

## **State of Knowledge: Ecosystem Services from Forests**

### Contributors

**Evan Notman**, AAAS Fellow, USDA Forest Service, Washington, DC

**Linda Langner**, Resource Use Science, USDA Forest Service, Washington, DC

**Thomas Crow**, Environmental Sciences Research, USDA Forest Service,  
Washington, DC

**Evan Mercer**, Southern Research Station, USDA Forest Service, Research  
Triangle Park, NC

**Tracy Calizon**, Presidential Management Fellow, USDA Forest Service,  
Washington, DC

**Terry Haines**, Southern Research Station, USDA Forest Service, New Orleans,  
LA

**John Greene**, Southern Research Station, USDA Forest Service, New Orleans, LA

**Thomas Brown**, Rocky Mountain Research Station, USDA Forest Service, Fort  
Collins, CO

**John Bergstrom**, Department of Agricultural and Applied Economics, University  
of Georgia, Athens, GA

**John Loomis**, Department of Agricultural and Resource Economics, Colorado  
State University, Ft. Collins, CO

**Jennifer Hayes**, Rocky Mountain Research Station, USDA Forest Service, Fort  
Collins, CO

**Jessica Call**, Policy Analysis, USDA Forest Service, Washington, DC

## **State of Knowledge: Ecosystem Service from Forests**

### **Executive Summary**

This report summarizes the state of knowledge about ecosystem services provided by forests, the policies that influence their valuation and the creation of markets, and the tools and technologies for measuring, monitoring, and verifying them. The final section of the report summarizes how current or proposed policy instruments can affect management of four ecosystem services, and the challenges that exist to create policy to improve the measurement, valuation, and management of those services. The key ecosystem services described are biomass, carbon sequestration, water, and recreation opportunities.

The role that forests play in providing ecosystem services to the nation is profoundly influenced by the extent, pattern, and condition of forests within the landscape. While the gross amounts of forested land have stayed relatively constant for 30 years, there has been a net gain of forest cover converted from agricultural lands and a concurrent net loss of forest and agricultural land to urban uses. This loss of open lands, either forested or agricultural, to urban uses has implications for how growing urban populations use ecological goods and services.

Economic values for ecosystem services can be used to inform decisions that affect those services and to provide a basis for evaluating alternative policy options. Valuation methods exist to estimate monetary values for non-market ecosystem services, and have been used in these types of decisions. Market-type incentives such as cap-and-trade programs can be used to implement policies for the provision of those services.

Competitive market exchanges of ecosystem services are feasible when the service is scarce, when property rights to the service are well defined and enforced, and when transactions costs for exchange are not prohibitive. Woody biomass and private land recreation opportunities have most of the characteristics that allow private markets to work. Markets are already working to varying extents for these ecosystem services. Trading in water markets is also becoming more common, particularly in the western United States. Ecosystem services such as carbon sequestration and water quality are more likely candidates for economic incentives within a public policy framework. The Kyoto Protocol has already created a public policy framework for carbon in participating countries, and, most recently, California has chosen to implement a carbon policy. Very little water quality trading has actually taken place, because of a lack of an effective trading system with sound enforcement to ensure load reductions, a legal foundation allowing control flexibility to generate financial gains for participation, or a straightforward process for participating in the market.

A variety of State and Federal policy mechanisms are available to encourage private land owners to provide ecosystem services, including tax incentives, subsidies and cost-share programs, conservation easements, fee-simple purchases, tradable development rights, and regulations restricting land use. Most current policy instruments are aimed at protecting ecosystems in general, and not designed to influence the delivery of any single ecosystem service. Policies aimed at protecting ecosystems, or more specifically, ecosystem process may not maximize the

potential for the delivery of a specific ecosystem service, even if it is successful at protecting the target ecosystem.

A multitude of federal, state and local regulations influence the use of private property and the ecosystem services they provide. Many regulations directly restrict the way in which land can be used in order to limit activities that might have a negative impact on other people or on the environment. Both the Endangered Species Act and the Clean Water Act have spurred the development of a regulatory framework to encourage a market-based or trading approach to meeting the regulatory requirements of the Acts, including wetlands mitigation banking, which is arguably the most well established market-like system developed for the purposes of conservation.

There are also many federal and state incentive programs that provide financial or technical support to encourage private landowners to protect or restore natural ecosystems that provide goods and services. Cost sharing and technical assistance programs can provide incentives to private landowners to put land into conservation or implement practices that help maintain or restore ecosystem services. Because these programs are voluntary and may have multiple conservation and social goals, it may be difficult to direct funds to maximize the benefits gained to any particular ecosystem service. The effectiveness of most incentive programs is generally evaluated based on the number of acres put into conservation or the amount of area under a particular practice. Although useful for assessing participation, these measures provide limited information regarding the effectiveness of programs at maintaining or increasing ecosystem goods and services.

Current and future policy influencing ecosystem services must also function within the framework of the legal system. American common law plays an important role in determining how decisions about private land use are made. Many common-law regimes dictate how or why a landowner may choose to or decide against managing his land or forest to produce ecosystem services or conserve an intact ecosystem. Of these, property law and its tools and doctrines clearly wield the most influence. Property law is a core area of law that is likely to impact and influence every decision a landowner makes, and thus can significantly influence provision of and markets for ecosystem services.

Land management decisions by private landowners will continue to have large impacts on the nation's ecosystem services. Increased knowledge about the effective measurement of ecosystem services and increased understanding of the effects of policies and incentives on management of ecosystem services will improve our ability to develop policies to sustain their provision. The USDA Forest Service will continue to play an important role as a provider of ecosystem services on the public lands and in providing information to state and private landowners about management options for ecosystem services.

## Table of Contents

Introduction and Purpose .....	6
Land Use and Ecosystem Services .....	7
Observing and Predicting Land Use Change .....	9
Valuing Ecosystem Services.....	10
Methods for the Economic Valuation of Ecosystem Goods and Services.....	10
Market Mechanisms.....	11
Characteristics of Ecosystem Goods and Feasibility of Markets.....	13
Mechanisms of Exchange .....	14
Cap-and-Trade Programs .....	15
Requirements for Regulatory-Based Markets for ES .....	15
Policy Instruments .....	18
Regulation and Use of Market Mechanisms.....	18
Clean Water Act / Wetlands Mitigation Banking (WMB) .....	19
Clean Water Act / Water Quality Trading .....	19
State and Local Laws Protecting Water Quality.....	20
Endangered Species Act .....	21
Conservation Banking.....	21
International Trade.....	22
Incentive Programs .....	22
Non-Conservation Incentives.....	23
Program Effectiveness and Barriers.....	23
State Cost-Share Assistance Programs .....	24
Program Participation .....	24
Effects on Management Decisions.....	24
Collaborative Efforts.....	25
Federal Income Tax .....	25
State Income, Harvest, and Property Taxes .....	26
Federal Estate and Gift Taxes .....	26
State Estate, Inheritance, and Gift Taxes .....	27
Program Effectiveness .....	27
Common Law Principles.....	27
Property Law.....	27
Nuisance, Liabilities, and Rules.....	28
Local Land Use Planning Laws: Takings .....	28
Water Law.....	29
Key Ecosystem Services: Moving From Concept to Application .....	30
Biomass.....	30
Definition .....	30
Role of Forests .....	30
Measurement of Biomass.....	30
Policy Environment .....	31
The Role of Markets .....	31
Carbon Sequestration .....	32

Definition .....	32
The role of forests .....	32
Measurement.....	32
Policy Environment .....	32
National.....	33
State and Regional .....	33
Registries.....	34
Role of Markets.....	34
Water.....	36
Definition .....	36
Role of forests .....	36
Measurement of Water ES .....	36
Policy Environment .....	37
Role of Markets.....	37
Recreation .....	38
Definition .....	38
Role of Forests .....	38
Measurement.....	39
Policy Environment .....	39
Role of Markets.....	40
Literature cited.....	42

## **Introduction and Purpose**

Forested ecosystems provide many important goods and services to society, many of which are frequently undervalued commensurate with their economic value to society. Ecosystem services are undervalued because we frequently lack knowledge regarding the role that ecosystems play in delivering services, or because the benefits are indirect and thus difficult to measure, or it may be difficult to capture the value of ecosystem services in traditional markets. Finding ways to ensure that ecosystems are managed to maintain ecosystem services and that these services are adequately valued requires understanding all three factors.

These as well as other possible causal factors are considered in this report. Before doing so, however, the term “ecosystem services” needs to be explained. For purposes of this report, ecosystem services (ES) are defined as goods and services that flow from ecological processes that have immediate or long-term benefit to human society. Ecosystem goods are generally tangible, material products that result from ecosystem processes, whereas ecosystem services are usually improvements in the condition of things of value. This distinction is useful as many ecosystem goods include traditional commodities, such as timber, are easily valued through current markets, while services such as the provision of clean water or biological diversity are not. This distinction is not always straight-forward, however, particularly when it comes to determining the value of services.

USDA has a long history of programs that provide economic incentives to landowners to meet conservation goals. As Agriculture Secretary Mike Johanns stated at the White House Conference on Cooperative Conservation in St. Louis, MO, August 2005, USDA is seeking to broaden the use of market incentives to achieve natural resource conservation and environmental goals. In the environmental regulation arena, credit trading is increasingly viewed as a cost-effective approach to achieve pollution reduction goals. A variety of other mechanisms are also being considered in developing conservation and environmental policy, including insurance, mitigation banking, competitive offer-based auctioning, and eco-labeling.

Several Presidential initiatives feature the use of market mechanisms. USDA has responsibility for developing accounting rules and guidelines for crediting sequestration of greenhouse gases, and for recommending targeted incentives for forest and agricultural sequestration of greenhouse gases. Environmental credit trading is being explored as a vehicle for providing incentives to conduct desired forest management activities and to use biofuels for power generation. These types of approaches are likely to be incorporated in the 2007 Farm Bill, although at this point in time the exact form and focus are uncertain.<sup>1</sup>

At the June, 2005 National Leadership Team meeting, Deputy Chief Ann Bartuska committed the USDA Forest Service Research & Development to developing a synthesis of existing knowledge on policy instruments to promote the conservation of forest ecosystems and the services they provide. The summary is intended to provide a scientific foundation for policy

---

<sup>1</sup> see [www.usda.gov/documents/FarmBill07consenv.pdf](http://www.usda.gov/documents/FarmBill07consenv.pdf)

formulation in support of the Department's and Agency's goals in energy, watershed, recreation, and open space management, and to provide a basis for identifying key issues. In this report, we summarize the state-of-knowledge as it relates to ES provided by forestland and the policies that influence their valuation and the creation of markets, as well as the tools and technologies for measuring, monitoring, and verifying ecosystem service.

## **Land Use and Ecosystem Services**

Changes in patterns of land use, land cover, and land management profoundly affect the goods and services provided by the terrestrial and aquatic ecosystems that comprise the landscape. These changes are created through the complex interaction of culture with the environment, economics, policy, and technology (Nassauer 1995). Land use is the human employment of the land, while land cover denotes the physical and biological character of the land surface. A large body of work by environmental historians, anthropologists, and literary scholars suggests that human activities have long-shaped the character of the land (Gómez-Pompa and Kaus 1992, Diamond 2005, Mann 2005). The rate and magnitude with which contemporary changes are occurring, however, is clearly unprecedented (Meyer and Turner 1992). What were local or even regional impacts have become global impacts with the real possibility of rapid and profound changes to the biosphere (Foley et al. 2005).

Changes in land cover occur from both conversion from one category to another (e.g., forest to agriculture) as well as modification of conditions within a category (e.g., a more intensive form of agricultural production). Most of the attention in the literature is given to conversion from one category to another and much less is known about the modification of conditions without conversion. The general patterns of major land-use and land cover changes are fairly well documented. Current trends for land cover in the United States show a steady but significant loss of open space (Alig et al. 2003). From 1982-2001, 34 million acres of open space, an area equivalent to the state of Illinois, were converted to commercial and residential development. We are losing 6,000 acres of open spaces each day across the United States (Alig and Plantinga 2004, Theobald 2005). About one-third of this change represents the loss of forestland to urban development (Figure 1). Because the rate of land development is outpacing population growth, especially in rural areas where the pattern of growth is low density, dispersed housing, it is possible for small increases in population to have very large impacts on land use and the associated ES.

The patterns of land transformation are as important as the total amount of area developed. New houses with large lots are fragmenting farms and forests at a much higher rate than if they were clustered together. This pattern of low-density growth scattered across the landscape may not result in large changes in land cover, but may result in ecological and economic impacts as open spaces are divided into smaller ownership parcels. New roads and other infrastructure that serve scattered homes fragment wildlife habitat, block wildlife migration, foster the spread of invasive species, and pollute the water (Forman et al. 2003). Often, the most desirable building sites lie in ecologically fragile areas such as along streams and rivers or lakeshores.

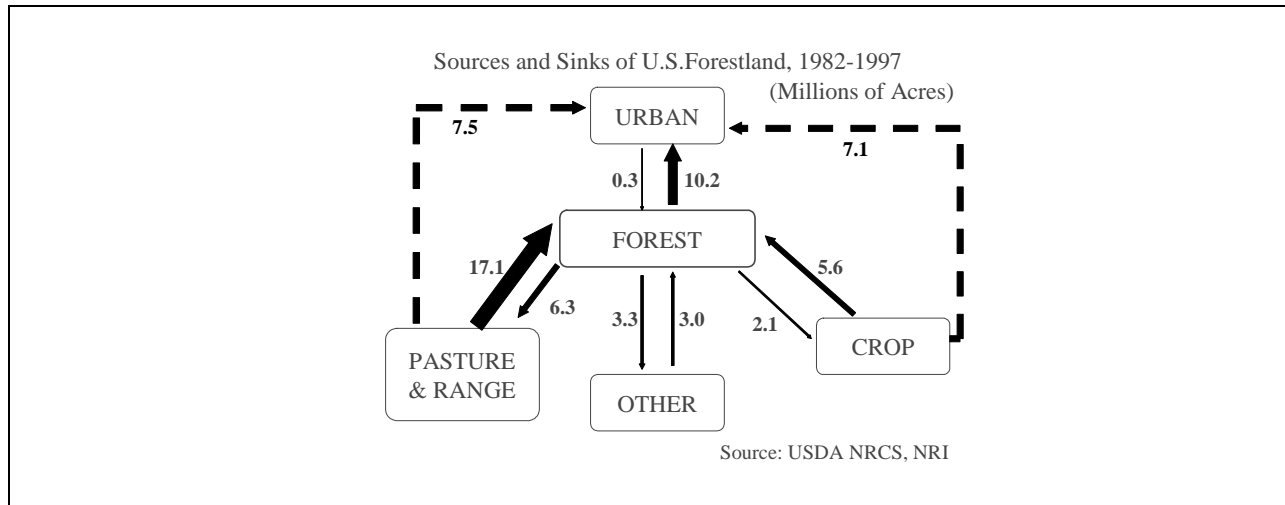


Figure 1. Changes in land use in millions of acres among major categories during the period 1982 to 1997 (Adapted from Alig et al. 2003).

Historically, forests have been the largest source of land for developed uses and this trend is likely to continue. The nation’s private forests are particularly vulnerable to change because of the differential in value between developed lands for housing and commercial uses and undeveloped lands being managed for timber or other activities (Alig and Plantinga 2004). Forestland values also reflect anticipated uses of land; that is, the value can increase dramatically if development to urban or commercial uses is anticipated (Wear and Newman 2004). The underlying factors driving these changes are growth in population and personal income. Without question, development sits on top of the economic pyramid for land uses. As a result, the flow of land between forest and urban use is largely unidirectional -- once land is developed, there is little likelihood that it will return to forest or agriculture production (Figure 1).

Forested areas are also influenced by changes in the agricultural sector. For example, technological advances in agriculture have significantly boosted productivity, allowing some marginal lands to revert to forest cover (Figure 1). Conversely, agricultural subsidies and governmental policies have prompted some forestland conversion into agriculture uses or discouraged the conversion of lower value agricultural land to forests (Lubowski et al. 2006, Plantinga 1996).

Counties with National Forests and Grasslands are experiencing some of the fastest growth rates in the United States as people are attracted to the natural and scenic environments provided by public lands (Dwyer and Childs 2004). As lands near National Forests are developed, land managers and planners are faced with a multitude of both new challenges and new opportunities. With residential and commercial development, the very amenities that attracted people – a natural setting, nature at your doorstep, clean water and air, elbowroom, a scenic view – are increasingly at risk (Gobster and Rickenbach 2004). As development on private land intensifies, so does the pressure on the public land managers to provide these amenities.



## **Observing and Predicting Land Use Change**

Methods for observing and predicting land-use and land-cover changes are essential for making informed land-use decisions, and understanding associated effects on ES. Numerous land-cover data bases have been created from remote sensing or from empirical information and many useful analytical tools are available for characterizing current conditions or predicting landscape change (e.g., Potts et al. 2004). In addition, the literature is rich with case studies of land use and land cover changes for specific landscape and regions (e.g., Andersen et al. 1996, Turner et al. 1996,). A significant challenge, however, remains in understanding socioeconomic and demographic factors involved in land use change and understanding the interaction of these factors with the physical environment (Crow et al. 1999). Further, the environmental, social, economic, and human health consequences of current and potential land-use and land-cover change are poorly understood (Meyer and Turner 1994).

Although it is clear that changing land use and land cover affect local environmental conditions, the cumulative impacts of specific and multiple changes are difficult to quantify. For example, vegetation, landform, soil properties, development features such as water impoundments, water diversions, drainage of wetlands, and tiling of agricultural fields all interact with the biological and physical environments to influence the water cycle. Understanding the effect of these interactions on ecosystem structure and function at multiple spatial scales is a critical research need. In the 2003 Strategic Plan of the US Climate Change Science Program (CCSP 2003), the following research questions were identified in the section dealing with land-use and land-cover change:

- How will different scenarios of land-use change affect the productivity of our natural resource base and the industries that depend on it?
- How will land-use and land-cover changes influence the form and functioning of ecosystems -- including their ability to provide essential ES and levels of ecosystem biodiversity?
- How can landholders, land managers, and policymakers formulate land use and land management decisions at multiple spatial scales in order to mitigate (or take advantage of) affects related to global change?
- What are the impacts of future land-use and land-cover change on water quality and quantity?

Our ability to project land-use and land-cover change for a specific point in space is limited, but researchers are making significant strides in projecting broad trends in land use and land cover over large areas. Spatial dynamic models are being used to simulate urban growth and related issues such as sprawl in a regional context based on existing land-use policy, land accessibility and suitability, distance to population centers, and amenity values. Verburg et al. (2002), for example, compute the probability of land use change for a landscape using variables such as those just listed. Alig and Healy (1987) found population and personal income to be important determinants of development. Using these two variables, Alig et al. (2004) project a 79% increase for urban lands in the United States during the next 25 years, thus increasing the proportion of area in urban development from 5.2 to 9.2% of the total land base. The projected increases vary by region, with the greatest increases most likely to occur near important

transportation corridors and in coastal areas – regions that already have significant environmental problems.

## **Valuing Ecosystem Services**

Humans derive a variety of benefits from ecosystem goods and services, which in turn depend on well-functioning ecosystems. Both economists and ecologists have turned their attention to better understanding how these services are valuable to people both in production and consumption (Costanza et al., 1997, Daily, 1997, Alcamo et al., 2003; Heal et al., 2005). Economic values do not capture the full value of ecosystems, but are the focus for purposes of this paper. Obviously, other values (e.g. spiritual values) are equally important in land management decisions.

The economic value of an ecosystem good or service consists of both use and nonuse values. Use value may result from either direct or indirect use. Direct use involves some form of direct physical interaction with the good or service. With ecosystem goods, direct use may be consumptive (e.g., hunting) or nonconsumptive (e.g., bird watching). Consumptive uses involve some form of extraction or harvesting, whereas nonconsumptive use leaves the quantity of the good or service undiminished. However, nonconsumptive uses may affect the quality of the resource or service, perhaps by pollution or crowding. Indirect use involves ES that contribute to the quality of an ecosystem good or a produced good. For example, natural water purification that occurs in a watershed contributes to the quality of the streamflow. Nonuse value arises for ecosystem goods or services that people value simply for their existence. Nonuse value can be thought of as the difference between total value and use value. Nonuse values can be substantial, but are difficult to quantify (Heal et al., 2005). Brown et al (2006) provide a more detailed discussion of the economic framework for the provision of ES.

### **Methods for the Economic Valuation of Ecosystem Goods and Services**

Market prices are a good indicator of economic value when markets are competitive. In many cases, however, competitive market do not exist for ES, and therefore other valuation methods have been developed to estimate economic values of ES. Four principal categories of methods are available (Heal et al. (2005) :

- Revealed preference methods
- Stated preference methods
- Production function methods
- Replacement cost method

Revealed preference and stated preference methods were developed to estimate monetary values for goods and services not traded in markets (e.g. recreation). They have been used primarily for public decision-making about natural resources, such as public land management and natural resource damage assessment. Recently described in some detail in Champ et al. (2003), these methods estimate values based on individual choices and preferences.

Production function approaches are used to value inputs in the production of a marketed good. As described by Young (2005), these approaches require observing, and perhaps modeling, the behavior of producers, including their response to changes in environmental conditions that influence production of the market good. The effect of the environmental change on the costs or output level of the production process yields an estimate of the economic value of the change.

The production function approach has typically been used to value ecosystem goods and the replacement cost method has typically been used to value ES. The nonmarket approaches, about which so much has been written, have typically found application for just a few of the ecosystem goods and services (de Groot et al. 2002).

Replacement cost methods do not rely on observing or modeling the behavior of persons or firms as they respond to existing or posited conditions. Rather, these methods compute the cost of replacing a lost environmental good or service, or conversely the replacement cost avoided if the environmental good or service is preserved. Because the replacement cost is a measure of cost, not of value, it is not truly a valuation method. However, the method—or, more precisely, the estimate of cost that it entails—is commonly used with ES.

## **Market Mechanisms**

Market mechanisms for providing ES are basically means to turn recipients of free benefits into buyers (Jenkins et al., 2004). Some formal arrangement, like purchase, is needed to make this happen. Typically the sellers are landowners where the good or service originates. Government agencies can act as “sellers” either as stewards of public lands or as enforcers of environmental laws.

Market mechanisms can be used to provide incentives to private landowners to begin, continue, or enhance provision of ES, often with the associated objective of providing a counterbalance to incentives to convert ecosystems to other land uses. There are two basic options: buy the land or arrange to pay only for the ecosystem good or service of interest (or for the management change needed to protect, maintain or enhance the good or service). The various policy instruments available, such as conservation easements and direct payments, are described in more detail in the following sections. Market mechanisms can also be used to force individuals or firms to pay for pollution of the environment through approaches such as cap-and-trade schemes, direct pollution taxes or other charges. These approaches are linked to environmental standards for emissions and other pollutants.

Using economic terms, all of the payment alternatives “internalize externalities.” In the first case, beneficiaries of a positive externality begin paying for the benefit, and in the latter case, entities causing negative externalities begin paying for the harm they cause. By internalizing externalities, payment provides signals that encourage behavior that more accurately reflects the full value of the resources at issue.

For exchange to occur for any good or service, three basic conditions must exist: 1) the good or service must be scarce; 2) the good or service must have nonattenuated property rights; and 3)

transactions costs must not be excessive. If a good or service is not scarce (i.e., if supply is unlimited relative to demand), there is no incentive for anyone to pay for it because they can get all they want for free. Currently this is an issue with some ES.

Nonattenuated property rights are unambiguous, transferable, exclusive, and enforced (Randall, 1987). Nonattenuated property rights to normal commercial goods and services, such as timber or livestock, are taken for granted. Such goods are easily defined and transferred, they belong solely to the owner, and a person's right to such a good is unquestioned and protected via widely available law enforcement. However, these characteristics are not so easily established for many ecosystem goods and services.

Definition and measurement of ecosystem goods is fairly straightforward, but for services, definition and measurement can be a major stumbling block. For example, the amount of water purification, or conversely the amount of non-point water pollution, that occurs on a given parcel of land is extremely difficult to quantify because of the multiple points at which the water enters the stream. The issue is further complicated by the fact that water quality is a matter of numerous different constituents and can be determined using a variety of criteria (e.g. drinking water, wildlife habitat). If parties cannot agree on a measurement protocol or do not have faith in the measurement that occurs, possibilities for exchange are seriously compromised.

Enforcement of exchange agreements is another hurdle. With ecosystem goods, contracts for delivery rely on fairly well-established laws that are unlikely to change in the foreseeable future. However, arrangements for provision and financing of ES are often fairly new and typically rely on unique, recently established rules announced by the government. Such rules may be subject to change, leaving uncertainty in the minds of private participants. If potential participants lack confidence that the agreements will endure and be enforced, they may decline to participate despite the announced benefits.

Transaction costs include costs of getting information, finding willing sellers or buyers, and transferring title, which are commonly borne by the parties to the exchange. Transaction costs also include the underlying costs of establishing and enforcing nonattenuated property rights to the good or service, which are commonly borne by a governmental entity (Randall 1987). These underlying costs may involve monitoring. If transaction costs borne by the parties to the transaction exceed the benefits of the exchange, exchange will not occur. If transaction costs borne by a government entity are excessive relative to the perceived public benefits of the resultant transactions, exchange is also unlikely to occur.

These three requirements or conditions, however, are not necessarily sufficient for exchange to occur. One potential hurdle is that, because the gains from trade in an ecosystem good or service market will depend on the initial allocation of property rights, the resulting distribution of resources and incomes may be viewed as unfair. Inequity, especially involving lower-income providers of ES, is a potential barrier to exchange, especially if the exchange is of a good or service with public good qualities (Landell-Mills, 2002). Thus, passing an economic fairness or social justice test may be another necessary condition. This has been of particular concern in developing countries where payment for ES has also been viewed as a means for poverty alleviation, but might not help large numbers of rural poor without title to land.

There may also be political, social, or even moral opposition to the idea of trading ecosystem goods or services (McCauley 2006). Some people, for example, hold the strong opinion that the public has inherent rights to ecosystem good or services and that provision and protection of these things should not be granted as rights to trade. For example, many people may view access to clean air and water as a fundamental human right and morally object to forcing people to pay for this right through market transactions. This group would likely rather see government provide and protect clean air and water through general tax revenues, regulation and pollution taxes under the “polluter pays” principle (Randall 1987).

Markets exist for many ecosystem goods. If the conditions described above are met, and if a sufficient number of units of the good or service are available, an active market may develop. Only some ecosystem goods and services are amenable to provision in relatively competitive markets. In other cases, as described in more detail in the next subsection, some government intervention is needed to move provision toward an efficient outcome.

### **Characteristics of Ecosystem Goods and Feasibility of Markets**

The degree to which a good or service is *rival* and *exclusive* determines the feasibility and appropriateness of different provision and financing mechanisms, as well as the level to which government must be involved to produce an economically efficient allocation (Randall1987). A *rival* good is one for which consumption by one person reduces the amount of good or service available to others, e.g. apples and fish in a lake. A nonrival good or service is one for which consumption by one person does not reduce the amount available to anyone else, e.g. carbon sequestration. For a nonrival good or service, “consumption” must be thought about in a broader, passive sense. When a nature lover looks out over a scenic view, for example, they “consume” enjoyment of the view without using up any of the view—thus, a scenic view is a nonrival good.

An *exclusive* good or service is one from which consumers can be excluded unless they meet the conditions prescribed by the party controlling the good or service. Goods offered for sale are exclusive goods. Conversely, a nonexclusive good or service is one from which consumers cannot be excluded, even if they do not pay for it. A good or service may be nonexclusive because of its physical characteristics. For example, because tuna range over the vast expanse of international ocean waters, it is not feasible for a private company or a government to establish exclusive rights over them; thus, tuna are a nonexclusive good. In a large National Forest with many access points, scenic views may also be nonexclusive goods.

Free market provision and financing of goods and services are best suited to rival, exclusive goods and services. Most tangible ecosystem goods, but few services, potentially can be traded efficiently in competitive private markets. Private markets, in fact, already exist for many rival, exclusive ecosystem goods such as fossil fuels, timber and big game hunting opportunities. If exclusion is not feasible, economically efficient free market provision and financing of goods and services are not feasible.

## **Mechanisms of Exchange**

Private individuals or firms can be either buyers or sellers of ecosystem goods and services. Government entities can also either be buyers or sellers of ecosystem goods and services. Thus, the four general categories for exchanging ecosystem goods and services are: 1) individual buyer, individual seller; 2) individual buyer, government seller; 3) government buyer, individual seller, and 4) government buyer, government seller.

Individual Buyer, Government Seller. Ecosystem goods and services are commonly financed via individual tax payments to government entities that manage public land to provide the goods and services. Non-excludable ecosystem goods and services tend to be provided by government entities to users without direct charge. In the case of excludable ecosystem goods and services, fees may be charged for use or access rights to an ecosystem good or service. For example, in the U.S., federal, state and local governments charge fees for many types of outdoor recreational opportunities (e.g., entrance fees to public parks). In addition, states charge for fishing and hunting licenses. In most cases, the money generated from outdoor recreation fees goes back to managing natural resources that support recreational opportunities. The federal government in also charges fees for stumpage, grazing rights, and mineral and energy extraction on public lands.

Government Buyer, Individual Seller. Payments from government entities to individuals for the conservation practices which may protect maintain, and enhance protection of ES are generally known as subsidies or incentive programs, a number of which are described in the following section. The payments induce landowners such as farmers and non-industrial forest owners to alter their behavior in a way that benefits others (Brown et al., 1993). Such arrangements are voluntary and tend to be popular with recipients, and can increase economic efficiency as long as the marginal benefits exceed the marginal costs.

Government Buyer, Government Seller. Governments may also pay (or subsidize) other governments to help provide and protect ecosystem goods and services. For example, the U.S. Environmental Protection Agency (EPA) provides funds to local governments to assist with development of wastewater treatment plants that help to protect surface and ground water quality. The U.S. Agency for International Development (USAID) provides funds to foreign government entities to foster resource conservation and environmental protection in their countries.

Individual Buyer, Individual Seller. There is much current interest in providing and financing ES through new private markets characterized by individual buyer, individual seller transactions. Mechanisms where individuals pay individuals include both familiar markets for rival, exclusive ecosystem goods such as timber and mineral resources, nontraditional arrangements to provide ES, and cap and trade markets where permits or credits are traded.

Established markets with self-organized private transactions exist for many recreational opportunities, such as hunting, fishing, and whitewater rafting. Private markets have existed for hunting opportunities for many years. In recent years, markets with self-organized private

transactions have developed for scenic landscapes. For example, private land trusts have been established that purchase conservation easements from private landowners to protect scenic landscapes from development. Because of the limited number of buyers, the market for such conservation easements is likely to be uncompetitive and economically inefficient.

Another type of individual-to-individual mechanism is that of private organizations granting funds to private individuals or groups to provide and finance provision of ecosystem goods and services. Another category of individual-to-individual transactions involves price premiums for commercial goods paid by consumers who want to encourage or reward environment-friendly production methods.

### **Cap-and-Trade Programs**

Cap-and-trade is a widely-used approach to control negative externalities. These programs use permits to emit a regulated pollutant or credits that offset (i.e., mitigate or compensate for) the emission. While cap-and-trade permits or credits are traded among individuals, substantial government involvement is required.

With a cap-and-trade program, a government entity (1) imposes a limit or cap on some emission or activity, (2) establishes permits or credits for the specified amount of emission or activity and allows individuals or firms to trade permits or credits under certain institutional rules, and (3) monitors the emissions or activity in question and assesses a penalty if the cap is exceeded. The ES delivered from such a program occurs with setting and enforcing the cap. The trade part of cap-and-trade then allows firms in aggregate to most cost-effectively reach the cap. With permit schemes, firms that can lower their emissions at low cost do so and sell their permits to firms for which costs of cutting emissions are higher than the cost of purchasing permits. With credit schemes, firms that desire to exceed the cap must purchase credits that offset the increase in emissions.

Cap-and-trade is being successfully used in several important programs, including the U.S. effort to control acid rain by limiting SO<sub>2</sub> emissions (Stavins, 1998, 2005). Fossil fuel electric power plants are issued *permits* by the U.S. EPA for a certain amount of SO<sub>2</sub> emissions. The initial cap was set in 1995 for the eastern U.S.; in 2000 the cap was lowered and expanded to the rest of the U.S. The permits may be traded among the utilities, either in private transactions or during a government-sponsored auction. Compliance is encouraged via a penalty per ton of emissions that exceed the permitted level.

### **Requirements for Regulatory-Based Markets for ES**

The creation of a regulated system for trading of ecosystem service credits is an important step in the development of markets for non-exclusive ES. Although the mechanisms of exchange, including the types of buyers and sellers and the types of ES, will have an influence on how a regulatory system of trading is structured, there are a number of components that any system is likely to address.

Reporting Registries. For voluntary trading systems, a registry serves as a central listing or register, of projects or individuals providing ES. For cap and trade systems all entities regulated under the “cap” must register and non-regulated entities may also be required to register if they wish to sell credits to regulated entities. In the U.S., examples of registries for ES include state and federal carbon registries, state and local scale wetland mitigation banks, and various local / regional water quality trading registries. For more details on carbon registries see Call and Hayes (2005).

Whether registries use entity-level or project-level reporting is an important issue for ES accounting. For entity reporting, an entity must report all activities that affect the ES, both positive and negative. For example, carbon registries using entity reporting, should report carbon emission and sequestration for all activities under its jurisdiction. Cap and trade systems require entity-level reporting. In wetland mitigation, mitigation banks may not be required to provide detailed information, but mitigation credits are regulated by state and federal agencies. Voluntary ecosystem service markets are more likely to use project level reporting, which includes only information on the gain or protection achieved on ES from a particular project.

Certification. Certification is used to guarantee the quality and accuracy of entity and/or project reports submitted to the registry. Registries with third-party certification are generally considered to have more accurate and reliable results. Third-party certification requires an independent, third party that follows a set procedure to certify each project or entity report submitted to the registry.

Ownership. Determining who has rights to the ES is an important component of trading and may also influence how the service is measured.

Liability. Registries or mitigation banks should identify who will be responsible if a project or entity fails to meet promised goals. If forest sequestration projects fail to sequester projected carbon due to miscalculations, changes in project design, or natural disturbances such as fire, rules must be in place to determine who is responsible. In wetland mitigation, liability is transferred from the permittee to the seller of credits. Commercial wetland mitigation banks generally must show some financial assurance that a mitigation project will continue in case of financial failure (Landry et al. 2005).

There are two general approaches to liability: buyer vs. seller liability. For buyer liability, the purchaser of an ES credit or offset, such as carbon or wetland is responsible for any shortfall in a project. With seller liability, the original landowner, project designer, or mitigation bank is responsible for any difference between the expected and actual delivery of an ecosystem good or service. Seller liability should generally encourage heavy trading because more buyers enter the market since they bear no risk if a project fails. On the other hand, seller liability may be difficult to enforce particularly if sellers are individual landowners. With buyer liability, the offset buyer will be responsible if the project fails, so the buyer is only likely to buy offsets that have little risk. The disadvantage of buyer liability is that it may discourage offset buyers from entering the market, or reduce value received by sellers, thus reducing their entry into the market.



Measurement methodology. Registries must determine what type of activities can be included in trading systems and how the benefits will be measured. For instance, wetland trading banks must determine what characteristics of wetlands must be measured and reported for selecting equivalent wetland habitat. Important considerations include the quality and cost of the existing methods for measuring the service and the contribution of an activity to the net change in the amount of service being provided. For example, the measurement of soil carbon tends to be very costly and time intensive. Although soil carbon is often a significant portion of a forest's overall carbon stock, the size of the pool often changes slowly and is difficult to measure over short timeframes.

Baseline. Baseline is a point in time or a level of ES from which an entity will measure changes in total service availability. For example, in wetland mitigation a baseline inventory of wetland habitat in an impacted area is required. In carbon sequestration projects, the two most common means of establishing a baseline are the base year and the moving baseline approaches. In the base year approach a specific year (or span of several years) is selected for initial measurement. Future measurements are then compared against this initial base year measurement. The moving baseline approach projects a measurement as if the project(s) were never undertaken. This projected baseline is then compared to the actual measurement after the project to determine the change due to the project. This method provides a better estimate of the effect of the project than the base year approach (see additionality).

Additionality. To meet the conditions of additionality, activities to produce ES from a project should be additional to what would have occurred had the project not taken place. If a registry wants to record projects that create a quantifiable offset to loss or degradation of an ecosystem service it should include additionality requirements. Common requirements for additionality include requirements that projects go beyond existing legal requirements. For example, maintaining protected forest lands would not be a permitted carbon sequestration project as the forest would be maintained under existing rules; likewise reforestation after timber harvest would not be a permitted sequestration project if already required by law. Strict additionality requirements may, however, penalize early adoptors of practices to provide services and limit participation in programs.

Permanence. Permanence refers to the ability to ensure that the service in question will be delivered for an agreed-upon time period. This is of particular concern for carbon sequestration as biological sequestration is not permanent. Entities registering forest carbon can work towards permanence by using long-term conservation easements. The easement allows the landowner to practice forestry, but ensures that the overall landscape is protected and will retain carbon for a designated time period. Certain forest carbon credits may be better suited as "temporary" rather than "permanent" credits. Wetland mitigation credits are generally for very long time periods or in perpetuity. In practice such long time periods are probably impossible to guarantee.

Leakage. Leakage occurs when activities outside of the boundaries of the project boundaries cause reductions in ES. The problem of leakage can in theory occur with any ecosystem service but are most likely to be of greatest concern for services that have global impact such as carbon sequestration and maintenance of biodiversity. Protection of a watershed in one area that leads

to the degradation of watersheds elsewhere due to the shift land use activity would also be considered leakage.

There are two types of leakage: activity-shifting leakage and market leakage. Activity-shifting leakage occurs when an activity is shifted from one area of an entity's property to another. For example, if a landowner implements practices to protect a forested watershed on their property as a carbon offset project, but damages the watershed on another section of land as a result, then leakage occurs. Accurate measurements should use the net carbon sequestered by subtracting the emissions from the leakage activity from the sequestration project.

Market leakage occurs when an ES project causes a change in activity outside of the reporting entity's boundaries, through shifts in market demand and supply. For example, if timber harvest resulting in forest removal is reduced on one landowner's land in a region due to carbon sequestration projects, then demand may simply shift to another landowner in the region, resulting in no net increase in carbon sequestration for the region. Market leakage is very difficult to measure other than through comprehensive accounting of all service opportunities and is not currently required by existing state carbon registries. The problem of market leakage is particularly great when trying to account for ecosystem services across jurisdictional/political boundaries.

## **Policy Instruments**

A variety of mechanisms are available to encourage private land owners to provide ES. Policy instruments include tax incentives, subsidies and cost-share programs, conservation easements, fee-simple purchases, tradable development rights, and regulations restricting land use. Table 1 summarizes Federal programs that provide incentive payments to landowners. Mandatory and voluntary approaches have been used to encourage landowners to incur costs to protect or increase the production of ES from their land. In some cases, policies may provide new sources of revenue to landowners by creating demand for ES produced from their land, such as the restoration of degraded land for carbon sequestration.

Policies that influence the production and protection of ES on private lands may be categorized in many different ways. Here we divide policy approaches into four broad categories: regulation and market infrastructure, cost-sharing programs, tax policies, and property law. We focus on national policies and programs, but also attempt to highlight state and local policies that are either representative of similar policies in many areas or are unique or innovative.

### **Regulation and Use of Market Mechanisms**

A multitude of federal, state and local regulations influence the use of private property and the ES they provide. Many regulations directly restrict the way in which land can be used in order to limit activities that might have a negative impact on other people or on the environment.

Two important federal statutes that directly impact the management of private lands for ES are the Endangered Species Act (ESA) and the Clean Water Act (CWA) (16 U.S.C. 1251 *et seq.* and 33 U.S.C. 1311 *et seq.*) Both of these Acts have spurred the development of a regulatory

framework to encourage a market-based or trading approach to meeting the regulatory requirements of the Acts.

#### Clean Water Act / Wetlands Mitigation Banking (WMB)

Wetlands mitigation banking (WMB) is arguably the most well established market-like system developed for the purposes of conservation. WMB evolved to allow more comprehensive and flexible development while maintaining wetland values and acreage. The primary driver behind WMB is the CWA, and later additions that set guidelines for mitigation banking (404(b)(1) guidelines<sup>2</sup>). As of 2005, WMB accounts for approximately 31% of all wetland mitigation in the country. There are 405 U.S. Army Corp of Engineers-permitted banks in the country, 330 of which are active, and 75 of which had sold all of their credits. Of those 405 banks, 72.2% are sponsored by private entrepreneurs or companies (Environmental Law Institute 2005).

Mitigation policies emphasize wetland “functions” and do not preclude consideration of ES in determination of permissible wetlands banking, but there is no explicit adoption of ES as factor in wetlands mitigation banking decisions (Ruhl and Gregg 2001). A current issue of debate in mitigation banking is determining appropriate “rules” for geographic placement of mitigation projects. Placement can affect the function of wetlands in the landscape, as well those who receive any services produced by the wetland. Banking policy generally requires that wetlands be “swapped” for a similar kind within a service area, which is usually defined by watershed boundaries (Ruhl and Salzman 2006). However, there is an increasing tendency to permit banks in one watershed to compensate for losses in a different watershed due to increasingly constrained markets, allowable if “practicable and environmentally desirable” under the banking guidance (Salzman and Ruhl 2000).

WMB has resulted in a market-driven migration of wetlands from urban to rural areas, and has also shifted the human beneficiaries of wetland ES, who differ significantly in terms of minority populations, median income, and population density (Ruhl and Salzman 2006). The difficulties in measuring many services accurately and efficiently make determining the consequences of the shifting spatial distribution of actual ecosystem service challenging (Ruhl and Gregg 2001). Currently, there are no databases that track WMB transactions at the federal or any state levels (Ruhl and Salzman 2006).

#### Clean Water Act / Water Quality Trading

The 1972 CWA prohibits discharge of any pollutant into waters of the United States, and initially focused its enforceable provisions on the pressing problems of effluent discharges from point sources (33 U.S.C. 1311; Brown et al. 1993; Ruppert 2004). When effluent controls on point sources fail to achieve water quality standards for the water body’s designated uses, the provisions of § 303 of the CWA mandate that the states must shift to water quality-based, or “in-situ” permitting (33 U.S.C. 1312; Boyd 2000). To do this, the states must set a total maximum daily load (TMDL) for waterways and water bodies failing to achieve water quality standards. EPA published its Water Quality Trading Policy (WQT Policy) in 2003, which officially recognizes the practice of trading “pollution credits” between and among dischargers within a

---

<sup>2</sup> Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material, 40 C.F.R. Part 230 *et seq.*, Subparts A-I, available at <http://www.epa.gov/owow/wetlands/pdf/40cfrPart230.pdf>

watershed and encourages trading between and among point sources; point and non-point sources; and nonpoint-nonpoint sources. The goal of this trading is to achieve reductions in nutrients (total phosphorous and total nitrogen) and sediment loads and facilitate the implementation of TMDLs (EPA 2003).

Despite promotion by economists for decades, and a flurry of trading institutions, guidance, websites, and rhetoric, very little water quality trading has actually taken place (Boyd 2000, King and Kuch 2003, King 2005, Ruppert 2004). King (2005) found that nationwide, there were about 70 WQT efforts in 2005, but almost no actual trading (Breetz et al. 2004, ELI 2005, King 2005). An effective trading system requires sound enforcement to ensure load reductions, a legal foundation allowing control flexibility to generate financial gains for participation, and a straightforward process for participating in the market (Boyd 2000). These ingredients are missing in WQT as it currently exists. There is no federal enforcement mechanism against non-point sources. EPA Policy encourages states to enact monitoring and enforcement procedures for non-point sources, but factors contributing non-point source loading are complex and varied, making monitoring technically difficult and expensive (EPA 2003). Without adequate information about non-point contributions, enforcement is unrealistic, even if states have enforcement proceedings against non-point sources in their regulations (Boyd 2000).

An additional problem is that subsidies or “green payments” effectively reduce the supply of credits that could be offered by non-point sources, because baseline conditions for determination of credit availability likely will not include those nutrient reductions for which non-point sources have already been paid (e.g., installing riparian buffers under a grant from the Conservation Reserve Program (King and Kuch 2003, Ruppert 2004, King 2005). The decision to include incentive payments in any baseline for trading can be determined by rulemaking.<sup>3</sup>

#### State and Local Laws Protecting Water Quality

In addition to each state’s water quality act, which applies to all waters of the state, additional laws in many states also regulate forest uses. In a study by Edwards and Stuart (2002), 161 water quality-related laws in 48 states were reported to regulate forest uses. Multi-program state regulation for NPS water quality protection include laws for scenic rivers, shoreline, floodplain, and wetlands protection; state forest practices acts; sedimentation and erosion control laws; and laws prohibiting stream obstruction.

An example of the layering effect of multiple regulatory programs is found in Maryland. Four separate programs are administered by four different agencies. The Chesapeake Bay Critical Area Program is administered by the Forest, Park, and Wildlife Service; the Non-Tidal Wetlands Program is implemented by the Non-Tidal Wetlands Section of the Water Resource Administration; local soil conservation districts and the Maryland Department of Natural Resources oversee the Erosion and Sediment Control Program and permits under the Waterway Access Program are issued by the Waterway Access Section of the Water Resources Administration (Ellefson et al. 1997).

---

<sup>3</sup> see [www.usda.gov/documents/FarmBill07consenv.pdf](http://www.usda.gov/documents/FarmBill07consenv.pdf)

### Endangered Species Act

The Endangered Species Act of 1973 (ESA), as amended (16 U.S.C. 1531 *et seq.*) is a classic example of command-and-control legislation, prohibiting actions that are harmful to listed threatened or endangered (T&E) species or their habitats. The reach of the ESA extends not only to governmental entities but also to private landowners, such that if listed species' habitat exists on private landowners' property, the landowner is subject to severe penalties for developing their land in a way that may harm the species by destruction of its habitat. This feature of the ESA has created the unintended consequence of a *disincentive* to conserve habitat: private landowners may intentionally destroy or take T&E species, or develop potential habitat before federal agencies responsible for administering the ESA are able to identify the species or its habitat located on the landowners' property (Lueck and Michael 2003).

In the years since enactment of the ESA, federal and state wildlife agencies have recognized that protection of T&E species cannot be accomplished without the partnership and cooperation of private landowners (Wilcove et al. 1998). The ESA does not compel beneficial actions to restore, improve, or sustain T&E species' habitats. As such, FWS has implemented a variety of programs to encourage private landowners to improve habitat prior to listing of a species as threatened or endangered, or to assist landowners in complying with the ESA if T&E species are identified (see Table 1).

The Candidate Conservation Agreements with Assurances (CCAAs) program is an example of providing regulatory stability to encourage landowners to take voluntarily action. Landowners who enter into CCAAs with FWS agree to voluntarily undertake proactive measures to restore candidate species' habitat, in exchange for incidental take authorization under ESA §10(a)(1)(A) process, and assurances that the landowner will not be subject to future regulatory obligations in excess of those entered into at the time of the agreement.

### Conservation Banking

Against the backdrop of ESA regulations, and inspired by wetlands mitigation banking, the concept of conservation banking arose. The FWS defines conservation banks as "permanently protected privately or publicly owned lands that are managed for endangered, threatened, and other at-risk species." The bank owner has habitat or species credits to sell and can potentially generate profit from managing and selling habitat. Conservation banking shares many of the same potential environmental benefits with wetlands mitigation banking.

Conservation banking is probably the most appropriate conservation incentive when developmental pressure on the resource is relatively high because there will be many buyers and sellers, banking can keep land acquisition costs relatively low, and conservation banks are funded by developers through purchase of bankable credits. One of the negative aspects of conservation banking is relatively high administrative costs, including oversight of application process, and establishment of a system to track the transfer of bankable credits (Parkhurst and Shogren 2003). The most important potential benefit of conservation banking is removing the incentive of landowners to destroy T&E species or their habitat, because they are compensated for their conservation efforts through this voluntary incentive mechanism (Parkhurst and Shogren 2003, Mills 2004).

Conservation banking is not a perfect tool. The proxy of acres of habitat preserved, restored, or enhanced describes little about what ES are protected. This is because the conservation bank management plan, required before a bank is permitted to sell credits, may permit uses that have little or no impact on the species to be protected, but could impact ES as we have described them in this document. At present, there is no database or clearinghouse that tracks conservation bank transactions, credits, or uses on permitted banked areas. Without this basic information, any statement of what services are protected by conservation banks is little more than speculation.

### International Trade

International trade agreements that include changes in subsidies for agriculture can play a major role in determining the economic viability of agricultural and timber production, but predicting the impact of a particular subsidy agreement can be both complex and controversial (Nordstrom and Vaughn 1999, Cosby 2004, Esty and Ivanova 2004, Anderson and Martin 2005, CBD 2005). Trade agreements may also impact national environmental legislation and regulation if they are found to have trade-distorting effects and future agreements may limit the ability of countries to use environmental payments if they are based on production. Trade agreements can also limit the ability of importing countries, including the US, from restricting importation of timber and other forest products based on concerns about the damage to the environment (including ES) that harvesting may have caused (Jansen and Keck 2004).

### **Incentive Programs**

The federal government has instituted a number of policy mechanisms to encourage private landowners to adopt stewardship practices that enhance ES among other values. Table 1 lists major federal incentive programs that include at least some forest-related component. The desired goals of these policies include improved forest productivity, retention of lands in forest or undeveloped uses, protection of soil and water quality, wetlands enhancement and preservation, and wildlife habitat improvement. Incentives offered to landowners include cost-share payments, rental payments for easements, and technical assistance in developing management plans.

One of the largest of these programs is the Conservation Reserve Program (CRP) which together with the Conservation Reserve Enhancement Program (CREP) has accounted for 70% of cumulative expenditures for all cost sharing conservation programs between 1996-2001 and currently have nearly 35 million acres enrolled (Hummon and Casey 2004, FSA 2006). CRP and CREP are unique in providing rental payments; other federal conservation programs offer cost sharing, and technical assistance programs that help landowners use environmentally beneficial practices, or set aside land for conservation via easements (see Table 1).

One of the primary goals of CRP is to reduce soil erosion by providing incentives to farmers to convert farms on areas of high erosion and low productivity from annual crop production to other land uses such as grassland or tree cover. CRP pays enrolled landowners annual rental payments to convert farmland using approved environmental practices. Landowner's bids are selected based on consideration of the potential environmental benefits as well as cost.

Recent reviews of the CRP program have highlighted the need to assess the effectiveness of CRP at achieving specific environmental goals rather than the number of acres enrolled (Hyberg 2005). The Conservation Effects Assessment Project currently underway is addressing this issue (Kellogg 2005). An additional area of concern is the expiration of CRP contracts and the subsequent fate of the land.

#### Non-Conservation Incentives

In addition to the programs included in Table 1, agricultural programs that assist production agriculture, such as price and income supports, and crop insurance also have a major impact on land use decisions. Spending for commodity programs was over \$15 billion in 2005, almost three times that of spending on conservation oriented programs (\$5.6 billion approximately).

The federal commodity programs help to stabilize and support farm incomes by shifting some of the risks of short-term market price instability and longer-term capacity adjustments to the federal government. The “Sodbuster,” “conservation compliance,” and “Swampbuster” provisions added to the 1985 Farm Bill halted producer access to many federal farm program benefits if they did not meet conservation program requirements for highly erodible lands and wetlands, but there is still considerable debate regarding the impact of these programs on conservation within the agricultural sector. Without question, the funding from these programs play an important role in land use decisions on land with agricultural potential.

#### Program Effectiveness and Barriers

A number of studies have examined the social and economic efficiency of public financial incentive programs for private forest investments. One hypothesis has been that these programs substitute government payments for private capital investments. Several studies have shown that cost-share assistance programs are effective in terms of increased forest land productivity (Mills 1976, Risbrudt and Ellefson, 1983, Royer and Moulton 1987). Some studies have found that owners who participate in an incentive would have done the supported practice anyway (James et al. 1951), while others found that the incentives enabled owners to treat additional acres (Royer and Moulton 1987, Bliss and Martin 1990).

An important aspect of forest cost-share and management assistance programs is the interaction the programs foster between forest landowners and land managers. Generally, landowners are required to develop management plans prior to receiving cost-share or lease payments. Direct contact with professional land managers has been identified as a leading factor in landowners’ decisions to adopt conservation practices that enhance ES (James et al. 1951, Kilgore and Blinn 2004, Greene et al 2005).

In a study of the Forest Stewardship Program (FSP), two-thirds of the program participants made their first contact with a professional forester while developing the required management plan (Esseks and Moulton 2000). A similar number began managing their land for multiple purposes and using new practices. In addition, participation in FSP prompted owners to spend an average of \$2,767 of their own funds for forest management activities. Nearly two-thirds said that they would not have made the expenditures without receiving cost-share assistance through FSP.

### State Cost-Share Assistance Programs

Many state governments began initiating cost-share programs in the 1970s and 1980s to supplement federal funding that was insufficient to meet the needs of landowners (Haines 1995). Similar to federal programs, the availability of state management and cost-share assistance funding has fluctuated over the years. Some states' programs adopted in the 1970s and 1980s are no longer available, while other programs have been initiated. The largest programs in terms of payments and acreage treated have historically been in the South, where forest industries are a leading sector in the regional economy and landowners have markets for their wood. (Haines 1995). Although state programs initially focused on timber productivity, over the past 25 years the focus has expanded to promote the retention of agricultural and forestry land uses; protection of riparian areas and wetlands; enhancement of wildlife habitats; and water quality and soil conservation. State programs primarily assist with development of management plans and cost-share assistance to implement stewardship practices. State program structure is generally based on features of the various federal cost-share assistance programs. At least 17 states have adopted cost-share assistance programs (Greene 2005).

In states where state law establishes minimum forest management standards, cost-share assistance programs' eligibility requirements limit practices to those that go beyond activities required under state law. For example, the Oregon Forest Resource Trust and the California Forest Improvement Program do not fund practices required to fulfill reforestation and other standards required under the California and Oregon Forest Practices Acts. However, both states provide cost-share assistance for the development of management plans. In other states where voluntary, recommended conservation standards have been developed, practices eligible for cost-share assistance are also limited. For example, the Virginia Reforestation of Timberlands Act does not provide funding for practices established in their voluntary silvicultural Best Management Practices programs (Haines 1995).

### Program Participation

A variety of research studies have consistently found that participation is linked to demographics, economic factors, and program awareness. For example, a number of studies in different regions have found that landowners choosing to participate in programs are generally wealthier than eligible non-participants, although this pattern is not universal (Bell et al. 1994, Luzar and Diagne 1999, Kline et al. 2000a). The area of land under management has also been found to be an important factor for participation (Luzar and Diagne 1999, Kline et al. 2000a, Langpap 2004). An important factor limiting program participation is general distrust of regulating agencies running programs (Loftus and Kraft 2003, Breetz et al. 2005).

### Effects on Management Decisions

Non-industrial private forest (NIPF) landowners, in contrast to commercial timber land owners, do not own timberland primarily for producing timber (Alig et al. 1990, Hodges and Cabbage 1990). NIPF owners who harvest timber tend to have lower incomes and education and place higher values on income rather than amenity production (Dennis 1980, 1990). Similarly, wealthier landowners often restrict timber harvests to produce amenity benefits (Hyberg and Holthausen 1989). Technical assistance is the most effective way to encourage owners to apply sustainable practices (Kilgore and Blinn 2004). Some studies concluded that cost-share payments increased tree planting (Brooks 1985, Hyberg and Holthausen 1989). Others found



that many participating owners would have implemented the recommended management practices without the incentives, but that cost-share programs may have enabled some owners to treat additional acres (Royer and Moulton 1987, Bliss and Martin 1990).

### Collaborative Efforts

If the effects of landowners' decisions on ES are spatially interdependent, policies and programs designed and implemented at a landscape level rather than with individual ownerships are required to produce optimal quantities of ES (Gottfried et al 1996). In landscapes with multiple ownerships and spatially varied impacts on the production of ES, markets for ES will most likely fail, even in the presence of traditional methods of internalizing externalities (e.g. taxes and subsidies) (Gottfried et al. 1996). This suggests that a combination of different interventions will usually be required to ensure successful and efficient ES production across a landscape.

With sufficient incentives, a large enough number of landowners in the watershed or landscape are likely to participate in coordinated efforts to produce ES. However, the transaction costs involved in acquiring information and negotiating agreements between landowners may be so high that even in the presence of government incentives, collective efforts might not succeed (Hodge and McNally 2000).

One example of successful collaborative efforts is the watershed councils of all stakeholders used widely throughout the Midwest to develop and implement watershed restoration plans and to coordinate management of riparian areas (Gottfried et al. 1996). Another example is the Oregon Coastal Salmon Restoration Initiative (OCSRI) (Kline et al. 200b).

## **Federal and State Tax Policies**

### Federal Income Tax

The federal income tax has the greatest economic effect of any tax on private forest land in the U.S. The economic effect of an income tax is to increase the variable cost of owning or managing forest land. It influences how intensively owners manage their holdings (Gregory 1972). A number of provisions that help non-industrial private forest owners retain their forest via deductions or reforestation incentives have been added to the federal income tax (Haney et al. 2001).

Among the most important of the general provisions are:

- Long-term capital gain treatment of qualifying timber income;
- Depletion deductions when timber is sold or disposed of;
- Annual deduction of management costs;
- Depreciation deductions;
- The section 179 deduction for property costs; and
- Deductions for casualty losses or other involuntary conversions.

The Federal income tax provisions specifically for forest owners and other rural landowners include:

- Reforestation incentives;
- Special treatment of qualifying cost-share payments; and
- Charitable contribution deduction for donation of a conservation easement.

Although the financial benefit that private forest owners can gain from using these tax provisions is substantial, many owners are simply not aware of them. A recent survey of forest owners in South Carolina found that most were aware of only four or five provisions. Some 80% were aware of the provisions available to all taxpayers, but little more than half were aware of the provisions specifically for forest owners (Greene et al. 2004).

Large industrial forestland owners are subject to different taxes and generally do not receive the same federal deductions. Forest industry firms structured as large C-corporations are taxed at a 35% rate on both ordinary income and capital gains. In contrast, institutional investors structured as TIMOs (Timber Investment Management Organizations, which often are held by tax-exempt organizations) or REITs (Real Estate Investment Trusts, which are pass-through entities for tax purposes) pay little or no federal taxes.

Historically, the capital gain tax due on forestland held on a firm's books at a low cost basis and sold at market price has been an impediment to large-scale sales. Now, however, the buyer and seller typically postpone or eliminate the tax through the use of a variety of financial strategies.

#### State Income, Harvest, and Property Taxes

States vary widely in how they tax personal income, although most state income tax codes closely resemble Federal tax code. The economic effect of state income taxes mirrors that of the Federal income tax, but the impact is smaller because state tax rates are lower than Federal rates.

Because they occur annually, property taxes have the greatest potential of any state tax to influence forest owners' forest management decisions. The economic effect of a property tax is to increase the fixed cost of owning or managing forest land; it therefore influences owners' decisions about whether or not to continue to hold their land (Gregory 1972). All states assess or tax forest land at preferential rates, either as timberland or as agricultural or unproductive land. The states vary substantially in the approaches they use and the methods by which they apply taxes.

#### Federal Estate and Gift Taxes

The economic effect of estate and gift taxes is difficult to quantify because they occur at irregular intervals. They do, however, increase risk and put a premium on keeping management options open. The federal tax code includes numerous provisions that reduce or eliminate the impact of the federal estate and gift taxes. These provisions help forest owners keep their holdings intact through a transfer from one generation to another and reduce the need to liquidate timber or fragment the holding in order to pay tax. As with federal income tax, some are general provisions available to all taxpayers, while others are specifically for forest owners and other rural landowners (Siegel et al. in press). These latter provisions include a special use valuation,

exclusion for land in a qualified conservation easement, the use of business organization to transfer forest resources to family members, and trusts.

With the many strategies available to reduce or eliminate the impact of the estate tax, one might expect that only the estates of people who fail to plan would owe tax. Many forest owners, however, do not realize the value of their holdings, while others are unable or unwilling to accept the loss of ownership and control that the strategies entail (Greene et al. 2006).

### State Estate, Inheritance, and Gift Taxes

The states also vary widely in the way they tax the transfer of estates and gifts. Like the federal government, 18 states, principally in the North and South, tax the right of a decedent's estate to transfer property. In contrast, 10 states, particularly in the North, levy a tax on the right of heirs to receive property. Nationwide, 3 states levy both estate and inheritance taxes, and a different 3 states tax large gifts made during the donor's lifetime. The remaining states do not tax inter-generational transfers (Siegel et al., in press).

### Program Effectiveness

Tax incentives have had minimal impacts on NIPF management decisions and achieved only modest success, possibly because tax incentives have been too small to affect long-term NIPF behavior when development pressures are large (Brockett and Gerhard 1999, Hibbard et al. 2003). Tax incentives often simply reward landowners for doing what they would have done without the tax relief (Greene et al. 2005).

## **Common Law Principles**

American common law, or law that is derived from judicial decisions instead of from statutes, plays an important role in determining how decisions about private land use are made (Legal Information Institute 2006). Unlike a federal statute such as the ESA, or a state law forbidding discharge of pollutants into a water body, common law is not codified, determined by elected officials, or written down, aside from judges' decisions reported in legal opinions, and common law varies slightly or greatly from state to state. Nevertheless, this section will concentrate on general principles of the common law of property as they relate to conservation ethic and provision of ES.

### Property Law

Many common-law regimes dictate how or why a landowner may choose to or decide against managing his land or forest to produce ES or conserve an intact ecosystem. Of these, property law and its tools and doctrines clearly wield the most influence. These tools and doctrines include property rights and liabilities, nuisance doctrine, easements (conservation, negative, and otherwise), adverse possession, takings, split-estate, public trust doctrine, land-use planning/tradable development rights, and others.

Property law is a core area of law that is likely to impact and influence every decision a landowner makes, and thus can significantly influence provision of and markets for ES. The major reason that property law looms large in our consideration of ES is the nature of ES themselves, and the notion of "trans-boundary flow." Ecosystem services transcend the

boundaries of defined private properties; this requires a mechanism for distributing the rights among property owners, all of whom can reasonably make some claim to them (Ruhl *in press*). Important considerations include who is assigned the right or “ownership” of ES (Ruhl *in press*).

#### Nuisance, Liabilities, and Rules

Nuisance is a very old common law doctrine that provides that no landowner may unreasonably interfere with another person’s use and enjoyment of his or her property. As such, it may be the basis for a lawsuit for damages and/or an injunction ordering the person or entity causing the nuisance to stop or limit the activity. As applied, a particular use of land must not *unreasonably* interfere with the use and enjoyment of another’s property. How courts decide what is “reasonable” depends on locality and circumstances. An industrial plant built near a residential area might be considered a nuisance while one in a remote area may not be. Thus, historically, those wanting to build a factory, start a hog farm, etc., would most likely be immune from challenge if they engaged in their conduct in less developed areas, away from where anyone would be “unreasonably” bothered (Sprankling 1996, Ruhl *in press*).

If a court found that changes on one owner’s property constituted an unreasonable interference with a downstream landowner’s use of his property by damaging the property’s ability to provide ES, the court could, in theory, order the upstream landowner to cease his activities so that ES received downstream might be preserved. This has not yet actually occurred, but it could in theory. Alternatively, the courts may find that changes in the land use by the first owner are more valuable to society than the injuries suffered by the downstream landowner are harmful to that landowner, and permit the injurious activity to continue if the downstream owner is paid to compensate him for the damages, inconvenience, and *nuisance* he suffers. How the ES are valued may have a large bearing on how such a case would be decided, and/or the damages to be paid to the aggrieved landowner.

Because nuisance rules are generally retroactive, they may not prevent activities from harming ecosystems until after major damage has been done. Common law is slow to respond to changing knowledge and circumstances, though it arguably has the ability to do so more rapidly than statutory or regulatory intervention (Ruhl *in press*).

#### Local Land Use Planning Laws: Takings

The language of the Fifth Amendment of the U.S. Constitution provides that “private property [shall not] be taken for public use, without just compensation,” U.S. Const. Amend V, (“Takings Clause”). In the landmark case *Lucas v. South Carolina Coastal Council*, 505 U.S. 1003 (1992), the Supreme Court announced that where a new land use regulation denies all economically beneficial or productive use of the land, in that case a blanket prohibition of development, it must be treated as a *per se* or categorical taking under the Fifth Amendment and the landowner aggrieved by the regulation must be compensated (Ruhl *in press*).

An important impact of this decision with regards to ES is that it “place[s] the pro-development common law in the role of gatekeeper for the validity of pro-environment legislation” (Ruhl *in press*, *Lucas*, 505 U.S. 1003 *page cite* (1992)). Indeed, the Court said that when land is required to be “left substantially in its natural state,” there is a “heightened risk that private property is being pressed into some form of public service under the guise of mitigating serious public

harm.” *Lucas*, 505 U.S. 1003 *page cite* (1992). The on-the-ground effect of this ruling is that when “economic development” on private land is not permitted by an environmental regulation, the landowner must be compensated.

### Water Law

Water law is complex and dynamic. Water shares characteristics of both private property and a public good (Howitt and Hansen 2005). The appropriation of rights to water can have a major impact on who has a “right” to the watershed services from forests. Ultimately, the respective States “own” water within their boundaries, but the rights to *use* the water (usufructuary rights) vary dramatically among states. There are two basic systems of water law in this country: the riparian system in the east, and the prior appropriation system in the west.

The eastern riparian doctrine’s basic premise is that water use is attached to the land; “riparian proprietors” are entitled to the natural flow of the river without diminution to their injury. They must be “reasonable” in their use of the water. These rights are of equal priority (Tarlock et al 2002).

The western system of prior appropriation evolved in response to the exigencies of climate west of the 100th meridian, which makes water supplies scarce and unreliable. Under this system, water in its natural course is the property of the public and is not subject to private ownership, but a vested right to use the water may be acquired by appropriation and application to a beneficial use. Priority of use is established by time of application, and beneficial use is the basis, measure, and limit of the right (Ruhl *in press*).

The western “prior appropriation” system generally requires both a beneficial use and a diversion from the watercourse in order for a water rights holder to *keep* his/her rights to use the water. A holder that allows water to remain in the stream for recreation, wildlife, aesthetic, etc., purposes has traditionally been at a risk of losing his/her water rights. Some state courts have recognized that “instream flow” is a beneficial use not requiring a diversion, and other state legislatures have acted to allow the state to “reserve” water in its natural course for the purposes of wildlife and/or recreation (Ruhl *in press*).

Both riparian and prior appropriation systems have failed to prevent overuse, over consumption, and/or degradation of the aquatic resource. Many courts, state legislatures, developers, farmers, and others, see water as a commodity for “productive” use not as a component of an ecosystem. Water stands little chance of being managed to maintain ecosystems and their services unless the states step in and exert rights as “owners” of the resource.

## Key Ecosystem Services: Moving From Concept to Application

While the list of potential ES from forests is large, a small number of ES have been chosen for more detailed evaluation based on the following criteria: a) current or proposed policy instruments affect management of the ES; b) forests are important contributors to the service; and 3) private forests are an important contributor. The key ES described in this section are biomass, carbon sequestration, water, and recreation.

### Biomass

#### Definition

Biomass is an ecosystem good like other goods produced from natural or managed ecosystems such as timber or cash crops and thus many of the potential benefits of woody biomass may be captured relatively easily within existing markets. However, for purposes of this report we will focus on the portion of woody biomass that should be removed to achieve forest management objectives, but is not being used because of insufficient value in existing markets. This is similar to the definition of woody biomass used by the Forest Service Woody Biomass Utilization Team<sup>4</sup>.

*“Woody biomass is the material from trees and woody plants, including limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, farm, rangeland, or wildland urban interface environment, that are the by-products of forest management, ecosystem restoration, or hazardous fuel reduction treatments.”*

#### Role of Forests

Woody biomass is a product of forests, although woody biomass can also be removed from other ecosystems as well as human dominated environments. Both public and private forests provide woody biomass, although more attention has been focused on public lands because of the relationship between woody biomass and fire risk.

#### Measurement of Biomass

Measurement of woody biomass is relatively straightforward. It can be measured in volume (e.g. cubic meters) or weight (e.g. ton of material). Baseline estimates of biomass can be obtained from forest inventory data or direct sampling where available.

Biomass may also be viewed as an important component of forest ecosystems, and measures of biomass may be used to characterize forests and as an indicator of potential risks to ecosystem function, such as elevated fire risk. Unlike many ecosystem goods, for which extraction is often weighed against potential harm to the ecosystem, removal of high levels of biomass in the form of small diameter trees to improve forest health and productivity may be seen as a primary goal for encouraging woody biomass utilization. Woody biomass is an important component of forest carbon sequestration and therefore policies and regulations effecting biomass must also consider carbon sequestration issues.

---

<sup>4</sup> <http://www.fs.fed.us/forestmanagement/WoodyBiomassUtilization/index.shtml>

### Policy Environment

Biomass, as defined for this report, is of great interest to policy makers. While markets for woody biomass are currently limited, policies have the potential to greatly influence demand for biomass. Demand for biomass for energy generation may be particularly responsive to policy because of current high prices for traditional energy sources. Tax incentives and regulation (e.g. requirements for renewable fuel use) could be used to encourage use of biomass for energy. Federal and state support of research and innovative technologies for the use of woody biomass could also result in the creation of new or more efficient ways to use it and thus create increased demand<sup>5</sup>. In particular, policies directly focused on transportation fuel production from lignocellulosic material would create a strong market-based incentive for using woody biomass.

The Forest Service's national strategy for biomass utilization (US Forest Service 2005) provides additional detail on the opportunities for biomass utilization and obstacles to increasing use. Federal government efforts are underway to encourage the utilization of woody biomass in order to promote forest restoration and fuel reduction activities. The USDA, the United States Department of Energy, and the United States Department of the Interior signed a Memorandum of Understanding (MOU) to agree on the key policy principles that should be used in these efforts, and highlight the various areas in which policy may be used to influence how woody biomass from forests is valued. The four approaches include supporting research and development for new technologies for use of biomass, providing incentives for biomass use in existing technologies, providing assistance and/or incentives to landowners to remove excess biomass on private forests, and changing regulations that influence harvest of small diameter trees on public lands to increase demand.

### The Role of Markets

Forest biomass has great potential to serve as a sustainable energy source. Emerging technologies may improve the competitive position for biofuels and biomass energy. New uses for low valued biomass and forest residues can also increase the value of biomass, which in turn would increase the probability of removal of these materials without subsidies and other costly interventions. Currently, the market price of biomass is often too low to make use of many woody forest materials. One of the major obstacles to their use is the cost and energy use associated with harvesting and transportation of the material.

Research is underway to develop better tools to evaluate the costs and benefits of biomass removal, primarily linking biomass removal with fire risk or forest restoration objectives. Software for financial comparisons of fuel treatment options was developed primarily for public land management planning to help evaluate projects as part of National Environmental Protection Act analysis.<sup>6</sup> The effects of biomass utilization on fuel treatment alternatives in the Bitterroot Valley of Montana and the Front Range of Colorado are being studied, as is a west-wide analysis to model the market impacts of fuel treatment thinning programs and related wood utilization. An analytical tool has also been developed to use Forest Inventory (FIA) data with

---

<sup>5</sup> see Database of State Incentives for Renewable Energy (DSIRE), <http://www.dsireusa.org> for a list of current grants and incentives.

<sup>6</sup> [http://www.fs.fed.us/fire/tech\\_transfer/synthesis/economic\\_utilization\\_team/MyFTP\\_home.htm](http://www.fs.fed.us/fire/tech_transfer/synthesis/economic_utilization_team/MyFTP_home.htm)

forest simulation models and GIS models of road networks to identify best locations for siting biomass cogeneration or wood processing facilities (Fried et al. 2004). These types of analysis are not limited to woody biomass, but that portion of total biomass is of particular interest in these studies, since it tends to be the most limiting economic factor. Although much of this research focuses on removals from public lands, the lack of markets for biomass limits the financial feasibility of forest management actions on private lands as well. Research is also underway to help reduce biomass harvesting and transportation costs and develop cost-effective transportation fuels from woody biomass.

## **Carbon Sequestration**

### Definition

Carbon sequestration is one of the best known ES. Plants capture carbon dioxide in the photosynthesis process; therefore forests are a primary vehicle to remove carbon from the atmosphere.

### The role of forests

Forests play an important role in global carbon cycles. Policies that influence the rate of conversion of forest to other land use, or encourage afforestation and reforestation of deforested lands have the potential to have a large impact on concentrations of atmospheric CO<sub>2</sub> (IPCC 2001). Forest conversion is the second largest global source of anthropogenic carbon dioxide emissions, and is likely responsible for 10- 25% of carbon dioxide emissions worldwide (Houghton 2003, Santilli et al. 2005). Within the U.S. forests are net carbon sinks, sequestering approximately 780 Tg/yr CO<sub>2</sub> Eq. (latest data for 2004), which is approximately 11% of U.S. greenhouse gas emissions (US EPA 2006). A number of existing and proposed policy instruments specifically include the use of forests to capture CO<sub>2</sub>.

### Measurement

Forest carbon includes live trees, understory vegetation, standing dead trees, down dead trees, forest floor litter, soil organic carbon, and wood products in use and in landfills. Generally the measure of interest is carbon flux, which is calculated as change in successive carbon stocks (usually reported in tons of carbon). While this seems relatively straightforward, there are a number of methods to model carbon inventory and flux, and there are also data and information issues that further complicate forest carbon accounting (Heath and Smith 2000). Technical guidelines are provided for the 1650(b) voluntary reporting of greenhouse gas program.

### Policy Environment

Carbon sequestration is usually part of a suite of policies that contribute to a program for greenhouse gas (GHG) reduction. Policy instruments that influence how forests are used to sequester carbon currently operate at different scales, including international, national, regional, and state. These instruments may be based on encouraging voluntary action, market based greenhouse gas trading schemes, or strict regulation.

### International

The United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto protocol within the UNFCCC are the two major agreements addressing climate change and



reduction of greenhouse gases (GHG). Both the UNFCCC and the Kyoto protocol require that signatory countries include estimates of carbon emissions due to land use change, including deforestation, as part of a country's greenhouse gas reporting obligations, but the inclusion of the effects of forest management on greenhouse gas is voluntary. Reporting requirements have led to the development by the IPCC of good practice guidance for assessing forest carbon stocks and their changes (IPCC 2003).

The Kyoto protocol also potentially allows for the purchase of carbon credits via forest carbon sequestration as part of the Clean Development Mechanism (CDM). There are still no approved forest sequestration projects within the CDM, thus limiting the current use of forest related projects for forest carbon credits. Less than five percent of the 107 million metric tons of CO<sub>2</sub> Eq. from projects exchanged in 2004 (before the Kyoto Protocol officially took effect) was in forestry projects (World Bank 2005). The purchase of carbon credits from forestry projects is likely to drop even further when the Kyoto Protocol takes effect, unless rules for forest carbon sequestration are agreed upon by the parties.

#### National

The U.S. is a party to the UNFCCC, but not to the Kyoto Protocol. Currently no national regulation of CO<sub>2</sub> emissions exists. At least 18 bills addressing climate change were submitted to the House or Senate during the 109<sup>th</sup> Congress. Among these bills, the Climate Stewardship and Innovation Act of 2005 (S. 1151) and the House version of this bill, the Climate Stewardship Act of 2005 (H.R. 759) are the only proposed legislation that would create a cap-and-trade regulatory system, specifically allowing covered emitters to offset greenhouse emissions through forest sequestration projects. H.R. 955 would amend the Clean Air act to require the EPA to establish a mandatory GHG registry for entities emitting over 10,000 metric tons of carbon and would allow for the voluntary reporting of projects for forest sequestration.

Currently Section 1605(b) of the 1992 Energy Policy Act requires the Department of Energy (DOE) to maintain a national registry for the voluntary reporting of GHG emissions (CITE). This registry is voluntary and does not require any third party certification of reporting (Call and Hayes 2005).

#### State and Regional

A number of states have passed legislation designed to encourage or require a reduction in greenhouse gas emissions. Information on this legislation, and GHG registries, including those at the state and regional level has been reviewed by Mercer and Bristow (unpublished), and Call and Hayes (2005) and will be summarized here.

State and regional policy and regulation to limit or reduce emissions of GHG have all focused on the use of systems to promote trading of GHG emissions and/or sequestration credits. On September 21, 2006 California passed the nation's first statewide legislation to cap greenhouse gas emissions from industry. The "Global Warming Solutions Act", A.B. 32, will cap CO<sub>2</sub> and other greenhouse gas emissions to 1990 levels, or approximately 25%, by 2020.

Although other states still rely on voluntary participation, a regional initiative of Northeastern and Mid-Atlantic states is designed to move towards mandatory cap-and-trade regulation within

participating states. States participating in the regional initiative (Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont), released the final version of a model rule for public comment on August 15, 2006. The model regulations detail the proposed program agreed upon by the participating states. The finalized model rule forms the basis of individual state regulatory and/or statutory proposals to implement the program<sup>7</sup>.

The process by which states adopt these rules will vary state by state. In some states, such as New Hampshire, legislative approval will be sought before the rulemaking may begin. In other states, such as New Jersey and New York, the rulemaking may begin after the model rule is finalized.<sup>8</sup>

Under the proposed rules a source will be permitted to cover up to 3.3% of emissions with offsets. Greater offsets will be allowed if the cost of carbon allowances exceeds a prescribed threshold. Under the currently proposed rules, forestation of non-forested land will be the only type of biological sequestration for verified reduction projects. Projects may take place anywhere in the United States, but offsets from non-participating states will be awarded a one ton credit for each two tons of verified reduction.<sup>9</sup>

### Registries

The basis of GHG trading is the establishment of a registry to quantify GHG emission and sequestration by participating entities. The stated purpose and rules by which GHG registries operate may differ significantly, including rules about forest carbon sequestration. The Northeast States for Coordinated Air Use Management (NESCAUM) provides a helpful discussion on registry purposes.<sup>10</sup> Registries can be used to develop a state inventory of GHG emission and sequestration levels; to provide corporate and/or landowner GHG inventory assistance; to provide public recognition for entities taking action on climate change; to establish baseline protection, so that entities making emission reductions now will not be penalized under future regulatory schemes; and/or to record emission reduction efforts and make them quantifiable and fungible (i.e. tradable in the market).

### Role of Markets

Policies influence the cost of forest-based carbon credits relative to other carbon credits, or to other GHG emission reduction options. In areas where markets for carbon credits are developed, a key issue influencing whether forest based carbon credits are used will be the relative cost of these credits relative to other carbon credits. Synthesis studies by Richards and Stokes (2004), and Stavins and Richards (2005) have found that costs estimates range from \$10 - \$150 per ton of carbon worldwide (Richards and Stokes 2004) and \$25-\$90 in the U.S. (Stavins and Richards 2005). Stavins and Richards (2005) summarized major factors influencing the estimation of the cost of carbon sequestration in the U.S., including:

---

<sup>7</sup> <http://www.rggi.org/modelrule.htm>

<sup>8</sup> [http://www.rggi.org/docs/faqs\\_at\\_draft\\_mr\\_release.pdf](http://www.rggi.org/docs/faqs_at_draft_mr_release.pdf)

<sup>9</sup> [http://www.rggi.org/docs/faqs\\_at\\_draft\\_mr\\_release.pdf](http://www.rggi.org/docs/faqs_at_draft_mr_release.pdf)

<sup>10</sup> [www.nescaum.org](http://www.nescaum.org)

- (1) Rates of carbon yield;
- (2) Opportunity cost of the land;
- (3) Forest management costs;
- (4) Disposition of forest biomass;
- (5) Anticipated changes in forest and agricultural product prices;
- (6) Analytical methods used to account for carbon flows over time;
- (7) Discount rate employed in the analysis; and
- (8) Policy instruments used to achieve a given carbon sequestration target.

Richards and Stokes (2004) also point out the importance of considering the potential for leakage if reforestation of agricultural areas results in higher pressure to convert forested land to agricultural land in areas that do not offer economic incentives to maintain forestland.

While analyses continue to assess policy options, a number of voluntary and regulatory frameworks already exist and markets for carbon are evolving within these frameworks (Call and Hayes 2005). Market mechanisms evolving from the Kyoto Protocol are linked to an international agreement for reducing GHG emissions, with each participating country having reduction targets. The European Carbon Exchange (ECX) is a trade exchange where members can trade permits within a set of well-defined rules. Prices per ton of carbon on the ECX ranged between 25 and 30 euros through early 2006, although prices dropped sharply at the end of April to about 17 euros, as a result of surplus permits. Prices have remained relatively stable since April.

Regulatory schemes have also been implemented by individual states in the U.S. and Australia. In addition to regulatory schemes, the voluntary market for carbon trading is expanding. The Chicago Climate Exchange (CCX) provides a trade venue for the U.S. voluntary market. Participation in voluntary markets may meet any number of strategic objectives, including demonstrating corporate social responsibility, gaining knowledge of carbon trading in preparation for possible regulatory actions, and generating positive public relations. The CCX continues to have an increasing volume of trade and increasing prices. Since the U.S. system is voluntary, prices are substantially lower than ECX prices, averaging slightly over \$4 per ton of carbon in mid-August 2006.<sup>11</sup> Most recently, the Montréal Climate Exchange has been established in partnership with the Chicago Climate Exchange.

A final type of market activity for carbon is the “retail” market, which encompasses activities by individuals or organizations seeking to become “climate neutral” in their activities, even though they are unlikely to ever be regulated for GHG emissions. Motivations for participating in this market may be similar to those for voluntary markets. This market is characterized by purchases of small quantities of emission reductions that provide a tax write-off for the buyer when they are retired.<sup>12</sup>

---

<sup>11</sup> <http://www.chicagoclimatex.com/index.html>

<sup>12</sup> [http://ecosystemmarketplace.com/pages/marketwatch.backgrounder.php?market\\_id=11&is\\_aggregate=0](http://ecosystemmarketplace.com/pages/marketwatch.backgrounder.php?market_id=11&is_aggregate=0)

## **Water**

### Definition

Water is the source of a wide variety of ES. Some of those services are associated with water quantity and water flows, while others are associated with water quality. Water may be the actual service, as in the case of delivering water for consumptive use. In many cases, some attribute of water contributes to other services (e.g. providing a recreation environment), or attributes of water may be the result of conditions of terrestrial ecosystems (e.g. sediment loads or nutrient levels).

### Role of forests

Much of the freshwater in the United States originates in forested watersheds (USFS 2000). Loss of forestland has created concerns about the future of water resources in the U.S. Land use affects a number of hydrologic processes such the timing, the quantity of surface and subsurface hydrological transport, as well as the physical, chemical, and biological quality of water. With the conversion of forests to agricultural and urban land uses, the quantity of water discharged from a watershed is likely to increase but the quality of water will likely decrease. Numerous studies show strong, positive relationships among a suite of measures used to characterize human impacts on the landscape (e.g., percent non-forest, density and length of paved road, and building number and density) and the standard parameters used to measure water quality ( $\text{NO}_3$ ,  $\text{NH}_4$ , turbidity, total coliform, fecal coliform, and fecal streptococcus) (Osborne and Wiley 1988, Zampella 1995, Bolstad and Swank 1997). Furthermore, this body of work indicates consistently higher downstream changes during stormflow when compared to baseflow conditions. This trend suggests that the impacts of land alteration are much greater during storm events due to increased overland flow and transport of pollutants directly to the stream.

The timing, quality, and quantity of water all affect the biological integrity of river and stream ecosystems. Roth et al. (1996) evaluated stream conditions using an Index of Biotic Integrity (IBI) and a Habitat Index (HI) to assess the effects of landscape conditions on stream health in a largely agriculture landscape. Based on their measures of fish assemblages, habitat quality, and land use at multiple spatial scales, the ecological integrity of aquatic ecosystems as a measure of health is more strongly influenced by larger landscape characteristics than by local conditions.

### Measurement of Water ES

Water quantity can be measured by volume (e.g. acre feet, cubic feet) or by flow (e.g. cubic feet per second), although both measures can include a temporal component. Volume measures are primarily used for consumptive water uses such as irrigation or municipal use. Flow measures are often important for evaluating aquatic habitat characteristics that influence a range of services. Measuring the volume of water that moves through forest ecosystems and quantifying the major inflows and outflows provide a measure of the potential impact that changes in forest cover or structure might have on water resources, but any prediction of change in water must also include information on non-forested areas. Measures of percent of forested watersheds or the quantifying the amount water originating from forested areas provides only limited information about the potential value of forests for water related services.

Water quality has numerous attributes. The quality attribute of interest is a function of the intended water use or service. For example, quality measures to assess safe drinking water may vary from measures to ensure trout habitat to recreational boating. However, there are well-defined measures from most quality attributes, and those measures can be compared to standards embodied in federal and state statute and regulations.

The more challenging problem for both quality and quantity measures is linking changes in management actions to resulting changes in water quantity and quality, and ultimately changes in the desired social outcome. Some measures are easier to monitor than others; for example, point sources of pollution have been the primary focus of water quality efforts because it is much easier to monitor water quality at definable points than to monitor impacts of nonpoint source pollution. General patterns of the effect of changes in forest cover and tree density are also fairly well understood, but variation due to the effect of climate, soils, and forest composition and development stage make application to specific locations more complex, although regional models may be useful at longer time scales (Sun et al. 2004).

#### Policy Environment

Federal, state, and local legislation, policies, and regulations were described in some detail in an earlier section. The CWA is the primary federal legislation affecting water quality, while States and local governments have an array of policy instruments to protect water quality. Water quantity is primarily the province of the States, as described in the Water Law section.

#### Role of Markets

Water rights are well defined throughout the U.S., which is one pre-condition for the efficiently operating of markets. Water markets are much more active in the western U.S., partly a result of relative scarcity, but also because the west primarily operates under the prior appropriate doctrine. In over 2,000 water transactions that occurred in the western U.S. over the past 14 years (1990 through 2003), roughly half of the transactions were sales of water rights; the rest were water leases (Brown 2004). The transactions show that the price of water is highly variable both within and between western states, reflecting the localized nature of the factors that affect water prices. Water trades are much more common in some states (e.g., California and Colorado) than others (e.g., Montana and Oklahoma). Water scarcity no doubt plays some role in determining the number of trades, but institutional and legal differences are probably the most important factors affecting sale frequency among the western states.

Self-organized private transactions for water are not common, but they are occurring. Perhaps the most famous case is that of Perrier-Vittel, the bottled water company, which spent several million dollars to alter the farming practices in the watershed affecting the quality of the springs where the firm acquires its water (Daily and Ellison 2002). In the western U.S., 150 market purchases of water for environmental purposes (generally for maintaining instream flow) were reported during the period 1990-2003 (Brown, 2006). Most of these purchases were by government agencies, but 14 were by private environmental organizations, and in 13 of those cases the sellers were farmers or other private parties.

Several “markets” have evolved in response to regulatory frameworks. The market incentives used to implement the regulatory framework for WMB were described previously. The result

has been a migration of wetlands to rural areas. While there is no database of WMB transactions, wetland credit prices have been ranging from \$5,000 to \$250,000 per credit (CITE). The variability in price for wetland section 404 credits reflects differences in the availability and price of land suitable for bank development and the cost to create an acre of compensation within a given region. Army Corps of Engineer District offices and some state agencies set “in lieu” prices that can be paid if mitigation opportunities are not available. Recent examples of these fees ranged from \$23,000 per acre for nontidal wetland in southeast Virginia to \$400,000 per acre of tidal wetland in Virginia.<sup>13</sup>

The second regulatory framework described previously is the CWA framework for water quality trading. EPA recognizes the practice of trading pollution credits among dischargers to achieve TMDL-based water quality standards. The basic idea is to allow polluters with high costs of pollution reduction to contract with other entities to lower cost of reduction to meet pollution reduction requirements. However, the complexities of measuring, monitoring, and enforcing water quality standards have limited the use of trading.

## **Recreation**

### Definition

The service provided by forests is a potential recreational environment, rather than the recreation activity itself. Recreationists can be thought of as “creating” a recreation experience by combining their time and resources with the recreation environment provided by the recreation site, which is a combination of biophysical characteristics, management attributes, and infrastructure.

### Role of Forests

Forests are a preferred environment for recreation. While public lands are often most closely associated with recreation opportunities, private lands currently play an important role. About 640 million of the 750 million acres of forestland in the U.S. are available for recreation either by the general public or by a more restricted audience. The western U.S. has a much higher proportion of forestland available to the general public for recreation because of the dominance of public lands. The combination of increasing population and decreasing private forest area available for public recreation are leading to a declining per capita availability of forestland for recreation. Since private forestlands dominate the eastern U.S., recreation opportunities in the eastern U.S. will be more affected (Cordell 2004).

Very little is known about recreation use of private lands. A study conducted in the mid-1990s found that most private landowners only allow recreational access to family and friends. It was estimated that only 15-20% of private forestland is open to the general public, and the trend seems to be downward, based on earlier private land studies. Access to corporate ownerships tended to be limited to leaseholder or others with exclusive access privileges (Teasley et al. 1999).

---

<sup>13</sup> [http://ecosystemmarketplace.com/pages/marketwatch.backgrounder.php?market\\_id=4&is\\_aggregate=0](http://ecosystemmarketplace.com/pages/marketwatch.backgrounder.php?market_id=4&is_aggregate=0)

### Measurement

Measuring the “recreation opportunity” can be complex. One factor to consider is capacity, such as the “persons at one time” measure often used to measure the capacity of campgrounds and other facilities. Capacity can be limited by the biophysical characteristics of the site (e.g. soil compaction, sensitive riparian areas) or by social characteristics (e.g. crowding tolerance), or the interaction of the two. While there is scientific information to use as guidance on how various characteristics affect recreation opportunities, management involves constant monitoring and balancing. Also important is to understand how management action affects site characteristics, which in turn affect the recreationists’ willingness to use the site.

### Policy Environment

Recreation is usually considered a public sector issue, and has received less attention in policies designed to influence private land management. However, several of the incentive programs described previously can also enhance recreation opportunities on private lands. Federal cost sharing programs that can enhance habitat for endangered species or other wildlife, such as CRP, may also provide additional economic returns via increased potential for recreational use of the ecosystem. Wildlife habitat was added to the environmental benefit index used to rank CRP bids starting in 1996 and annual non-market economic benefits of CRP from wildlife related activities have been estimated at over \$737 million dollars (Sullivan et al. 2004). Because trees were used as a cover in only 8% of CRP grants, the majority of these benefits are likely to come from non-forest ecosystems (Sullivan et al. 2004). It is important to point out, however, that these estimated values were the value of benefits to the recreationists and do not reflect potential income to the landowners implementing the habitat changes.

Conservation easements and special use provisions (see federal tax section) that provide tax relief may also be applied to land that is used for recreation purposes and may encourage landowners to offer the use of their land for recreation without charging additional fees.

Concern about reduced access to quality hunting and fishing opportunities led to proposed federal legislation for “Open Fields.” Both the Senate and House introduced legislation in 2005 that intended to make millions of acres of additional private lands available for hunting and fishing. Increases in USDA funding were targeted to bolster existing state access programs for “walk-in” access or to establish new programs. These program offer small per-acre payments to rural landowners to voluntarily open their acreage, improve habitat, and expand huntable land.<sup>14</sup>

These state “open access” programs are specifically aimed at supporting landowners who are willing to provide access to their land for hunting and wildlife viewing. Currently at least 21 states have programs that vary in their specific rules and requirements for participations<sup>15</sup>. Most programs list properties of enrolled landowners that have agreed to allow access to land under specified conditions. Landowners in turn are generally provided limiting funding to improve wildlife habitat and delimit areas for hunting or wildlife viewing and in many cases also are granted limited liability protection by the state in case of accidents occurring to visitors to their land.

---

<sup>14</sup> [http://www.trcp.org/ea\\_openfields.aspx](http://www.trcp.org/ea_openfields.aspx)

<sup>15</sup> see <http://www.trcp.org/stateprograms.aspx>

### Role of Markets

The National Private Landowners Survey conducted in 1995-1996 queried landowners about their land use objectives, including recreational use. Many landowners indicate that one of their reasons for owning land is for aesthetic enjoyment, or to provide wildlife habitat. However, 70% of landowners also expect their land to produce economic returns. As mentioned previously, most landowners only allow family and friends to recreate on their land, but some landowners do provide access on a fee or lease basis. Leasing is much more common (Teasley et al 1999).

Landowners can control access to their land and charge visitors for the use of goods and services. Therefore, it is possible for landowners to capture the recreation value of ecosystems on private lands even in the absence of incentives and other policies. In fact, markets have developed for recreation access, with hunting being the predominant “fee” recreation use.

The primary private land “market” for recreation is hunting, particularly big game hunting. The typical hunting market arrangement is one where an individual or group of individuals leases hunting rights on private land for a negotiated payment to the landowner. In some regions of the U.S. there are many hunters (buyers) and many landowners (sellers) willing to lease hunting rights; thus, prices of private land hunting leases are fairly competitive. The rival, exclusive nature of markets for hunting, fishing, and rafting opportunities means that provision and price of these opportunities may be economically efficient.

Results from the 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation provide a perspective on the role of private markets in providing recreation opportunities for those activities in 2001. Out of a total of 12.6 million total hunters, 982,000 hunters spent \$624 million leasing 225 million acres of private land. By comparison, about 200,000 anglers spent \$161 million to lease 1.3 million acres of land, and 116,000 wildlife watchers spent \$301 million leasing 10.5 million acres (US DOI and US DOC 2002). So, while only a small percentage of participants leased land (8% of hunters, less than 1% of anglers and wildlife watchers), significant amounts of revenue were generated for private land owners.

Not surprisingly, the use of private lands by hunters is much higher in states with small proportions of public land, particularly the Plains states, and most of the east. The percent of hunting days on private land is even more disproportionately distributed between east and west. Except for the interior west (with the highest proportion of public land), over half of hunters hunt part of the time on private land, with over 80% of all hunter in the eastern US using private lands (Aiken 2005). These data indicate that there is substantial potential for expansion of private land recreation opportunities.

### **Acknowledgements**

We thank Greg Arthaud, Marilyn Buford, and Anne Hoover for their helpful reviews of drafts and for sharing their knowledge about ecosystems services with us. The summary represents the work of many contributors, all of whom generously shared their work, including peer reviewed publications, white papers, and draft manuscripts with those responsible for compiling the summary (Notman, Langner, and Crow). We are especially indebted to Tom Brown and his co-



October 5, 2006 **FINAL**

authors for sharing a draft of their paper *Ecosystem Goods and Services: Definition, Valuation and Provision* that has been accepted for publication in the Natural Resources Journal. For the section on Policy Instruments, we drew heavily on a manuscript being prepared by Evan Mercer, Tracy Calizon, Terry Haines, Evan Notman, and John Greene. We relied on an unpublished paper by Jessica Call and Jennifer Hayes for the section on regulatory-based markets. Finally, the publication *Cooperating Across Boundaries, Partnerships to Conserve Open Space in Rural America* (USDA Forest Service, FS-861, August 2006) was helpful in developing the sections on Land Use and Ecosystem Services and Observing and Predicting Land Use Change.

## **Literature cited**

- Aiken, R. 2005. Private and public land use by hunters. Report 2001-8. Washington, DC: U.S. Department of Interior Fish and Wildlife Service. 32 p.
- Alcamo, J., N.J. Ash, C.D. Butler, J.B Callicott, D. Capistrano, S.R Carpenter, et al. 2003. Ecosystems and human well-being: a framework for assessment. Island Press, Washington, D.C.
- Alig, R.J. and R. Healy. 1987. Urban and built-up land area changes in the United States: an empirical investigation of determinants. *Land Econ.* 63: 215-226.
- Alig, R.J., K.J. Lee, and R.J. Molton. 1990. Likelihood of timber management on nonindustrial private forests: evidence from research studies. General Technical Report SE-60. Asheville: USDA Forest Service Southeastern Forest Experiment. Station. 40 p.
- Alig, R.J., J.D. Kline, M. and Lichtenstein. 2004. Urbanization on the US landscape: looking ahead in the 21<sup>st</sup> century. *Landscape and Urban Planning* 69: 219-234.
- Alig, R.J., S. Plantinga, S. Ahn, and J.D. Kline. 2003. Land use changes involving forestry in the United States: 1952 to 1997, with projections to 2050. PNW-GTR-587. Portland, OR: USDA Forest Service. Pacific Northwest Research Station.
- Alig, R.J. and A. Plantinga. 2004. Future forestland area: impacts from population growth and other factors that affect land values. *J. Forestry* 102(8): 19-24.
- Andersen, O., T.R. Crow, S.M. Lietz, and F. Stearns. 1996. Transformation of a landscape in the upper mid-west, USA: the history of the lower St. Croix River valley, 1830 to present. *Landscape Urban Planning* 35: 247-267.
- Anderson, K. and Martin, W. 2005. [Agricultural Trade Reform and the Doha Development Agenda](#). *World Economy* Vol. 28 (9):1301-1327.
- Bliss, J. C. and A.J. Martin. 1990. How tree farmers view management incentives. *Journal of Forestry*. 88(8):23-29.
- Bolstad, P.V. and W.T. Swank. 1997. Cumulative impacts of landuse on water quality in a southern Appalachian watershed. *Journal American Water Resources Association* 33: 519-533.
- Boyd, J. 2000. The new face of the Clean Water Act: a critical review of the EPA's new TMDL rules. *The Duke Environmental Law and Policy Forum* 11(1):39-87.
- Breetz, H. L. K. Fisher-Vanden, L. Garzon, H. Jacobs, K. Kroetz, R. Terry. 2004. Water quality trading and offset initiatives in the U.S.: a comprehensive survey. Available at <http://www.dartmouth.edu/~kfv/waterqualitytradingdatabase.pdf>.

Brooks, D.J. 1985. Public policy and long-term timber supply in the South. *Forest Science* 31:342-357

Brown, T. C. 2004. The Marginal Economic Value of Streamflow From National Forests. USDA Forest Service RMRS - RWU 4851 Discussion Paper. Available at [http://www.fs.fed.us/rm/value/docs/marginal\\_economic\\_value\\_streamflow\\_forests.pdf](http://www.fs.fed.us/rm/value/docs/marginal_economic_value_streamflow_forests.pdf)

Brown, T.C., D. Brown, and D. Binkely. 1993. Laws and programs for controlling nonpoint source pollution in forest areas. *Water Resource Bulletin* 29: 1-13.

Brown, T.C., J.C. Bergstrom, and J.B. Loomis. 2006. Ecosystem goods and services: definition, valuation, and provision. USDA Forest Service RMRS-RWU-4851 Discussion Paper, May 31, 2006. Available at [http://www.fs.fed.us/rm/value/docs/ecosystem\\_goods\\_services.pdf](http://www.fs.fed.us/rm/value/docs/ecosystem_goods_services.pdf)

Brockett, C.D. and L. Gephard. 1999. NIPF tax incentives: do they make a difference. *Journal of Forestry* 97:16-21.

Call, J. and J. Hayes. 2005. A description and comparison of selected forest carbon registries: A guide for states considering the development of a forest carbon registry. USDA Forest Service unpublished white paper.

CBD. 2005. The impact of trade liberalization on agricultural biological diversity: domestic support measures and their effects on agricultural biological diversity. CBD Technical Series no. 16. Secretariat of the Convention on Biological Diversity. Montreal. 47 p

CCSP. 2003. Strategic plan for the U.S. Climate Change Science Program. A report by the Climate Change Science Program and the Subcommittee on Global Change Research, Climate Change Science Program Office, Washington, D.C.

Champ, P.A., K. J.Boyle, and T. C. Brown. (eds.). 2003. A primer on nonmarket valuation. Kluwer Academic Publishers, Boston, MA.

Coggins, G.C., Wilkinson, C.F., and John D. Leshy. 2002. Federal public land and resources law. Foundation Press, New York.

Cordell, H. K. 2004. Outdoor recreation for 21<sup>st</sup> century America. Venture Publishing, Inc., State College, PA.

Cosbey, A. 2004. Lessons learned on trade and sustainable development distilling six years of research from the trade knowledge network. International Institute for Sustainable Development. Winnipeg. Available at [http://www.tradeknowledgenetwork.net/pdf/tkn\\_lessons\\_learned\\_en.pdf](http://www.tradeknowledgenetwork.net/pdf/tkn_lessons_learned_en.pdf)

Costanza R, d'Arge R, Groot R de, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P, Belt M van den. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387: 253-260.

October 5, 2006 **FINAL**

Crow, T.R., G.E. Host, and D.J. Mladenoff. 1999. Ownership and ecosystem as sources of spatial heterogeneity in a forested landscape, Wisconsin, USA. *Landscape Ecology* 14: 449-463.

Daily, G. C. 1997. Introduction: what are ecosystem services? In G. C. Daily (Ed.), *Natures services: societal dependence on natural ecosystems*. pp. 1-10. Island Press, Washington, D.C.

Daily, G. C., and Ellison, K. 2002. *The new economy of nature: the quest to make conservation profitable*. Washington, D. C.: Island Press.

Dale, V.H. (editor). 1994. *Effects of land-use change on atmospheric CO<sub>2</sub> concentrations*. Springer-Verlag, New York.

de Groot, R.S., M.A. Wilson, and R.M.J. Boumans. 2002. A typology for the classification, description and valuation of ecosystem functions, goods, and services. *Ecological Economics* 41: 393-408.

Dennis, D.F. 1980. An economic analysis of harvest behavior: integrating forest and ownership characteristics. *Forest Science* 35:1088-1104.

Dennis, D.F. 1990. A probit analysis of the harvest decision using pooled time-series and cross-sectional data. *Journal of Environmental Economics and Mgmt.* 18:176-187.

Diamond, J. 2005. *Collapse, how societies choose to fail or succeed*. Viking, New York.

Dwyer, J.F. and G.M. Childs. 2004. Movement of people across the landscape: a blurring of distinctions between areas, interests, and issues affecting natural resource management. *Landscape and Urban Planning* 69: 153-164.

Edwards, P.J. and G.W. Stuart. 2002. State survey of silviculture nonpoint source programs: A comparison of the 2000 northeastern and national results. *Northern Journal of Applied Forestry*. 19(3): 122-127.

Ellefson, P. V. and A. Cheng. 1997. State forest practice regulatory programs: An approach to implementing ecosystem management on private forest lands in the United States. *Environmental Management* 21(3): 421-432.

Environmental Law Institute. 2005. National forum on synergies between water quality trading and wetland mitigation banking: Forum Report. July 11-12, 2005.

Esty, C., M. Ivanova 2004, Globalization and environmental protection: a global governance perspective. Yale Center for Environmental Law and Policy Working Paper No. 0402  
<http://www.yale.edu/envirocenter/0402%20esty-ivanova.pdf>

October 5, 2006 **FINAL**

Esseks, J. D. and R. J. Moulton. 2000. Evaluating the forest stewardship program through a national survey of participating forest land owners. Northern Illinois University, Social Science Research Institute, Center for Governmental Studies, De Kalb, Illinois. 111 p.

Farm Service Agency. 2006. Conservation Reserve Program: summary and enrollment statistics 2005. U.S. Department of Agriculture, Farm Service Agency. Available at <http://www.fsa.usda.gov/dafp/cepd/stats/2005Booklet.pdf>

Foley, J.A., R. DeFries, G.P. Asner, C. Barford, G. Bonan, S.R. Carpenter, F.S. Chapin, M.T. Coe, G.C. Daily, H.K. Gibbs, and others. 2005. Global consequences of land use. *Science* 309: 570-574.

Forman, R.T.T., D. Sperling, J.A. Bissonette, A.P. Glevenger, C.D. Cutshall, V.H. Dale, L. Fahrig, R. France, C.R. Goldman, K. Heanue, J.A. Jones, F.J. Swanson, T. Turrentine, T.C. Winter. 2003. Road ecology, science and solutions. Island Press, Washington, DC.

Freeman, A.M., III. 2003. Economic valuation: what and why, pp. 1-25. In P.A. Champ, K.J. Boyle and T.C. Brown (eds.), *A Primer on Non-market Valuation*. Kluwer Academic Publishers, Boston, MA.

Fried, Jeremy S., Glenn Christensen, Dale Weyermann, R. Jamie Barbour, Roger Fight, Bruce Hiserote, and Guy Pinjuv. 2004. [Modeling opportunities and feasibility of siting wood-fired electrical generating facilities to facilitate landscape-scale fuel treatment with FIA BioSum](#) In: Bevers, Michael; Barrett, Tara M., comps. *Systems Analysis in Forest Resources: Proceedings of the 2003 Symposium; October 7-9, Stevenson, WA. Proceedings RMRS-P-000*. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Gobster, P.H. and M.G. Rickenbach. 2004. Private forestland parcelization and development in Wisconsin's Northwoods: perceptions of resource-oriented stakeholders. *Landscape and Urban Planning* 69: 165-182.

Gómez-Pompa, A. and A. Kaus. 1992. Taming the wilderness myth. *BioScience* 42: 271-279.

Gottfried, R., D. Wear, and R. Lee. 1996. Institutional solutions to market failure on the landscape level. *Ecological Economics* 18:133-140.

Greene, J.L., T.J. Straka, and R.J. Dee. 2004. Nonindustrial private forest owner use of Federal income tax provisions. *Forest Products Journal* 54(12): 59-66.

Greene, J., S. Daniels, M. Jacobson, M. Kilgore, and T. Straka. 2005. Existing and potential incentives for practicing sustainable forestry on non-industrial private forest lands. Final Report to the National Commission on Science for Sustainable Forestry Research NCSSF Project C2. 33p.

Greene, J.L., S.H. Bullard, T.L. Cushing, and T. Beauvais. 2006. Effect of the Federal estate tax on nonindustrial private forest holdings. *Journal of Forestry* 104(1): 16-20.

Gregory, G.R. 1972. Forest resource economics. The Ronald Press Company, New York. 548 pp.

Haines, T. 1995. Federal and state forestry cost-share assistance programs: structure, accomplishments, and future outlook. Res. Pap. SO-295. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 18 p.

Haney, H.L., Jr., W.L. Hoover, W.C. Siegel, and J.L. Greene. 2001. Forest landowners' guide to the federal income tax. Agriculture Handbook No. 718. U.S. Department of Agriculture, Forest Service, Washington, D.C. 157 pp.

Heal, G. M., E.B. Barbier, K.J. Boyle, A.P. Covich, S.P. Gloss, C.H. Hershner, et al. 2005. Valuing ecosystem services: toward better environmental decision-making. National Academy Press. Washington, D.C.

Heath, L. S. and J. E. Smith. 2000. Soil carbon accounting and assumptions for forestry and forest-related land use change. In: Joyce, Linda A. and Richard Birdsey, tech eds. The impact of climate change on America's forests. RMRS-GTR-59. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 89-101

Hibbard, C.M., M.A. Kilgore, and P.V. Ellefson. 2003. Property taxation of private forests in the United States: A national review. Journal of Forestry 101(3): 44-49.

Hodge, I. and S. McNally. 2000. Wetland restoration, collective action, and the role of water management institutions. Ecological Economics 35:107-118.

Hodges, D.G. and F.W. Cabbage 1990. Nonindustrial private forest management in the South: assistance foresters' activities and perceptions. Southern Journal of Applied Forestry 14:44-48.

Houghton, R.A. 1995. Land-use change and the carbon cycle. Global Change Biology 1: 275-287.

Houghton, R. A., 2003. Revised estimates of the annual net flux of carbon to the atmosphere from changes in land use and land management 1850-2000. Tellus 55B, 378-390.

Houghton, R.A. and D.L. Skole. 1990. Changes in the global carbon cycle between 1700 and 1985. In: B.L. Turner II, W.C. Clark, R.W. Kates, J.F. Richards, J.T. Mathews, and W.B. Meyer, eds., The earth transformed by human action: global and regional changes in the biosphere over the past 300 Years. Cambridge University Press, Cambridge, U.K.

Howitt, R., and K. Hansen. 2005. The evolving western water markets. Choices 20(1):59-64.

Hummon L. and F. Casey. 2004. Status and trends in federal resource conservation incentive programs: 1996-2001. Conservation Economics Program Working Paper 1, Defenders of Wildlife, Washington D.C. Available at [www.biodiversitypartners.org/pubs/NSI/01.shtml](http://www.biodiversitypartners.org/pubs/NSI/01.shtml)

Hyberg, B.T. and D.M. Holthausen. 1989. The behavior of nonindustrial private forest landowners. *Canadian J. of Forest Research* 19:1014-1023.

Hyberg, S., 2005. The role of science in guiding the Conservation Reserve Program: past and future. *in* Allen, A.W., and Vandever, M.W., eds., 2005, *The Conservation Reserve Program—Planting for the future: Proceedings of a National Conference*, Fort Collins, Colorado, June 6–9, 2004: U.S. Geological Survey, Biological Resources Discipline, Scientific Investigations Report 2005-5145, 248 p.

IPCC. 2001. *Climate change 2001: Synthesis report. A contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* R.T. Watson and the Core Writing Team (eds.). Cambridge University Press, Cambridge, New York, NY, USA, 398 pp.

IPCC. 2003. *Good practice guidance for land use, land-use change and forestry.* In: J. Penman, M. Gytarsky, T. Hiraishi, T. Krug, D. Kruger, R. Pipatti, L. Buendia, K. Miwa, T. Ngara, K. Tanabe and F. Wagner, (eds.). *IPCC National Greenhouse Gas Inventories Programme.* UNEP, Institute for Global Environmental Strategies (IGES). Kanagawa, Japan.

James, L.M., W.P. Hoffman, and M.A. Payne. 1951. *Private forest landownership and management in central Mississippi.* Technical Bulletin 33. Mississippi State College, Agricultural Experiment Station, State College, Mississippi. 38 p.

Jansen, M. and A. Keck 2004, *National environmental policies and multilateral trade rules.* Staff Working Paper ERSD-2004-01. World Trade Organization

Jenkins, M., S.J. Scheer, and M. Inbar. 2004. *Markets for biodiversity services: potential roles and challenges.* *Environment* 46: 32-42.

Kellogg, R.L., 2005. *Measuring environmental benefits of conservation practices: the conservation effects assessment project.* *in* Allen, A.W., and Vandever, M.W., eds., 2005, *The Conservation Reserve Program—Planting for the future: Proceedings of a National Conference*, Fort Collins, Colorado, June 6–9, 2004: U.S. Geological Survey, Biological Resources Discipline, Scientific Investigations Report 2005-5145, 248 p.

Kilgore, M.A., and C.R. Blinn. 2004. *Policy tools to encourage the application of sustainable timber harvesting practices in the United States and Canada.* *Forest Policy and Economics* 6(2): 111–127.

King, D.M. 2005. *Crunch time for water quality trading.* *Choices* 20(1):71-76.

King, D.M., and Peter J. Kuch. 2003. *Will nutrient credit trading ever work? An assessment of supply and demand problems and institutional obstacles.* *Environmental Law Review News & Analysis* 33:10352-10368.

October 5, 2006 **FINAL**

Kline, J, R. Alig, and R. Johnson. 2000a. Fostering the production of nontimber services among forest owners with heterogenous objectives. *Forest Science* 46:302-311.

Kline, J.D., R.J. Alig, and R.L. Johnson. 2000b. Forest owner incentives to protect riparian habitat. *Ecological Economics* 33:29-43.

Landell-Mills, N. 2002. Developing markets for forest environmental services: an opportunity for promoting equity while securing efficiency? *Philosophical Transactions of the Royal Society of London* 360: 1817-1825.

Landry, M., A. Siems, G. Stedje, L. Shabman. 2005. Applying lessons learned from wetlands mitigation banking to water quality trading. White Paper prepared for Office of Policy, Economics and Innovation and the Office of Water, U.S. Environmental Protection Agency.

Langpap, C. 2004. Conservation incentives programs for endangered species: an analysis of landowner participation. *Land Economics* 80(3):375-388.

Legal Information Institute. 2006. *Wex Legal Dictionary*. Cornell Law School. Available at <http://www.law.cornell.edu/wex/index.php/Category:Definition>.

Loftus TT, S.E., Kraft 2003, Enrolling conservation buffers in the CRP. *Land Use Policy* 20(1):73-84

Lubowski, R.N., S. Bucholtz, R. Claassen, M.J. Roberts, J.C. Cooper, A. Gueorguieva, and R. Johansson. 2006. Environmental effects of agricultural land-use change: the role of economics and policy. *Economic Research Report No.25*. Washington, DC: USDA Economic Research Service, 81 p.

Lueck, D. and J. A. Michael. 2003. Preemptive habitat destruction under the Endangered Species Act. *The Journal of Law and Economics* 46:27–60.

Luzar, E.J. and Diagne, A. 1999. "Participation in the next generation of agriculture conservation programs: the role of environmental attitudes," *The Journal of Socio-Economics* 28(3):335-349.

Mann, C.C. 2005. 1491, new revelations of the Americas before Columbus. Alfred A. Knopf, New York.

McCauley, D.J. 2006. Selling out on nature. *Nature* 443(7): 27-28.

Meyer, W.B. and B.L. Turner II. 1992. Human population growth and global land-use/cover change. *Annual Review Ecol. Syst.* 23: 39-61.

Meyer, W.B. and B.L. Turner II (eds.). 1994. *Changes in land use and land cover: A global perspective*. Cambridge University Press, Cambridge.



October 5, 2006 **FINAL**

Mills, T.J. 1976. Cost effectiveness of the 1974 forestry incentives program. Res. Pap. RM-175. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23p.

Mills, C.S. 2004. Note: Incentives and the ESA: Can conservation banking live up to its potential? *Duke Environmental Law and Policy Forum*. 14:523-561.

Nassauer, J.I. 1995. Culture and changing landscape structure. *Landscape Ecology* 10: 229-237.

Nordstrom, H. and S. Vaughan. 1999. Trade and environment. Geneva: World Trade Organization.

Osborne, L.L. and M.J. Wiley. 1988. Empirical relationships between landuse/cover and stream water quality in an agricultural watershed. *J. Environ. Management* 26: 92-97.

Parkhurst, G.M. and J.F. Shogren. 2003. Evaluating incentive mechanisms for conserving habitat. *Natural Resources Journal* 43:1093-1149.

Pimm, S.L. and P. Raven. 2000. Extinction by numbers. *Nature* 403: 843-845.

Plantinga, A.J. 1996. The effect of agricultural policies on land use and environmental quality. *American Journal of Agricultural Economics* 78 (4):1082-1091.

Radeloff, V.C., R.B. Hammer, S.I. Stewart, J.S. Fried, S.S. Holcomb, and J.F. McKeefry. 2005. The wildland-urban interface in the United States. *Ecological Applications* 15: 799-805.

Randall, A. 1987. Resource economics: an economic approach to natural resource and environmental policy (2<sup>nd</sup> edition). John Wiley and Sons, New York.

Richards, K. and C. Stokes. 2004. A review of forest carbon sequestration cost studies: A dozen years of research. *Climatic Change* 63: 1-48.

Risbrudt, C. D. and P.V. Ellefson. 1983. An economic evaluation of the 1979 forestry incentives program. Station Bulletin 550. St. Paul, MN. University of Minnesota Agricultural Experiment Station. p. 1-13.

Roth, N.E., J.D. Allan, and D.L. Erickson. 1996. Landscape influences on stream biotic integrity assessed at multiple spatial scales. *Landscape Ecology* 11: 141-156.

Royer, J.P. and R.J. Moulton. 1987. Reforestation incentives—tax incentives and cost sharing. *Southern Journal of Forestry*. 85: 45-47.

Ruhl, J.B. and R. Juge Gregg. 2001. Integrating ecosystem services into environmental law. *Stanford Environmental Law Journal* 20: 365.

October 5, 2006 **FINAL**

Ruhl, J.B. The “background principles” of natural capital and ecosystem services. *Journal of Land Use and Environmental Law*. *In press*.

Ruhl, J.B., and James Salzman. 2006. The effects of wetland mitigation banking on people. *National Wetlands Newsletter* 28(2): 8-14.

Ruppert, T.K. 2004. Water quality trading and agricultural nonpoint source pollution: an analysis of the effectiveness and fairness of EPA’s policy on water quality trading. *Villanova Environmental Law Journal* 15:1-39.

Salzman, J., and J.B. Ruhl. 2000. Currencies and the commodification of environmental law. *Stanford Law Review* 53:607-694.

Santilli, M., P. Moutinho, S. Schwartzman, D. Nepstad, L. Curran and C. Nobre. 2005. Tropical Deforestation and the Kyoto Protocol, *Climatic Change* 71: 267–276.

Siegel, W.C., and H.L. Haney, Jr., with J.L. Greene. *Estate Planning for Forest Landowners: What Will Become of Your Forestland?* U.S. Department of Agriculture, Forest Service, Southern Research Station. (In press).

Sprankling, J.G. 1996. The antiwilderness bias in American property law. *University of Chicago Law Review* 63(2): 519-590.

Stavins, R.N. 1998. What can we learn from the grand policy experiment? Lessons from SO<sub>2</sub> allowance trading. *Journal of Economic Perspectives* 12: 69-88.

Stavins, R.N. 2005. Lessons from SO<sub>2</sub> allowance trading. *Choices* 20: 53-57.

Stavins, R. and K. Richards. 2005. The cost of U.S. forest-based carbon sequestration. Pew Center on Global Climate Change, Arlington, VA. Available at <http://www.pewclimate.org/docUploads/Sequest%5FFinal%2Epdf>

Sullivan P., D. Hellerstein, L. Hansen, R. Johansson, S. Koenig, R. Lubowski, W. McBride, D. McGranahan, M. Roberts, St. Vogel, and S. Bucholtz. 2004. The Conservation Reserve Program: economic implications for rural America. AER-834. USDA Economic Research Service, Washington, DC.

Sun, G., S.G. McNulty, J. Lu, D.M. Arnatyac, Y. Liang, R.K. Kolka. 2005. Regional annual water yield from forest lands and its response to potential deforestation across the southeastern United States. *Journal of Hydrology* 308:258-268.

Tarlock, A.D., Corbridge, J.N., and David H. Getches. 2002. *Water Resources Management*. Foundation Press, New York

Teasley, R. J., J. C. Bergstrom, H. K. Cordell, S. J. Zarnoch, and P. Gentle. 1999. Private lands and outdoor recreation in the United States. In: H.Ken Cordell, principal investigator. *Outdoor*

October 5, 2006 **FINAL**

recreation in American life: a national assessment of demand and supply trends. Sagamore Publishing, Champaign, IL:

Theobald, D.M. 2005. Landscape patterns of exurban growth in the USA from 1980 to 2020. *Ecology and Society* 10: 32.

Turner, M.G., D.N. Wear, and R.O. Flamm. 1996. Land ownership and land-cover change in the southern Appalachian highlands and the Olympic Peninsula. *Ecological Applications* 6: 1150-1172.

U.S. Department of the Interior and U.S. Department of Commerce. 2002. The 2001 national survey of fishing, hunting, and wildlife-associated recreation. Washington, DC.

U.S. Environmental Protection Agency. 2003. Water Quality Trading Policy. Office of Water, Washington, DC. Available at <http://www.epa.gov/owow/watershed/trading/finalpolicy2003.pdf>

U.S. Environmental Protection Agency. 2006. Inventory of U.S. greenhouse gas emissions and sinks: 1990 -2004, EPA 430-R-06-002. U.S. Environmental Protection Agency, Office of Atmospheric Programs. Available at [www.epa.gov/globalwarming/publications/emissions](http://www.epa.gov/globalwarming/publications/emissions).

U.S. Forest Service. 2000. Water and the Forest Service. FS-687. Washington, DC.

U.S. Forest Service. 2005. "A national strategy for improving woody biomass utilization through USDA Forest Service programs and activities. USDA Forest Service, Washington, DC.

Verburg, P.H., W. Soepboer, R. Limplada, M.V.O. Espaldon, M. Sharifa, and A. Veldkamp. 2002. Land use change modeling at the regional scale: the CLUE-S model. *Environmental Management* 30: 391-405.

Wear, D.N. and D.H. Newman. 2004. The speculative shadow over timberland values in the U.S. South. *J. Forestry* 102: 25-31.

Wilcove, D., M. J. Bean, R. Bonnie, and M. McMillan. 1998. Rebuilding the ark: toward a more effective Endangered Species Act for private land. *Environmental Law Reporter* 28:10701.

World Bank. 2005. World Bank Group progress on renewable energy and energy efficiency: fiscal year 2005. The International Bank for Reconstruction and Development, The World Bank Group. Washington, DC.

Young, R.A. 2005. Determining the economic value of water: concepts and methods. Resources for the Future, Washington, DC.

Zampella, R.A. 1995. Characterization of surface water quality along a watershed disturbance gradient. *Water Resources Bulletin* 30: 605-611.



**Table 1. Summary of Federal programs providing payments to landowners that may encourage the provision of ecosystem services.**

<b>Program</b>	<b>Agency</b>	<b>Description</b>	<b>Cost share</b>	<b>Technical assistance</b>	<b>Other</b>
<b>Conservation Reserve Program (CRP)</b>	USDA-FSA	Targets marginal crop and pasture lands to reduce soil erosion, reduce sedimentation in streams, and lakes, improve water quality, establish wildlife habitat, restore floodplains, and enhance forest and wetland resources. Farmers receive annual rental payments for the term of 10-15 year contracts.	up to 50%		
<b>Conservation Reserve Enhancement Program (CREP)</b>	USDA-NRCS	Provides benefits similar to the (CRP), but is tailored to meet specific environmental needs of individual states. CREP programs have been funded in about half the states.	yes		
<b>Forest Land Enhancement Program (FLEP)</b>	USDA-FS and State agencies	Provides educational, technical, and cost-share assistance to help private forest landowners implement sustainable forestry management objectives. Individual states develop funding priorities, including technical and educational assistance, and practices that are allowable for cost-share assistance. Landowners need a forest management plan to be eligible for cost-share assistance.	50 - 70% on up to 1000 acres	yes	Future funding uncertain
<b>Forest Legacy Program (FLP)</b>	USDA-FS	Supports state efforts to protect environmentally sensitive private forest lands from conversion to non-forest uses through the development and implementation of state forest conservation plans and via acquisition of conservation easements, without removing the property from private ownership.	up to 75%	yes	

<b>Forest Stewardship Program (FSP)</b>	USDA-FS	Provides technical assistance, through state forestry agencies, to non-industrial private forest owners to encourage long-term forest management to provide timber, wildlife habitat, watershed protection, recreational opportunities. Landowners develop comprehensive, multi-resource forest stewardship plans		yes	
<b>Healthy Forests Reserve Program (HFRP)</b>	USDA-FS	Provides financial assistance for private forest landowners to protect, restore, and enhance forest ecosystems to promote the recovery of endangered species, improve biodiversity, and enhance carbon sequestration. Enrollment is limited to owners with lands occupied with rare species.	yes	yes	Funding uncertain
<b>The Environmental Quality Incentives Program (EQIP)</b>	USDA-NRCS	Offers financial and technical assistance for structural and management practices on eligible agricultural land. One to 10 year contracts provide incentive payments and cost-shares to implement conservation practices with an approved plan.	up to 75%	yes	
<b>Wetlands Reserve Program (WEP)</b>	USDA-NRCS	Offers landowners an opportunity to establish long-term conservation and wildlife practices to protect, restore, and enhance wetlands. There are three options: (1) permanent conservation easement, (2) 30 year conservation easement (3) ten-year, cost-share restoration agreement.	100% for permanent easement, 75% for 30 Or 10 year		
<b>Wildlife Habitat Incentives Program (WHIP)</b>	USDA-NRCS	Provides technical and financial assistance to landowners to develop a wildlife habitat plan and improve upland, wetland, riparian, and aquatic habitat areas on their property. Projects with declining wildlife species are given priority.	up to 75%	yes	

<b>Conservation Security Program (CSP)</b>	USDA-NRCS	Provides financial and technical assistance to promote the conservation and improvement of soil, water, air, energy, plant and animal life, and other conservation purposes on tribal and private working lands including forested land that is an incidental part of an agriculture operation. The program provides equitable access to benefits to all producers, regardless of size of operation, crops produced, or geographic location.	yes	yes
<b>Renewable Resources Extension Act (RREA)</b>	USDA-CSREES	Provides funds for extension and educational programs to promote forest and rangeland renewable resources management and sustainability. Educational topics include all aspects of forest and rangeland renewable resources	grants	
<b>Economic Action Programs (EAP)</b>	USDA-FS	Assists rural communities and businesses dependent on natural resources to become sustainable and self-sufficient. The EAP's are not specifically dedicated to landowners, but are meant to improve economies of natural resource-dependent communities as a whole.		
<b>Private Stewardship Program (PSP)</b>	DOI-FWS	Provides direct funding through grants and other assistance on a competitive basis to individuals and groups to implement voluntary conservation activities to benefit federally listed, proposed, or candidate species, or other at-risk species on private lands.	grants	
<b>Landowner Incentives Program (LIP)</b>	DOI-FWS and state wildlife agencies	Offers direct funding and technical assistance to supplement state efforts to support on-the-ground projects that enhance, protect, or restore habitats that benefit "species-at-risk" on privately owned lands through a competitive grant program that establishes partnerships between federal and state governments and private landowners.	75%	
<b>Partners for Fish and Wildlife (PFW)</b>	DOI-FWS	Offers direct funding and technical assistance to support <i>voluntary</i> restoration of wetlands and other fish and wildlife habitats (native grasslands, riparian areas, and in-stream habitats) on private land through public-private partnerships.	grants 1:1 match by landowners including in-kind	yes

<b>North American Wetlands Conservation Act Grants Program (NAWCA)</b>	DOI-FWS	Offers direct financial assistance to organizations and individuals who have developed partnerships to carry out wetlands conservation projects. Targets long-term protection of wetlands and associated uplands habitats, including forests, needed by waterfowl and other migratory birds in North America.	grants, 1:1 match by landowners
<b>The National Coastal Wetlands Conservation Grant Program</b>	DOI-FWS	Provides direct financial assistance for acquisition, restoration, management, or enhancement of coastal wetlands. Funds are available through competitive grants, to states that border the Atlantic or Pacific Ocean, the Gulf of Mexico, and the Great Lakes.	competitive grants