios can correct for this difference. If two sources are located in different watersheds, it will generally not make sense for trading to be allowed between them as the reductions in pollution achieved by the seller of credits will occur in a different watershed than the one where the environmental damage caused by the pollution from the buyer is occurring.

The use of a clearinghouse is an element of some nonpoint-point source water quality trading programs. In this case, the generators of credits, such as agricultural producers, negotiate to undertake activities that reduce pollution with an entity designed especially for these purposes, usually associated with the establishment of the trading program. A good example of a clearinghouse structure can be found in Pennsylvania, where Fairview Township decided to meet its water quality requirements by purchasing nitrogen credits from the Red Barn Trading Company. The Red Barn Trading Company aggregates, certifies, and verifies nutrient credits for use under the State's nutrient credit trading program. In this case, Fairview County will pay Red Barn Trading Company for credits it generates by buying poultry manure from farmers and then disposing of the manure outside the Chesapeake Watershed. The trading agreement, which lasts for 15 years, will save the Township 75 percent of the cost of upgrading its wastewater treatment plant.

Contract liability

A final issue concerns the legal liability resulting from the nonperformance of nonpoint sources to reduce emissions. If a point source is to purchase credits from nonpoint sources in order to offset emission reductions of their own, they will want assurance that the credits they have purchased will, in fact, meet their legal obligations. If in the process of water quality monitoring, it becomes apparent that less water quality improvement is being generated by the agricultural sources than anticipated prior to trading, there is an important liability question of who, if any, will be held responsible for seeing that the water quality improvements are made.

Point sources can ensure that the credits they purchase fulfill their legal obligations by entering into a trading agreement (contract) with the credit supplier that clearly spells out the supplier's responsibility in the event of natural disaster or a failure of the practice underlying the credits. The permit authority should also agree to the conditions spelled out in this agreement and where applicable include it in the permit itself. By doing this the buyer, supplier, and permitting authority will know who is responsible in the case of nonperformance of practices.

Presumably in the agreement if the lack of water quality improvements occur due to the nonperformance of an agricultural producer (e.g., for not implementing or maintaining the agreed upon conservation practice), the liability would rest with the producer. However, if the lack of water quality improvement is due to unusual weather conditions or a lower performance of the conservation practice than anticipated, will the permitting authority require that the point source under the terms of the trading agreement be required to make up the difference? There are at least two possibilities: 1) that the point source will not be held liable and the water quality will not, for the duration of the trading period, meet the water quality standard, or 2) that the point source will be held liable. If the first approach is followed, point sources are more likely to be interested and willing to participate in the trading program but, of course, this comes at a cost of the possibility of not meeting the standards. In the second case, the standard will be met, but point sources will understandably be more reticent to participate in these programs. Ultimately, this is a decision that must be addressed by policymakers, legal counsel, and designers of water quality trading programs.

The role of NRCS staffs and partners

Water quality credit trading is still new, and relatively few trades have occurred compared to their potential trading volume. Those with expertise in agricultural conservation systems who understand the scientific and institutional realities of agriculture and water quality can play a significant role in helping producers understand their options. There are a number of direct roles that NRCS staffs could potentially support:

- Explain the benefits and costs of participating in these markets to potential participants, along with other available incentives as a part of the conservation planning process

- Become familiar with the technical standards and documentation requirements that, in the future, may incorporate in the conservation plan baseline information and potential quantification of impacts of each alternative

- Develop tools for measuring baseline information and the potential effect(s) of alternatives that could be used for credits

NRCS staffs and RC&Ds are likely to be particularly effective in helping to identify potential trading partners by understanding and explaining the pros and cons of participation in these markets. It will be important to not make any recommendations to producers with respect to credit trading. This is similar to avoiding making recommendations for tax purposes. It is not NRCS' role and may lead to a situation where a liability is created which NRCS should not incur. One resource that might be quite helpful in this regard is NutrientNet, a Web page supported by the World Resources Institute (*http://www.nutrientnet.org/*). This Web-based tool can help track and compute the potential credits that a particular conservation practice might expect to yield if adopted by a farmer or rancher in a given region. Additionally, information on the costs of implementing the practice and the identification of potential trading partners would be helpful, especially if they are Web-based and computer supported tools.

There are a number of examples of third parties acting as effective facilitators for trades. This may be a role that RC&D councils may be particularly well suited due to their expertise and access to information on the suitability of site-specific conservation activities.

It will be important for RC&Ds to work closely with the relevant authorities who administer and/or monitor trading programs. While the appropriate personnel will differ by State and trading program, key personnel are likely to be NPDES permit writers and authorities when point sources are involved in trading.

Local conservation districts, watershed groups, and other concerned citizens are likely to be major stakeholders in trading programs and water quality concerns in general. By understanding and explaining to these key stakeholder groups how trading works and what it can and cannot be expected to accomplish in a local region, NRCS staffs can be leaders in supporting cost-effective conservation systems. Whenever environmental improvements can be achieved at a lower cost than otherwise, there is potential for the environment, businesses, agricultural interests, and consumers to gain. Because of these potential gains, water quality trading continues to spark such interest.

There are many sources of information to explore the emerging opportunities in water quality trading. The following Web links and documents may be useful.

References and resources

Environmental Trading Network *http://www.envtn.org/*

World Resources Institute Nutrient Net *http://www.nutrientnet.org/*

Environmental Protection Agency Water Quality Trading

http://www.epa.gov/OWOW/watershed/trading.htm

Environmental Protection Agency Water Quality Trading Assessment Handbook
http://www.epa.gov/owow/watershed/trading/handbook/index.html

Breetz, Hanna, Karen Fisher-Vanden, Laura Garzon, Hannah Jacobs, Kailin Kroetz, and Rebecca Terry. 2004. Water quality trading and offset initiative in the U.S.: a comprehensive survey
http://www.dep.state.fl.us/water/watersheds/docs/ptpac/DartmouthCompTradingSurvey.pdf

Environmental Protection Agency Water Quality Trading Toolkit for Permit Writers
http://www.epa.gov/npdes/pubs/wqtradingtoolkit_fundamentals.pdf

Grassland Bypass Project: Economic Incentives Program Helps to Improve Water Quality
http://www.epa.gov/nps/Section319III/CA.htm

Bear Creek Watershed Association *http://www.bearcreekwatershed.org*

Lessons from the Trading Pilots: Applications for Wisconsin Water Quality Trading Policy
http://www.rs-inc.com/downloads/Water_Quality_Trading-Lessons_and_Applications.pdf

Chapter 6 Carbon Credit Trading

The purpose of this chapter is to address issues that are specific to the trading of carbon credits or more broadly, **greenhouse gas (GHG)** equivalent credits (this will be explained below) and to focus on the implementation challenges for creating a viable market for credits that sequester (or store) carbon in agricultural soils or supply other forms of GHG emission reductions. As in the chapter on water quality trading, this chapter is organized into sections describing who the buyers and sellers of carbon credits are and are likely to be, how the commodity is defined, and how the market for carbon credits functions. The chapter concludes with a discussion of the specific role that NRCS staffs and partner institutions could have in supporting the potential development of expanded markets.

With regard to trading, throughout this chapter, the term carbon trading is used. However, it is important to remember that units of carbon are not the same as units of carbon dioxide. Most international accounting related to climate change focuses on carbon dioxide, CO2, rather than just carbon. There is a relatively direct relation between these two, so that **carbon dioxide equivalents** (CO2E) can be obtained from **carbon** equivalents (CE) by multiplying the ratio of the atomic mass of a carbon dioxide molecule to the atomic mass of a carbon atom (44:12). It is important to remember which unit of measurement is being discussed, carbon or carbon dioxide, so that equivalent metrics are being used when trading is described (box 9).

A second important concept to understand when discussing carbon trading is the idea of carbon sequestration, also referred to as carbon storage. The environmental concern associated with climate change is related to the concentration of GHGs in the atmosphere, which have increased significantly over the past 150 years due to the use of fossil fuels. A primary greenhouse gas is carbon dioxide. There are two basic approaches to curbing the increase of atmospheric carbon dioxide: reduce carbon dioxide emissions in the atmosphere directly (such as by decreasing fossil fuel usage), or sequester carbon in soils, biomass and oceans (the process of extracting carbon dioxide out of the atmosphere and permanently or semi permanently storing carbon in earth systems).

In the context of agriculture or forestry, the sequestration of carbon can occur by storing the carbon in agricultural soils or in plants themselves, such as trees or perennials. Carbon can be sequestered in agricultural soils through conservation practices and land use changes. In many soils and in many climates, converting from conventional to conservation tillage results in increased organic matter and carbon. Switching from annual plants to perennial crops, such as those that might be grown for biofuel production (e.g., switchgrass and miscanthus), is another way that carbon can be stored. A number of carbon sequestration scenarios are also available for rangeland including management of stocking rates, the use of rotational grazing, and restoration of degraded rangeland. The potential for agricultural sources to earn credits for sequestering carbon and then selling them to firms that generate carbon emissions through energy use or other actions represents an important way for agricultural producers to participate in carbon trading programs.

An excellent source of information about the sources of carbon emissions from agriculture, as well as the activities that can reduce emissions and sequester carbon, is the information provided to support the

Voluntary Greenhouse Gas Registry of the Department of Energy. Established under Section 1605(b) of the Energy Policy Act of 1992, the Department of Energy has compiled a list of voluntary measures for sequestration or emissions reductions. Individuals or companies have an opportunity to voluntarily identify actions they have undertaken to reduce or mitigate greenhouse gas emissions. Of particular relevance to those interested in participating in carbon markets are the technical guidelines (*http://www.eia.doe.gov/oiaf/1605/gdlins.html*) that provide detailed information on the activities that can be voluntarily registered, as well as the methods for estimating reductions in GHG emissions from these activities.

Buyers and sellers

In a carbon credit trading program, the buyers of carbon credits are likely to be energy firms and industrial producers of products that use significant energy resources in the production of their products. These firms will demand carbon credits to offset their emissions of carbon, but only if the conditions are right. First and foremost, there must be a reason for them to care about reducing or offsetting their GHG emissions. The most direct reason would be if they face a limit on how much carbon they will be allowed to emit and then allowed to meet that limit either by reducing their GHG emissions internally or by purchasing offsets from another source. This is just a cap-and-trade approach. For cap-and-trade to become a major driver in the United States, a cap on GHG emissions would have to be set. If the United States had signed on to the Kyoto Protocol, such a cap would likely have been in place and spurred interest in carbon trading. Since there is no official cap in the United States, this is not currently driving carbon trading. Even if a carbon cap and trade program is established, it may not have allowed firms to offset their emissions with credits from sequestered carbon in agriculture or forestry.

While a cap and trade program does not exist at present, there are proposals for national programs and regional trading programs being developed and implemented. Boxes 7 and 8 briefly describe the regional programs being developed and implemented in the Northeastern States and in California, respectively. There may be significant opportunities for agricultural sources to participate in these markets, particularly as they become more established.

There is a second driver that might induce firms to purchase carbon credits to offset their GHG emissions: firms may wish to demonstrate to the public and government authorities that they care about their environmental “footprint” and are willing to do something to reduce their impact, even though regulations do not require them to do so. They may also believe that some form of carbon regulation is likely to occur in the future and they may wish to be ready for that eventuality by beginning to develop the knowledge needed to effectively participate in a trading program. While this may be real, it will likely be notably smaller than the demand for credits that would occur if a tight carbon cap were in place.

The Chicago Climate Exchange (CCX) was developed to support carbon trading based on this second driver: the desire for firms to demonstrate their willingness to make some voluntary commitment to reducing atmospheric carbon accumulation and to develop the know-how for firms to engage in a larger trading market if one comes along. Participants must agree to reduce their carbon emissions by 2010 to a total of 6 percent below their baseline emissions, (computed as an average of their 1998–2001 emissions) to become a member of the CCX. Participants can meet these reductions directly by reducing their emissions or indirectly by purchasing carbon credits from the exchange.

Box 7 Regional Greenhouse Gas Initiative of the Northeastern and Mid-Atlantic States

The Regional Greenhouse Gas Initiative (RGGI or Reggi) is an agreement among eight States (Connecticut, Delaware, Maine, Maryland, New Hampshire, New Jersey, New York, and Vermont) to develop a regional cap-and-trade program. The current plans are for the program to go into effect in 2009 and to cover carbon dioxide emissions from power plants, but the signatories have indicated that the program might be expanded to include other sources of GHG gas emissions.

Of central importance to the effectiveness of the program for reducing GHG emissions is the level of the cap that will be implemented. The program calls for a cap set at a total of 121 million tons per year for carbon dioxide emissions in the region from 2009 through 2015. The agreement then calls for a declining cap by 10 percent per year from 2015 to 2019.

Of central interest to the agriculture sector is that the program allows emission sources (power plants) to offset up to about 3 percent of their emissions with offsets from outside of the sector. These offsets could come from agricultural sources, reforestation, or other sequestration options. If the price of credits rises higher than expected, the program allows a greater proportion of offsets to be used to meet an entity's obligations. This provides flexibility in the program in case the cost of reducing emissions is higher than anticipated.

For more information: *http://www.rggi.org/rggi*

Box 8 The California Global Warming Solutions Act of 2006

In 2006, California became the first individual State to pass a law mandating reductions in GHG emissions (including carbon dioxide, methane, nitrous oxide, hydroflurocarbons, perfluorocarbons, and sulfur hexafluoride). The bill is referred to as AB 32 and it requires that the California Air Resources Board identify significant sources of these GHG and includes those sources among those it regulates. The goal of the program is to reduce California's net GHG emissions of GHGs by 25 percent from 1990 levels by 2020.

A timeline was established in the initial legislation for the development and implementation of the program. The timeline calls for the development of a cap-and-trade program and its implementation by 2012. Details concerning the exact industries to be regulated and the possible role of sequestration or offsets are yet to be developed. The program will be developed to be consistent with the voluntary registry program that California Air Resources Board has maintained since the 1990s.

For more information: *http://www.arb.ca.gov/cc/cc.htm*
http://www.arb.ca.gov/cc/factsheets/ab32factsheet.pdf

Who are the potential sellers of carbon credits? Because the members of the CCX can either reduce their emissions on their own or trade for credits, agricultural enterprises that sequester carbon can earn credits and sell them to CCX members. In fact, credits have been generated by a number of agricultural activities and sold on the exchange already. These activities include methane collection and combustion projects; conservation tillage, perennial plantings; and rangeland restoration (*http://www.chicagoclimatex.com/content.jsf?id=1101*).

The commodity

In addition to the commodity itself, there are several other issues that must be resolved before credits can be established and traded. In the case of carbon sequestration, these issues include how the credits are measured and verified, what baselines should be used to give credit for a practice that sequesters carbon, and how to address concerns that sequestered carbon is potentially nonpermanent.

Measurement and verification

As noted in the chapter on water quality, for a commodity to be bought and sold, there must be agreement between the parties (buyers, sellers, and regulators) as to how the credits will be measured. The agricultural sector may be able to participate in carbon markets via direct emission reductions, but a larger role is expected to be played, at least initially, by practices that sequester carbon. The amount of carbon that will be sequestered in a particular field can be widely variable. Soil carbon changes resulting from the adoption of a particular conservation practice, such as conservation tillage, will depend on a great many factors including the kinds of soils and climate of the region, as well as historical land use and management practices. Because this market is evolving, it is uncertain if credits will be available for protecting carbon presently sequestered (such as the carbon sink in rangeland) or only for newly sequestered carbon.

Thus, the amount of carbon that the adoption of a specific practice will sequester is difficult to know exactly ahead of time. However, it will often be possible to make reasonable predictions based on scientific studies and computer-based models. A number of such models are designed explicitly for this purpose. The COMET–VR model, developed by the Natural Resource Ecology Laboratory and the NRCS (*http://www.cometvr.colostate.edu/*), provides users with estimates (and confidence intervals) of the amount of soil carbon sequestered associated with historical, current, and planned land management practices. Another possible way in which carbon credits could be measured is directly through intermittent sampling of carbon sequestered in the actual field (or on average over an entire region).

A final way that carbon credits can be measured is by referring to default values or look-up tables such as those used by CCX or contained in the Voluntary Reporting of Greenhouse Gases 1605(b) Program. While the technical guidelines note that these default values do not take into account the variability across locations that are likely to be present, they provide a useful guide to the potential magnitude of carbon credits that might be reasonable to assign to agricultural activities. For example, table 1.H.23 on page 212 of the technical guidelines (*http://www.eia.doe.gov/oiaf/1605/gdlins.html*) indicates a default value for carbon sequestration of improved rangeland of 300, improved pastureland management of 730 to 900, improved grazing management on pasture of 2,900 and conversion of tillage methods from conventional to no till of 1,300 (all in kg/CO2/ha/yr).

If the credits given for carbon sequestrating practices do not accurately reflect the overall carbon sequestered, the resulting atmospheric concentration of carbon dioxide from trading will not match the atmospheric concentration attained if trading is not allowed. Environmentally, it does not matter whether the credits given for carbon sequestered on each individual pasture or field are correct, only that on average the carbon credits are about right to reduce the atmospheric carbon dioxide concentrations overall.

Regardless of how carbon credits are measured and monitored, as long as the estimates that are used to assign credits are reasonably accurate and verifiable, credits can be given to carbon sequestering practices, trades can take place, and the cost-saving benefits of carbon credit trading can accrue while maintaining environmental integrity. The key characteristic needed for a properly functioning market is that the buyers and sellers must be assured that the credits will be honored with respect to meeting their legal obligations under the credit trading program.

Baseline and timing

In addition to the problem of how to measure the credits that the adoption of conservation system will earn, is the question of what baseline should be used for computing credits. Should credits accrue for all carbon sequestered on a farm or ranch, regardless of when the sequestering practice was adopted? Should all of the sequestered carbon be eligible for credits or should only the level of treatment above some minimum level of treatment accrue credits?

These issues of the baseline are similar to those discussed in chapter 5 regarding water quality credits. Any formal cap-and-trade program that allows sequestration practices to earn credits will have to address these issues in the trading rules. If international agreements are involved, these decisions will be made by the entire international community.

From an environmental perspective, the question of whether credits can be earned for practices that have been installed and functional for many prior years is important. If a conservation practice has been in place for a number of years, then the carbon sequestered by it is already part of the baseline calculations of carbon sequestered in agricultural soils. This carbon does not offset current emissions. From an environmental perspective then, it seems that such credits should not be allowed. The counter argument is that this seems to unfairly treat those “good stewards” who were early adopters of conservation practices.

It is also argued that disallowing these credits will provide a producer an incentive to remove the practice or system and then reinstall it to qualify to supply credits, thereby releasing more carbon to the atmosphere. This all depends on whether it is a cap-and-trade or a baseline-and-credit program. Under a baseline-and-credit program the producers might be able to do this although it is certainly possible to write rules that would make this difficult to do and still be eligible for trading. Under a cap-and-trade program, there would be no incentive for an agricultural producer to do this since they would have to purchase credits to offset the lost carbon.

Regardless of how this debate ends, it is important to understand that if credit is given for such carbon sequestered before the baseline level of atmospheric carbon dioxide was established, tighter overall carbon emissions limits will be needed to achieve target atmospheric carbon reductions.

A final baseline-related issue is who owns the credits generated by an agricultural practice if funds from a government supported conservation program are used to support the implementation of the practice. For example, if a land owner enrolled in the Conservation Reserve Program (CRP) and planted trees as part of that program, would the land owner be allowed to earn carbon credits for this sequestration and sell them at market rates? In the cases of USDA-funded conservation programs, such as the CRP, the answer is yes. The USDA has made the policy decision that any credits generated through its conservation programs are owned by the program participant. In the case of other programs, however, the answer may not be so clear cut. USDA policies and those of other programs may change over time, so program participants should be careful to check on this before assuming that credits generated by government funded activities can be sold.

Permanence concerns

One important way in which agriculture is likely to participate in carbon markets is by adopting practices that sequester carbon in agricultural soils, trees, and other plants. One concern about credits earned in this manner is that they may not be permanent. While reductions in emissions are permanent, sequestered carbon is not. Carbon sequestered in a tree will be lost to the atmosphere if the tree burns (although not if it is cut down and used for furniture or other goods). Of equal or greater concern is the ease with which carbon sequestered in soils from the adoption of low or no-till methods can be lost by re-tilling the soil. This raises a question: if 1 ton of carbon was sequestered and then, a decade later, was lost back to the atmosphere, does that mean that it was worthless to have sequestered the carbon in the first place? The answer is no, since 1 ton of carbon that would otherwise have been in the atmosphere was stored for 10 years.

While temporary storage can contribute to mitigating carbon’s impact on climate change it is not as valuable as the sequestration of a ton of carbon that never reenters the atmosphere (i.e., is permanent). What does this mean for a credit trading program that includes carbon sequestration? One possibility is that credits given for carbon sequestering activities be for less than the amount of carbon actually sequestered by them to account for the possibility that some of the carbon will eventually be lost. In essence, this is quite similar to the idea of using a trading ratio that is less than one when relatively certain sources of emission reductions are traded for more uncertain ones—such as the case of point sources trading with nonpoint sources for water quality gains.

Another possible solution to the nonpermanence question might be to require in the initial contract, that a carbon credit be earned only if the supplier guarantees that the carbon stored is permanent. If it is released (accidentally or intentionally) an equivalent amount of carbon must then be sequestered by other means, or credits purchased to cover the released carbon. This form of a contract is referred to as a pay-as-you-go contract (Feng, Kling, and Zhao 2002). Another option is for contracts to be established where the payment for a carbon credit is placed in an annuity account whereby a farmer or rancher (or supplier of the credit) receives the interest from the account annually as long as the carbon remains sequestered. If the carbon is permanently stored or emissions permanently reduced, the farmer or rancher receives a never-ending stream of annual payments.

The potential impermanence of sequestered carbon is an important issue that needs to be adequately addressed in the creation and accounting of carbon credit programs. From all indications, it appears that carefully constructed programs should be able to accommodate these concerns.

Other greenhouse gases

Methane, nitrous oxide, and hydrofluorocarbons are other GHGs that contribute to global warming and climate effects (as identified by the International Panel on Climate Change). Each of these gases have different effects on global warming and the environment, so scientists have established **global warming potentials (GWP)** to compare them (see box 9). For example, the GWP of methane is "23," which means that methane contributes about 23 times as much to global warming as the equivalent amount of carbon dioxide. While we have used the term "carbon trading" throughout this reference, you could also imagine markets in which all of the GHGs are traded, but they are first converted into carbon (or carbon dioxide) equivalents using the GWP. In essence, GWPs act like a trading ratio between different GHG.

When explicitly considering any GHG other than carbon dioxide, a number of additional activities may be eligible for inclusion in trading programs or be subject to caps. The technical guidelines for the 1605(b) Voluntary Reporting of Greenhouse Gases Registry discussed earlier contains a listing of many such options including sources of GHG in both the agriculture and forestry sectors, as well as activities that sequester GHG. For example, livestock is a significant source of methane emissions via enteric fermentation and waste. The technical guidelines on voluntary reporting (*http://www.eia.doe.gov/oiaf/1605/gdlins.html*) provide default methane emission factors for cattle, sheep, and other livestock. These emissions factors vary by region of the country as well as by type of usage of the animal (e.g., beef cows, heifer stockers, dairy costs). Livestock waste is an important source of both methane and nitrous oxide. Anaerobic digesters are identified by the 1605(b) technical guidelines as an effective means of reducing greenhouse gas emissions.

Crop production can generate significant emissions of GHG. For example, the burning of residue associated with corn, peanuts, soybeans, barley, wheat, rice, grass seed, sugarcane, and other crops can produce significant amounts of nitrous oxide and methane. The cultivation of rice produces methane and the application of commercial fertilizers and manure can result in nitrous oxide emissions from agricultural soils. Alternative activities that reduce the amount of these emissions can potentially generate GHG emission reduction credits.

Market functioning

Carbon dioxide and other greenhouse gas credit trading is a global issue, and thus this market is not geographically dependent like other more local or regional environmental commodities. A ton of carbon emitted in Iowa has the same effect on the global carbon balance as a ton emitted in California, or for that matter, in any other part of the world. This is an important reason why the trading of carbon credits is part of the Kyoto Protocol that 172 countries (not including the United States) have ratified and which allows carbon credits to be traded among those countries.

In addition to the geographic scope of the market, another feature of the market structure is how trades take place. In the case of the CCX, market aggregators have played an important role in market functioning. For example, the Iowa Farm Bureau has contracted separately with a large number of producers who are willing to adopt carbon sequestering practices, such as low-tillage methods, to acquire a large amount of credits for sequestered carbon. This aggregation of carbon is sold on the CCX at going rates and the proceeds, less a fee for the aggregators, and the CCX are distributed back to the producers. Aggregators will likely be a fundamental part of the carbon market because it is more efficient for one entity to specialize in writing contracts with a large number of producers than for each producer to separately offer its carbon for sale on the CCX (or other market).

The role of NRCS staffs and partners

Those with expertise in agricultural conservation practices who understand the "ins and outs" of agriculture could play a large role in helping these markets reach their full potential. As with the case of water quality trading, there are a number of direct roles that the NRCS could play in support of these efforts, including:

- Identify potential generators of credits within privacy constraints
- Explain the benefits (and costs) of participating in these markets to potential participants, along with other available incentives as they pertain to a part of the conservation practices planning process
- Become familiar with the technical standards and documentation requirements which may in the future incorporate in the conservation plan baseline information and potential quantification of impacts of each alternative
- Develop or help support the development of tools for measuring baseline information and the potential effect(s) of alternatives which could be used for credits

NRCS staffs are likely to be particularly effective at identifying appropriate practices that can sequester carbon in the appropriate crop, range, and forestry contexts. Additionally, RC&D councils may be able to facilitate the aggregation of credits from a large number of ranches and farms reducing the transaction costs and therefore increasing the profitability of trades to all parties.

Box 9 Table of Global Warming Potentials

Gas	Global warming potential (GWP)1	Expected life in the environment (years)1
Carbon Dioxide	1	variable
Methane	23	12
Nitrous Oxide	296	114
HFC–23	12,000	260
HFC–125	3,400	29
HFC–134a	1,300	13.8
HFC–143a	4,300	52
HFC–152a	120	1.4
HFC–227ea	3,500	33
HFC–236fa	9,400	220
Perfluoromethane (CF4)	5,700	50,000
Perfluoroethane (C2F6)	11,900	10,000
Sulfur Hexafluoride (SF6)	22,200	3,200

1 Taken from table 6.7: Direct Global Warming Potentials (mass basis) relative to carbon dioxide (for gases for which the lifetimes have been adequately characterized). Chapter 6, Radiative Forcing of Climate Change, in Climate Change 2001: Working Group I: The Scientific Basis. *http://www.grida.no/climate/ipcc_tar/wg1/248.htm*

There are many useful sources of information to help one further explore the opportunities that continue to emerge regarding greenhouse gas and carbon trading. Here are some useful starting points available on the Web.

References and resources

California Climate Action Registry *http://www.climateregistry.org/*

Chicago Climate Exchange *http://www.chicagoclimatex.com/*

Emission Facts: Metrics for Expressing Greenhouse Gas Emissions: Carbon Equivalents and Carbon Dioxide Equivalents *http://www.epa.gov/otaq/climate/420f05002.htm*

Feng, H., J. Zhao, and C. Kling. "Towards Implementing Carbon Markets in Agriculture," *Choices* 2002

Greenhouse gas offset guidelines from Duke and Environmental Defense *http://nicholasinstitute.duke.edu/ecosystem/harnessing-farms-and-forests/harnessingfarms*

International Panel on Climate Change *http://www.ipcc.ch/*

Iowa Farm Bureau carbon program http://www.agragate.com/default.aspx

Technical Guidelines Voluntary Reporting of Greenhouse Gasses 1605b program *http://www.eia.doe.gov/oiaf/1605/gdlins.html*

Tools of the Trade: A Guide to Designing and Operating a Cap and Trade Program for Pollution Control, U.S. Environmental Protection Agency Office of Air and Radiation *http://www.epa.gov/airmarkets/resource/docs/tools.pdf*

USDA Forest Service, 1605b Forestry Tables *http://www.fs.fed.us/ne/durham/4104/1605b.shtml*

USDA-NRCS Air Quality and Atmospheric Change *http://www.airquality.nrcs.usda.gov*

USDA-NRCS Global Climate Change page *http://soils.usda.gov/survey/global_climate_change.html*

Chapter 7 Trading Wetlands

Over half the wetlands present 400 years ago in the continental United States have been drained or filled for agricultural or development purposes. Since wetlands can provide effective flood control, drought management, and a significant amount of wildlife habitat (especially for birds), there has been a major effort to reverse or slow the trend of wetland losses (*http://www.epa.gov/owow/wetlands/vital/status.html*).

A major factor in current wetlands policy is Section 404 of CWA which requires that anyone considering filling a wetland must first receive a permit from the U.S. Army Corps of Engineers (USACE). In issuing permits, the USACE requires that permit applicants restore or create wetlands to offset the wetlands that a fill project destroys. This requirement can be satisfied by the permit holder undertaking the restoration directly or by contracting with others to restore or create an equivalent amount of wetland acreage or services or both. The latter approach is, of course, a market-based solution to providing offset wetlands, although under its current implementation, there are some important limits to the amount and type of wetland trading that can occur.

The requirement that permit holders either restore wetlands directly or pay for the restoration of wetlands via the purchase of credits is intended to support the national goal of "**no net loss**" of wetlands. The goal has been in effect since the late 1980s when President George H.W. Bush accepted the advice from the National Wetlands Policy Forum to adopt such a goal. Presidents Bill Clinton and George W. Bush have both called for net increases in wetlands. While increases have not occurred, the U.S. Environmental Protection Agency (EPA) reports that wetland losses have slowed considerably since the 1970s when the United States was experiencing an annual loss of over 450,000 acres per year. In contrast, the United States had a net loss of only about 60,000 acres in 2004 (*http://www.epa.gov/ow/waternews/2004/062904.html*).

From the perspective of credit trading, the combination of the "no net loss" goal and the authority that the USACE has to issue permits that require the offsetting of wetland losses with the restoration or creation of wetlands elsewhere has the potential to act as a very effective cap to promote trading. While the presence of a clear cap sets the stage for a potentially effective trading program, whether this potential is realized will depend on a variety of factors concerning the definition of the traded commodity and details of the market. The remainder of this chapter addresses a number of those issues, beginning with a discussion of the buyers and sellers, the commodity, and the functioning of the market.

Buyers and sellers

Who are the potential buyers of wetland credits? Those affected by the 404b permit requirements comprise most of the buyers. In addition to the "no net loss" policy implemented by the USACE, many States and other authorities are developing wetlands strategies and requirements that may also serve to create the need for wetland offsets and, therefore, the demand for credits. Another driver of wetlands trading involves the **Swampbuster** provision of the previous two Farm Bills. In this legislation, an agricultural producer must receive valid wetland offsets for any wetland acreage they begin to farm to retain eligibility for agricultural program payments (for exemptions see www.nrcs.usda.gov ***Home / Programs & Services / Alphabetical Listing & Archive*** */ Conservation Compliance*). Producers that require wetland offsets are potential buyers of wetland credits, as well.

A major source for wetland restorations or creations is **wetland banks**. These are restored wetlands that are undertaken to provide offsets for the mitigation requirements of the 404b permits or other wetland restoration requirements. The definition provided in the Federal Guidance for the Establishment, Use, and Operation of Mitigation Banks is:

Mitigation banking has been defined as wetland restoration, creation, enhancement, and in exceptional circumstances, preservation undertaken expressly for the purpose of compensating for unavoidable wetland losses in advance of development actions, when such compensation cannot be achieved at the development site or would not be as environmentally beneficial. It typically involves the consolidation of small, fragmented wetland mitigation projects into one large contiguous site. Units of restored, created, enhanced or preserved wetlands are expressed as "credits" which may subsequently be withdrawn to offset "debits" incurred at a project development site.
http://ceres.ca.gov/wetlands/policies/mitigation_guidance.html.

This means that public or private organizations that create or expand ecologically sound wetlands can sponsor wetland banks. These banks can be used to offset the reductions in wetlands resulting from projects that cause wetland losses. Once sponsors of these banks meet the requirements for wetlands establishment, they are provided with credits based on the size and ecological integrity of the wetlands that can be sold to satisfy the requirements of wetland offsets from the permitting process of the USACE. The Environmental Law Institute (2006) reports that there were more than 200 wetland banks in existence across the United States in 2002 and that more than 130 were undertaking sales.

Agricultural enterprises may participate as either a seller or buyer of wetland credits. Since agricultural landowners may own land with remnant wetlands or previously drained wetlands, producers may find it profitable to sell land or easements to wetland banks and thus increase the supply of wetland credits.

The commodity

As noted in other chapters, for credits in an environmental commodity to be exchanged, there must be agreement between the parties (buyers, sellers, and regulators) as to how the commodity will be defined and measured. In the case of wetlands, a guidance document, released under the auspices of the EPA, USACE, U.S. Fish and Wildlife Service (USFWS), NRCS, and NOAA's National Marine Fisheries Service provides detailed guidance on the creation of wetlands that are suitable replacements for wetlands that are lost due to development or farming.

Wetland banks can effectively certify their credits as being valid for mitigation uses under the 404b permitting process or the Swampbuster provision or both by going through a process in which a Mitigation Bank Review Team is established. The guidance stipulates that representatives from the USACE, EPA, USFWS, NOAA's National Marine Fisheries Service, and NRCS, as well as other appropriate stakeholders, should serve as members of the review team. Generally, a representative from the USACE will serve as chair of the Review Team, except when the purpose of the bank is to provide offsets exclusively for Swampbuster provision wetland offsets. In that case, the NRCS takes the responsibility of chairing the Review Team.

There is no single metric for determining the number of credits generated by restoring or creating a wetland. Ideally, a wetland that is used to offset a drained or filled wetland should provide the same set of ecosystem services and functions. For this reason, it is generally preferable to have credits defined in terms of the functioning of the wetland. A number of assessment methodologies have been developed and are sometimes used to establish credits for wetland banks. Two such evaluation methods are the Wetland Evaluation Technique and the Hydrogeomorphic Approach (*http://water.usgs.gov/nwsum/WSP2425/functions.html*). Other approaches exist and are being further refined regularly. While ideal in many circumstances, evaluation methodologies are time consuming and imperfect.

A simpler approach for assigning credits to wetland banks is the most common and is based simply on the size of the wetland. This approach of course makes the assumption that the one acre of wetland established in the wetland bank provides the same amount of wetland functioning or value or both as the original wetland. This may not be true. The loss of a particularly unusual or well-placed wetland may result in the loss of more wetland services than those restored by an equal amount of wetland acreage in the wetland bank. To account for this possibility, permitting may require that more than one credit be attained to meet the offset requirements. For example, if 2 acres of a wetland are to be lost due a development project, the USACE may require the project sponsor to attain 6 acres of wetlands from a wetlands bank before granting the permit. This would imply a 3 to 1 trading ratio. This is analogous to the use of trading ratios for point-nonpoint source trades described in the water quality chapter or the use of discount factors in carbon credit markets.

In determining whether credits from a particular wetland bank can be used to offset a drained or filled wetland under a 404b permit or Swampbuster provision, the guidance document indicates that the review team should consider the following seven criteria.

Project applicability

Credits from mitigation banks may be used for 404b permits or Swampbuster offsets, but they must also satisfy any other program requirements and only one wetland credit can be used for a given activity (i.e., double counting is prohibited).

Relationship to mitigation requirements

Wetlands from a mitigation bank are to be used to offset wetlands only when all of the conditions of using a mitigation project rather than preventing the fill of a wetland or doing onsite mitigation have been ruled out. Both the Swampbuster provisions and the 404b permits require that before a wetland credit can be considered, all efforts at onsite mitigation must be considered and used if possible.

Geographic limits of applicability

When establishing a wetland bank, the providers of the bank should clearly indicate the geographic range for which the wetland services provided by the bank are relevant. The guidance suggests that generally wetlands created for a wetland bank should be allowed to provide offsets for drained or filled wetlands within the same ecoregion or hydrologic unit.

Onsite mitigation versus mitigation banking

In general, onsite mitigation is viewed more favorably than the use of credits from a wetland bank. The purpose of favoring onsite mitigation is that the environmental services lost by draining or filling a wetland are likely to be best replaced by a wetland sited near the original location. However, the guidance notes that there may be cases when the use of a wetland bank is more environmentally sound. Due consideration should be given to the habitat, compatibility of the wetland creation project with land uses neighboring it, and the ability to determine the ecological integrity of the site.

In-kind versus out-of-kind mitigation determinations

There are a number of different types of wetlands including marshes, swamps, bogs, and fens. The U.S. Department of Interior (DOI) has a formal classification scheme (*http://www.fws.gov/wetlands/*). The guidance indicates that in general, credits from wetland banks containing one type of wetland (i.e., tidal) should be used to offset wetland losses of the same type; this is referred to as an in-kind trade. If creation of a tidal wetland were used to offset a nontidal wetland, it would be considered an out-of-kind wetland mitigation. Exceptions where such out-of-kind exchanges may be appropriate occur when the wetland bank provides a particularly valuable or rare type of wetland whose services are deemed to be particularly valuable.

Timing of credit withdrawal

In general, credits should not be withdrawn from a wetland bank (i.e., sold to offset wetland losses elsewhere) until there is adequate functioning of the wetland to provide the ecosystem function and services as those lost in the project being offset. However, the guidance recognizes that the financial integrity of the wetland bank may require some compensation to the providers of the wetland bank before full wetland functioning is accomplished. Thus, the guidance indicates that it may be appropriate to allow some use of the credits prior to full functioning, depending on the financial situation of the bank and the likelihood that complete ecosystem functioning will follow.

Crediting/debiting/accounting procedures

The guidance calls for a careful accounting of all credits and debits to the bank. The credits and debits are to be assessed using an agreed upon assessment methodology for determining the ecosystem functioning of the wetlands under consideration (those in the bank for which credits are provided to the bank provider and those debited from the bank for use in offsetting wetland losses). Members of the Review Team are encouraged to take an active role in evaluating the long-term viability of the wetland bank and, based on the continuing assessment of wetland conditions, it is possible that the number of credits provided to the bank could be reconsidered.

Market functioning

While most of the attention in this chapter has focused on wetland banks and their operation, there are other market structures which have been used for wetland credit trading. So-called “in-lieu fee” programs have sometimes been used in the past. In these programs, a permit holder would be granted permission to undertake a project that drains or fills a wetland if they contribute to a fund. When enough money was collected by this process, a replacement wetland would be constructed. One of the chief shortcomings of this approach is that wetlands are lost before replacement wetlands are provided. This means that there is a net loss in wetlands and wetland services during this period of time. Largely for this reason, “in-lieu fee” programs have fallen out of favor.

Regardless of whether mitigation wetlands are provided by a wetland bank, the individual who needs the wetland offset, or any other provider, the question of legal liability for failure of the wetland to provide ecosystem functions at the level expected is an important component of assuring a well-functioning market. In the case of a wetland bank, the Federal Guidance document makes clear that this liability falls with the provider of the wetland bank, and not with the individual or entity that has purchased the credit. Thus, once credits have been established and provided to a wetland bank and once a permit holder has received approval to use those credits to satisfy their offset requirements, there is no longer any liability on the buyer of the credit. Once the wetland has been verified to provide the service and functions required, a conservation easement is transferred to a nonprofit organization. Clear indication of who is liable should a problem arise concerning the future viability of the wetlands that have been approved is an important component of providing the needed confidence in the commodity being exchanged for a well-functioning market to develop.

It is important to note that while there is full-fledged market in wetland credit trading, with a large number of trades occurring, there are limits to the extent of the market. Most notably, both the Swampbuster provision of the farm program and the permitting of wetland fills under the 404b permitting process place heavy emphasis on undertaking mitigation at or near the original wetland site, rather than allowing the use of credits for wetland remediation. And such mitigation is an option only after the permittee first demonstrates that all efforts to avoid the initial harm to the resource have been investigated. Shabman and Scodava (2004) argue that these requirements make wetland crediting more like a command and control approach than a market-based incentive approach. While there is no doubt that these requirements limit the size and extent of the market, it is still the case that the wetland offsets that are achieved should be those that are the lowest cost to provide—one of the key advantages of market based systems.

The role of NRCS staffs and partners

In the case of wetland banking, there is a clear role for NRCS staffs. As the Federal Guidance indicates, NRCS staffs are to be members of the Mitigation Banking Review Team that determines the viability of proposed wetland banks and the number of credits to be given to the bank. This role is even more significant when the wetland is being used to satisfy the requirements of the Swampbuster provision of the Farm Bill. As mentioned previously, NRCS staffs will typically then chair the Mitigation Bank Review Team. In this capacity, NRCS staffs will play a key role in determining whether a particular wetland is a viable substitute for a drained wetland.

In addition, NRCS staffs may play many support roles by:

- Explaining the benefits and costs of participating in these markets to potential participants, along with other available incentives as a part of the conservation planning process
- Becoming familiar with the technical standards and documentation requirements which may in the future incorporate in the conservation plan baseline information and potential quantification of impacts of each alternative
- Identifying potential sites for wetland restoration
- Working with producers to determine whether onsite mitigation is viable when Swampbuster provisions apply
- Supporting efforts to see that practices adopted to generate credits are being faithfully implemented

References and resources

Federal Guidance for the Establishment, Use and Operation of Mitigation Banks
http://www.epa.gov/owow/wetlands/guidance/mitbankn.html
http://ceres.ca.gov/wetlands/policies/mitigation_guidance.html

U.S. Army Corps of Engineers FACT sheet
http://www.mvm.usace.army.mil/regulatory/regulations/clean_water.htm

National Wetlands Mitigation Plan *http://www.fws.gov/habitatconservation/MAPwithsignatures.pdf*

EPA mitigation Web site *http://www.epa.gov/wetlandsmitigation/*

U.S. Army Corps of Engineers Regulatory Program Web site
http://usace.army.mil/CECW/Pages/cecwo_reg.aspx

Society of Wetland Scientists. Mitigation banking position paper.
http://www.sws.org/wetland_concerns/banking.mgi

National Mitigation Banking Association *http://www.mitigationbanking.org/*

Fish and Wildlife Service, National Wetlands Inventory *http://www.fws.gov/nwi/*

Classification of Wetlands and Deepwater Habitats of the United States
http://www.fws.gov/wetlands/_documents/gNSDI/ClassificationWetlandsDeepwaterHabitatsUS.pdf

Shabman, L., and P. Scodara. 2005. The future of wetlands mitigation banking. *In* Choices Magazine, 1st Quarter 2005. *http://www.choicesmagazine.org/2005-1/environment/2005-1-13.htm*

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Environmental Law Institute. 2002. Banks and fees: the status of off-site wetland mitigation in the United States. U.S. Army Corps of Engineers. Washington, DC. *http://www.elistore.org/reports_detail.asp?ID=10695&topic=Wetlands*

Chapter 8 Habitat Credit Trading

As of late 2007, the U.S. Fish and Wildlife Service (USFWS) reported that there are about 1,350 animals and plants listed as either **endangered** or **threatened** in the United States and another 280 animals and plants that are considered candidate species for listing (*http://ecos.fws.gov/tess_public/Boxscore.do*). Traditionally, market-based approaches have not been seen as a major tool for species conservation efforts. Recently however, **habitat credit trading** is emerging as an approach to support efforts to preserve habitat for wildlife and endangered or threatened species. The basic idea is to allow the conservation of habitat in one location to offset or trade for the loss of habitat elsewhere.

Ideally, market-based approaches will help make it possible to provide improved habitat and biodiversity at lower costs than would be possible using only standard regulatory approaches. As in most credit trading situations however, for both the environment to gain and costs to fall, the credit program must be structured correctly with adequate oversight to be sure that only appropriate trades occur. In May of 2003, the USFWS promulgated guidance regarding the establishment and running of "**conservation banks**" (*http://www.environmentaldefense.org/documents/2790_ConservationBanking.pdf*) which provides important information on the definition of credits for trade. Two additional developments may provide significant impetus for substantially more credit trading as a tool to support habitat protection. First, in April 2007, the NRCS, Department of Interior (DOI) and the Association of Fish and Wildlife Agencies signed an agreement concerning the evaluation of habitat credit trading for **at-risk species** habitat (*http://www.fws.gov/endangered/esa-library/pdf/Credit_Trading_MOU.pdf*). This agreement commits the organizations to use their programs to facilitate the creation of **habitat credit banks** to mitigate private sector requirements. Second, in November of 2007, the USFWS released draft guidance on a **recovery crediting system** referred to as "Endangered Species Recovery Credits." While still in draft form, this guidance sets out a plan to develop guidelines that will allow Federal agencies to establish **conservation credits** on private land that can later be used to offset negative impacts of Federal actions to wildlife habitat.

If one has read the previous chapter about wetlands trading, one no doubt sees a strong similarity between wetlands mitigation banking and habitat credit trading. While very similar in spirit, the two differ in one important way. In habitat credit trading, preservation of existing habitat with long-term conservation value is viewed as an important function of species conservation. As a result, conservation credits can be earned for preserving, as well as restoring or enhancing habitat for targeted species. In contrast, wetland credits are generally only earned for restoring or creating additional wetlands. Essentially, what differs between these two forms of credits is the definition of the commodity. In the case of conservation credits, the commodity is increased sustainability of the species, while in the case of wetland credits, the commodity is the creation of new wetland function.

As in the case of wetlands, there are important regulatory requirements currently in place that can act to provide important components of a credit trading system. The two major drivers are sections 7 and 10 (habi tat) of the Endangered Species Act. These are the only two sections of the Act under which incidental take of listed species can be authorized. Section 7 "directs all Federal agencies to use their existing authorities to conserve threatened and endangered species and, in consultation with the Service, to ensure that their actions do not jeopardize listed species or destroy or adversely modify critical habitat" (*http://www.fws.gov/endangered/esa-library/index.html#consultations*). This requirement applies to actions taken by the Federal Government directly and to Federal approval of permits for actions on private lands. Conservation banks are often used as part of regional planning efforts that result from large Habitat Conservation Plans (HCPs) developed under section 10 of the Act. However, HCPs on any scale may not be able to mitigate unavoidable adverse effects to species at conservation banks.

As in the "no net loss" wetland policy described in chapter 7, this requirement has the potential to act as an effective cap for the establishment of a vigorous credit trading program. However, whether this potential is realized will depend on a variety of factors concerning the definition of the trading commodity and details of the market. The remainder of this chapter addresses a number of those issues, beginning with a discussion of the buyers and sellers, the commodity, and the functioning of the market.

Buyers and sellers

The potential buyers of conservation credits[2] are firms or government entities wishing to develop land for commercial or residential use or alter land use in some other way (i.e., for road construction) in ways that will adversely affect threatened or endangered species or more broadly, any at-risk species that fall under the protection of Federal or State requirements.

One major source of supply of conservation credits is via conservation banks. This is habitat that is preserved permanently under long-term agreements. Once credits are certified, the owners of these credits can sell them to satisfy the mitigation requirements of developers or agencies whose land projects destroy or alter wildlife habitat. The USFWS defines a conservation bank as follows:

Conservation banks are lands that are permanently protected and managed as mitigation for the loss elsewhere of listed species and their habitats. Conservation banking is a free market enterprise based on supply and demand of mitigation credits. By mitigating multiple development projects at a single site, a conservation bank, all parties involved, including the species benefit from economies of scale
http://www.fws.gov/endangered/esa-library/pdf/ImperiledWildlifeFinalDec2005.pdf

Organizations that protect wildlife habitat with species of interest may be able to earn credits that can be sold to developers offsite. For an example of a well-functioning conservation bank, see box 10, which briefly describes the successes of a conservation bank located in California, the Dove Ridge Conservation Bank.

An example of a successful recovery crediting system venture is the bank developed by the Department of Defense (DOD) for the conservation of the endangered golden-cheeked warbler which activities on the Fort Hood, Texas, military base disrupted. By implementing actions on private lands near the base that supported recovery of the species, the DOD requested that credit for these activities be "banked" for its future use when various training exercises could disrupt the species on site.

[2] From now on, we use the term "conservation credit" to refer to any credits generated for purpose of habitat credit trading rather than the more specific terms, such as "recovery credits" that may be used under specific forms of habitat credit trading.

California has had an active conservation banking policy since 1995 (*http://ceres.ca.gov/wetlands/policies/mitbank.html*), and there were more than 50 such permanent banks active in the State as of 2006 (*http://www.environmentaldefense.org/article.cfm?contentID=2791*). While other States do not have such large numbers of banks yet, there are active banks in a number of locations outside of California.

The commodity

As for any marketed commodity, for exchange to take place, there must be agreement between the parties (buyers, sellers, and regulators) as to how the commodity will be defined and measured. In the case of conservation credits, certification will generally be done under the auspices of the USFWS since they are the agency responsible for the implementation of the Endangered Species Act. Other State and/or Federal agencies may also be involved in the certification of credits as agreements between agencies continue to develop and as these markets evolve.

As in the case of wetlands, no single criteria or set of criteria for determining the amount of credits to provide for a given amount of habitat is likely to work in all cases. Some criterion that may be used include quantity, quality, species covered, conservation benefits (property location and configuration, contribution to regional conservation efforts), and available or prospective resource values. Ideally, habitat that is used to mitigate lost habitat for a threatened or endangered species should provide the same, or superior, set of ecosystem services and functions and should support all of the same species as the mitigated site. In practice, credits have typically been assigned based on the amount of acreage of appropriate habitat and the presence of a nest site or family group of the species of interest.

Market functioning

At present, the purchase of credits from conservation banks is the primary way in which trading in conservation credits is occurring. Consequently, the key questions concerning market function relate to the development and functioning of conservation banks. As noted in the introduction, several recent documents have provided guidance concerning the trading of conservation credits generated by banks. In its May of 2003 guidance, the USFWS identified a number of guiding principles. Environmental Defense identifies the most important provisions as:

“(1) conservation commitments in banks must be permanent, secured by conservation easements or deed transfers;

(2) “service areas,” the geographic areas in which bank credits may be used to offset impacts, must generally be the recovery plan-designated “recovery unit” within which the bank occurs;

(3) a written “banking agreement” must be prepared for every bank, and that agreement must include both a formal management plan for the bank property and a funding commitment to implement it;

(4) credits are generally to be awarded for biological accomplishments achieved, rather than simply for conservation actions taken;

(5) the sale of credits before they are actually earned;

(6) preservation of existing habitat, which is generally not allowed by wetland mitigation banking policy, has been a common feature of conservation banking practice, and will continue to be under the new guidance; and

(7) a consistent and principled approach to mitigation, both as among multiple conservation banks for the same species, and as between banking and non-banking means of mitigation, is required. (*http://www.environmentaldefense.org/article.cfm?ContentID=2791*)"

While still an evolving area of credit trading, these principles are likely to serve as the main means for the workings of these markets in the near future.

The role of NRCS staffs and partners

As in many of the credit trading programs described in previous chapters, NRCS staffs and partners can play important informational roles in the developing and supporting conservation trading. Specifically, NRCS staffs and partners can help identify those farmers and landowners who would benefit from preserving habitat in exchange for credits that can be sold to willing buyers.

In short, NRCS staffs may play many support roles by:

• Explaining the benefits (and costs) of participating in these markets to potential participants

• Identifying potential sites for conservation banks

• Helping to support appropriate activities on land near conservation banks

References and resources on habitat and recovery credits

Endangered Species Recovery Credits Questions and Answer
http://www.fws.gov/home/feature/2007/EndangeredspeciesRecoveryQsandAsVF1107.pdf

U.S. Fish and Wildlife Service Permits for Native Species under the Endangered Species Act
http://www.fws.gov/endangered/esa-library/pdf/permits.pdf

USFWS Threatened and Endangered Species System (TESS) *http://ecos.fws.gov/tess_public/Boxscore.do*

Working Together: Tools for Helping Imperiled Wildlife on Private Lands
http://www.fws.gov/endangered/esa-library/pdf/ImperiledWildlifeFinalDec2005.pdf

Environmental Defense, Summary of Conservation Banking
http://www.environmentaldefense.org/article.cfm?ContentID=2791

Guidance for the Establishment, Use, and Operation of Conservation Banks, U.S. Fish and Wildlife Service, May 2003 *http://www.environmentaldefense.org/documents/2790_ConservationBanking.pdf*

Box 10 The Dove Ridge Conservation Bank

One example of a conservation bank that has successfully protected threatened species is Dove Ridge, located in California's Central Valley. This conservation bank covers 2,400 acres and currently holds 466 development credits. Credits have already been sold to developers in the area to satisfy their requirements to protect Fairy Shrimp and/or the Meadowfoam plant that lives in shallow wetland areas. Credits have also been sold to CalTrans, the California transportation authority, to offset impacts to the two species created by road construction.

Approval for the credits created by Dove Ridge was required from the USACE, the USFWS, the U.S. Environmental Protection Agency (EPA), as well as the California Department of Fish and Game. Credits have been sold at prices ranging from $70,000 to $200,000.

Much of the information in this box came from:
http://www.sfgate.com/cgi-bin/article.cgi?file=/c/a/2005/03/29/BAG3MBVSEG1.DTL

For a list of active and sold out banks in California: *http://www.fws.gov/sacramento/es/bank_list.htm*

Glossary

Aggregator A trading representative that acts on behalf of multiple participants in a trading program. It is a sort of broker that connects buyers and sellers and also forms contracts within the bounds of existing regulation.

At-risk species Plant and animal species that are listed as endangered or threatened under the Endangered Species Act (ESA); proposed or candidates for listing under ESA; likely to become candidates for listing in the near future; species listed as endangered or threatened (or similar classification) under State law; and State species of conservation concern.

Attenuation The degradation or diminishing of a pollutant through natural processes.

Baseline A minimum level of conservation that must be in place before additional practices may be eligible for trading.

Baseline-and-credit trading program A credit trading program where a firm or entity that is not otherwise required to meet environmental performance improvements can earn credits to sell to a firm that is required to meet environmental reductions.

Best Management Practices (BMPs) Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from nonpoint sources (taken from *http://www.epa.gov/OCEPAterms/bterms.html*).

Cap-and-trade A credit trading program where both the buyer and seller of credits are under an obligation to improve their environmental performance.

Carbon credits Reductions in carbon or carbon dioxide emissions that are used to offset carbon dioxide emissions elsewhere.

Carbon dioxide equivalent The quantity of carbon dioxide that would have the same global warming potential (GWP), when measured over a specified timescale (generally 100 years) as the gas being emitted.

Carbon equivalent The quantity of carbon that would have the same global warming potential (GWP), when measured over a specified timescale (generally 100 years) as the gas being emitted. Not commonly used anymore.

Carbon sequestration Any process that takes carbon from the atmosphere and stores it in the soil or oceans. Common practices include the planting of trees and using conservation tillage.

Conservation Lands that are managed in order to protect endangered or threatened species. They

banks	act as offsets for loss of habitat elsewhere.
Conservation credits	Credits for land that is set aside for conservation purposes. Credits may be traded when some activity may disrupt the habitat of endangered or threatened species.
Cost-share programs	State or Federal conservation programs that pay some, but not all, of the costs of adopting and implementing conservation practices.
Credit trading program	Any program in which a commodity is traded to follow regulation. Typical commodities include nitrogen, phosphorus, carbon, selenium, and heavy metals.
Ecosystem services	Resources and processes that ecosystems naturally provide. Examples are flood control, water purification, climate stability, pollination, disease control, and nutrient cycling.
Endangered	A species that is in danger of becoming extinct throughout all or a significant portion of its range (taken from *http://www.fws.gov/midwest/endangered/glossary/index.html*)
Environmental credit trading	Environmental improvements undertaken by one firm or entity in exchange for payment for these services from another entity to meet environmental goals (typically a mandatory standard of some form).
Environmental goods	A subset of goods associated with ecosystems and the environment which include clean air, clean water, biodiversity, scenic beauty, carbon sequestration, and wildlife habitat.
Equivalence ratio	Used to account for the differences in the environmental effects of different forms of a pollutant.
Externalities	The term used to describe the unintended effects of the production or consumption of a good on another person. Pollution is a classic example of an externality as it is typically a by product of producing a good that creates harm.
Global warming potential (GWP)	A measure of how much a given mass of greenhouse gas will contribute to global warming.
Greenhouse gases (GHG)	Gases in the Earth's atmosphere that reduce the loss of heat into space. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), ozone (O3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).
Green payment	A payment in which the government program pays landowners for environmental improvement. Actions taken by landowners may be using best management practices or setting aside working land.

Habitat credit banks	Habitats that have been restored, enhanced, or preserved and managed for at-risk species and act as potential offsets for species habitat converted to other purposes.
Habitat credit trading	A market-based system that facilitates the exchange between interested parties of credits that represent habitat that has been restored, enhanced, protected or otherwise conserved for the purpose of offsetting losses of at-risk species' habitat functions and values with the goal of achieving net conservation benefits for those at-risk species.
Leakage	The phenomenon that benefits from a credit trading program may be offset by a decrease in ecosystem services elsewhere.
Margin of safety	The amount that a reduction in pollution is discounted to account for the uncertainty about its effect on the environment.
Market-based incentive	A broad term used to refer to any number of components of public or private programs that have characteristics of a private market such as competition between sellers and/or buyers of a good or service. Environmental credit trading programs are one example of a market-based incentive.
National Pollution Discharge Elimination System (NPDES)	A permit system which restricts the amount of pollutants that a point source may emit.
No net loss	A policy in which every acre of wetland to be converted must be offset by the creation of an acre of wetland in another location.
Nonpoint source emission (or pollutant)	A source for which it is relatively difficult to identify the specific location where the emissions enter the system. Examples include runoff from urban roads and many agricultural sources.
Performance-based	An approach for achieving environmental improvement that focuses on the level or concentration of a measurable outcome such as emission level or emission concentration.
Point source emission (or pollutant)	A pollutant source where it is relatively easy to identify the exact location and amount of the emission that ultimately reaches the environment.
Practice-based	An approach for achieving an environmental improvement that focuses on the type and quantity of technologies being used.

Private goods Goods that when purchased by an individual are enjoyed primarily by that individual and not by others who did not share in the cost of providing it.

Public goods Goods that once provided can be enjoyed by many people, including those that did not help pay for them.

Recovery crediting system Program for which the Federal Government preserves habitat on private land that it is later used to offset negative impacts of Federal actions on wildlife habitat.

Swampbuster A provision of the Food Security Act that withholds Federal farm program benefits from any person who converts or modifies wetlands for agricultural purposes. (taken from *http://www.epa.gov/owow/wetlands/facts/fact19.html*)

Technology-based effluent limits (TBELS) A permit limit for a pollutant that is based on the capability of a treatment method to reduce the pollutant to a certain concentration.

Threatened A species that is likely to become endangered in the foreseeable future. (taken from *http://www.fws.gov/midwest/endangered/glossary/index.html*)

Total Maximum Daily Load (TMDL) The maximum amount of a pollutant that a body of water can receive and still meet its water quality standards and an allocation of that amount to the pollutant's sources. (taken from *http://www.epa.gov/owow/tmdl/intro.html*)

Trading ratio Used to discount or normalize the value of pollution credits based on its source.

Transaction costs Costs associated with finding other buyers and/or sellers and undertaking an exchange.

Uncertainty ratio Used to account for fact that some sources of pollution control have a less certain effect on the environment than others.

Wetland banks Wetlands that have been created, restored, enhanced, or preserved, and act as potential offsets for wetlands that will be converted to other purposes.