Economic Benefits of Protecting Healthy Watersheds: A Literature Review

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Executive Summary

Protecting our nation's remaining healthy watersheds is of the utmost importance, especially because of the critical services they supply for the country and for their role in providing a foundation for major sectors of economic activity. Provision of ecosystem services such as clean drinking water, clean air, nutrient cycling, pollutant filtration, fisheries and recreation is necessary for our quality of life. These services are provided by the natural environment and are often expensive or impossible to recreate after ecosystem degradation. An ever increasing body of research completed over the last several decades shows that conserved ecosystems generate social and economic benefits (Turner and Daily 2008). Recognizing the economic value of protected healthy watersheds and their contribution to the sustainable provision of ecosystem services will allow society to make decisions that more adequately reflect the value of our natural support system and the costs associated with ecosystem degradation. There are many estimates of the value attributed to the loss of natural assets or ecosystem services that range from $250 billion per year globally in terms of environmental damages due to land conversion (Balmford et al. 2002) to tens of trillions of dollars annually for loss of ecosystem services (TEEB 2008). Although difficult to quantify absolutely, the value of intact resources is significant, has the potential to appreciate rapidly, and provides a myriad of benefits to society if managed appropriately (Aronson et al. 2010b).

This paper explores the various methods that have been used to quantify the value of ecosystem services. Specifically, it examines payment for ecosystem service schemes, willingness to pay studies and cost avoidance scenarios. Cost avoidance scenarios, although generally considered to capture only the lower bounds of actual value, are used to communicate a clear message to society about the potential costs of losing an ecosystem service and replacing that service. Many case studies that examine the costs of replacing ecosystem services highlight the economic benefits of protecting healthy watersheds. For example, source water and other aquatic ecosystem protection can help alleviate the projected rise in drinking water treatment costs. Because urbanization and impervious surfaces increase the volume of water in peak flows, stormwater treatment costs are a burden in many regions; these costs can be avoided through protection of healthy watersheds, smart growth practices, and implementation of low impact development practices. When natural aquatic ecosystems are intact, flood related property damages are greatly reduced. The future costs of climate change adaptation have the potential to be staggering; protection of aquatic ecosystems will mitigate some of the cost. A cost effective and effective way to reduce the impacts of climate change is to increase the flexibility of ecosystems now, through the protection and maintenance of healthy watersheds, so that they may function and retain resiliency under a wider range of climatic conditions.

Beyond avoiding restoration and infrastructure replacement costs, protection measures can generate revenue at various scales. Property near healthy, open space is highly valued. Higher property values translate into higher property taxes paid by home owners; the revenues generated from these premiums can be a boon for cash-strapped communities. Homeowners are willing to invest in environmentally responsible development that has direct economic benefits for developers, local governments and society. Recreation and tourism are billion-dollar industries in the United States. There

are strong connections between a healthy tourist economy and a healthy environment. Some of the case studies in this paper occurred before the economic downturn of the early twenty-first century. Some of the monetary values used for specific home prices or tourism revenue may not directly reflect the current economic climate, but they still provide information about the relationships that exist. These studies show the magnitude of the effect that ecosystem services have on the economy. We are often presented with a false choice between protecting the environment and economic growth. These studies show that economic growth relies on the protection of healthy systems.

Environmental Protection and Economic Value

Scientists and land managers have long been aware of the many benefits of protecting healthy, intact watersheds and improving watershed health and function through restoration activities. Healthy watersheds provide many ecosystem services including, but not limited to: nutrient cycling, carbon storage, erosion and sedimentation control, increased biodiversity (or genetic variability), soil formation, wildlife movement corridors, water storage, water filtration, flood control, food, timber, forage, recreation, and reduced vulnerability to invasive species ,the effects of climate change, and to other natural disasters. These services derived from the natural world directly benefit people and the economy. To illustrate the importance of preserving ecosystem integrity to a broader policy-oriented audience, it is helpful to quantify and explain the benefits provided by healthy, intact watersheds using economic language.

The current traditional market system attributes little value to the role that healthy watersheds play in providing essential ecosystem services. The services provided by these watersheds are often expensive or even impossible to fully recreate through construction of ecosystem service replacement infrastructure. Natural or intact ecosystems provide many goods and services, commonly referred to as "natural capital," that are valued by society. These goods and services are essential to our social and economic well-being and are integral components of the earth's life-support system (Smith 2000). Non-market values of ecological services, such as carbon sequestration in trees and soil and water filtration in wetlands and forests are largely overlooked from an economic standpoint because they do not have a widely accepted market price. The under-valuation of natural capital often leads to the marginalization of lands and services when land use decisions are made. The U.S. Environmental Protection Agency's (EPA) Science Advisory Board (SAB) has identified the valuation of ecosystem services as an important aspect of the agency's role of protecting human health and well-being. The SAB recommends that the EPA evaluate ecological responses to land use change and subsequent ecosystem service provisions that affect human well-being to better capture the full range of value derived from ecosystems. The SAB recommends that the valuation of ecosystem services be used to assist in communicating the importance of environmental protection actions to the public and in deciding how best to protect lands and resources (US EPA 2009a).

Maintaining the integrity of natural ecological systems provides the foundation of a sustainable economy through the support of natural resource products and services from agriculture, fishing, timber, recreation, clean drinking water, etc. Markets do not currently value the range of ecological processes that support economic activity (Pacific Rivers Council 1993). Because these values are not represented in the current market system, they are considered externalities. Externalities are difficult to quantify because effects on the economy are often indirect (Pacific Rivers Council 1993). For example, degradation of a riparian ecosystem may cause negative economic effects far from the site where the degradation occurred (e.g. development within a watershed may yield downstream sedimentation and increased erosion causing the loss of arable land and altering fish habitat or spawning grounds). Many economic benefits to society from the protection of healthy watersheds come in the form of non-marketed externalities that accumulate over time and are expressed across various scales (Balmford et al. 2002). For example, in the construction of a new housing development, measuring the direct costs of materials and labor and the profits made from home sales misrepresents the net economic value to society; most often the total costs of a development do not include the cost of loss of ecosystem services or the cost of providing new supporting utility infrastructure. The total costs to society of new development are hidden and socialized, while the economic gains are privatized (Pacific Rivers Council 1993).

Development activities are often viewed through a lens in which new development is always more profitable than not developing and in which negative environmental effects are ignored or assumed reparable at a later time. However, the costs of remediating/addressing environmental impacts and building new infrastructure to support development can be substantial. Restoration and remediation activities can be very expensive and are not always possible or successful; a highly altered system may not ever be able to return to its “natural” state. The continental United States has spent on average a conservative estimate of over $1 billion each year on river restoration since 1990 (Bernhardt et al. 2005). The EPA estimates that because of urban runoff pollution, hundreds of millions of dollars are lost each year through increased government spending to control runoff, loss of economic outputs or illness (US EPA 1998). Meeting restoration goals for impaired waters can have a significant economic burden on state and local communities (Table1). Conservation of healthy, intact systems protects water quality, is less expensive than restoration and provides many other quality of life benefits. Conservation is not always at odds with economic gains or development; rather it encourages protecting the remaining healthy, functioning places that provide important ecosystem services at little to no cost to society, and directing development to less sensitive areas.

	Impairment	Miles	Cost	Avg Cost/mile
Corsica River, MD	**Nutrients**	**7.6**	**$17,500,000**	**$2,300,000**
Little Laurel Run, PA	**Metals**	**3**	**$1,048,013**	**$349,338**
Conewago Ck, PA	**Nutrients**	**17**	**$4,300,000**	**$252,941**
Bear Ck, PA	**Metals**	**5**	**$964,000**	**$192,800**
Catawissa Ck, PA	**Metals**	**57.9**	**$3,500,000**	**$60,440**
Thumb Run, VA	**Bacteria**	**17**	**$2,450,000**	**$144,117**
Willis River, VA	**Bacteria**	**30**	**$2,794,160**	**$93,138**
Muddy Creek, VA	**Bacteria**	**9**	**$2,612,000**	**$290,222**

Table 1. US EPA Region 3 water impairment clean-up costs (2006)

Using an economic argument to advocate for conservation can be difficult because conserving land does not always provide a direct economic benefit to the land owner. Often a landowner can make a higher profit if he or she sells to a developer, alters the landscape or uses intensive agricultural practices. However, in terms of ecosystem services, the total value that the land provides to society under an altered state is lower. There is a conflict between what is privately and socially valuable in land use decisions (Kroeger 2008a). In a study by the Defenders of Wildlife, the author looks at the economic benefits of conservation practices in 5 states (Florida, Nebraska, New Mexico, Maine and Oregon). The study provides strong evidence that conservation lands increase economic growth at the county level (Table 2) and none of the study areas showed a negative economic impact associated with land conservation activities (Kroeger 2008a). Providing landowners with information about the economic benefits of conservation to society may not be enough to change current land use and land valuation, but it is the first step in heightening awareness and encouraging behavioral change that could eventually affect market values. Given development and population pressures, it is likely that conservation will be at odds with development goals; the challenge is to direct development to areas where it results in the least economic and ecologic harm to society and to integrate conservation principles into development principles and land use or zoning decisions (Kroeger 2008a). Several studies in this paper highlight how revenue generated from conservation can compete with conventional business practices, and in many cases, show significant cost savings. Exploring and communicating the various ways that the economic benefits of conservation are quantified may help adjust land values to reflect their worth when protected.

		Estimated annual value in study area; million 2004$				
	Location:	Florida	Nebraska	New Mexico	Oregon	Maine
	Benefit / *Ecosystem type:*	- wetlands/ lowlands - (825 mi²)	- riparian - (658 mi²)	- forest - (4,900 mi²)	- coastal/ estuary - (29 mi²)	- upland/ wetland - (60 mi²)
Direct uses	TIMBER EXTRACTION	✓	-	3.2	✓	0.07 *
	NON-TIMBER PRODUCTS	?	-	3.7	?	✓
	GRAZING	✓	-	2.2	0.28	?
	COMMERCIAL FISHING	-	-	-	0.9	-
	RECREATION	2.6 *	23-37	70	1.0-2.3 *	0.25 *
	- Camping	✓	✓	✓	?	?
	- Backpacking	✓	?	✓	?	?
	- Picnicking and general relaxation	✓	✓	✓	✓	✓
	- Fishing	1.2	8.1-13.1	✓	1.0-2.3	✓
	- Hunting	0.03	✓	✓	?	✓
	- Hiking	0.13	✓	✓	✓	✓
	- Wildlife watching	1.2	15.0-23.4	✓	✓	✓
	- Cross-country/downhill skiing	-	-	✓	-	✓
	- OHV use	?	-	✓	?	✓
	- Mountain biking	-	-	✓	?	✓
	RESEARCH AND EDUCATION	✓	✓	✓	✓	✓
	PROPERTY VALUE PREMIUMS	6.5	0.5	5.3	0.42	2.0 *
Indirect uses	ECOSYSTEM SERVICES	135-306	0.6-3.6	22-120	0.2-0.6	2.9-4.0
	- Water supply	130-285	?	✓	?	2.7
	- Water quality	✓	✓	✓	✓	✓
	- Species habitat provision	✓	✓	✓	✓	✓
	- Biodiversity maintenance	✓	✓	✓	✓	✓
	- Temperature modulation	✓	✓	✓	?	?
	- Crop pollination	✓	?	?	?	?
	- Carbon sequestration	5.1-21.2	0.6-3.6	22-120	0.2-0.6	0.2-1.3
	- Air quality	✓	?	✓	?	?
Passive uses	PROVISION OF HABITAT FOR THREATENED, ENDANGERED, RARE OR "CHARISMATIC" SPECIES	✓	✓	✓	✓	✓
	TOTAL ANNUAL VALUE OF QUANTIFIED USES *(million 2004$)*	**145 - 315**	**24 - 41**	**106 - 205**	**3 - 5**	**5 - 6**

Table 2. Annual economic benefits from conservation activities in 5 states (Kroeger 2008a)

An asterisk indicates an incomplete estimate, a question mark indicates that the information is not documented, a dash indicates "not applicable" and a check mark indicates that there are benefits but they are not quantified by market prices

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Evaluating Ecosystem Services

Critical ecosystem services are inherently undervalued because they are provided for by the existence of healthy functioning watersheds with little to no capital investment. The diminished market value placed on ecosystem services supports the current practice of making land management decisions that yield short-term economic gains without consideration of the associated eventual long-term economic losses. Frequently in the United States, rural land has been viewed as a development opportunity to gain short-term profits, rather than valued for the long-term benefits it can provide through the maintenance of intact ecosystem functions. Internationally, other countries have viewed land in the same manner; however, many governments have taken an interest in supporting projects to understand the value their countries' natural environment and resources provide and are attempting to evaluate the long-term cost savings and societal benefits associated with land conservation. Globally, economic evaluation of environmental assets and financial payments for preserving ecosystem services are gaining momentum as important tools to combat the loss of healthy watersheds that support these services (Aronson et al. 2010a). Conservation and restoration can be viewed as prudent investments in times of unsustainable allocation of resources; they can also serve as integral components of socioeconomic development (Aronson et al. 2010a).

Assigning a monetary price to a particular ecosystem service can be very complicated and is not typically considered when assessing land value. Due to the complex interactions (both known and unknown) that characterize ecosystem functions, many services are intertwined with other services, so it is difficult to isolate the exact economic effects of one service in the absence of other services. Regional conditions (i.e. climate) or the scale at which an ecosystem service is evaluated can affect the value assigned to a specific service. The perceived or actual difficulty in pricing ecosystem services, non-pricing and under-pricing drives the continued exclusion of environmental degradation from market prices (Goldberg 2007). The absence of market-driven pressure to protect the environment demonstrates the inability of the market to sufficiently value ecosystem services (Ring et al. 2010).

Ideally, ecosystem service valuation is done to incentivize conservation activities. The main goal of ecosystem valuation does not lie in assigning a dollar amount to a particular service, rather it lies in demonstrating the effects of trade-offs in changes to ecosystems and the services they provide. For example, estimating the cost of the infrastructure needed to offset a 10% loss in water filtration capability due to loss of forest cover may provide a more meaningful dollar value than attempting to estimate the total value of the watershed and all its components (Ring et al. 2010). There are many ways in which we attempt to evaluate natural resources or ecosystem services. No existing valuation method is fully able to sufficiently explain all the economic and ecological complexities of a natural system, however valuing individual resources is often less useful for conservation goals and communicating economic benefits than valuing the avoidance of cost burdens borne by localities from ecosystem alteration (Limburg et al. 2002). The total economic and social values of the services provided by an intact watershed are likely very high, but due to natural complexity, they are not as easy to quantify as a loss in services, comparative land use scenarios, or an investment in replacement technologies.

One of the most important and frequently under-valued ecosystem service is the provision of clean drinking water. The general public is mostly uninformed about the role that intact watersheds play in supplying clean drinking water and about the costs associated with the degradation of healthy watersheds (Ernst 2004). Clean drinking water cannot be sustainably supplied by water treatment plants alone as the cost of treatment is too high due to the sheer volume of untreated water, the increased types and concentrations of contaminants found in water, and the cost of building new infrastructure (Barnes et al. 2009). Other services provided for free by intact watersheds, such as storm surge protection, flood and erosion control are costly to replicate and are not always effective. Several studies show that replacing critical ecosystem services would cost the United States many billions of dollars for water purification alone (Salzman et al. 2001).

Leaders from several top global financial institutions, such as Goldman Sachs, have voiced concern about the lack of ecosystem service evaluation in current markets and have created internal departments to deal with the developing future environmental markets (DeSantis and Ranganthan 2011). The momentum building behind the desire to quantify ecosystem services as a way to advocate for their protection will help land managers at various scales make smart economic decisions about their future growth options. To communicate the value of protecting healthy watersheds it is important to demonstrate that ecosystem service values provide economic benefits that are substantial to communities and that irreversible land alteration can be associated with negative economic effects. Several types of valuation studies attempt to demonstrate these economic relationships through diverse methods. None of the methods described in this paper have an ability to fully express the total economic value of an ecosystem, or to capture all of the economic benefits received by communities and individuals from an intact watershed. However, the variety of valuation methods that exist provides opportunities to develop communication tools that influence land use decision makers to support the protection of ecosystem services. Some methods may not be appropriate for all communities, and some may actually have a negative effect in their ability to provide a substantial economic argument. It is necessary to match the appropriate economic valuation tool and communication method with the appropriate audience to support the strongest argument for watershed protection. This section describes some of the most common types of ecosystem evaluation methods that are useful for communicating economic benefits of intact ecosystems.

Types of Valuation

Revealed Preference Approach: Payment for ecosystem services

The revealed preference approach to ecosystem valuation looks at the market price of ecosystem services, goods, land, and resources. With this approach, markets are generally established for tangible goods such as harvested timber, agriculture, fisheries, etc. but are developing for other sectors without tangible products and goods, such as nutrients, carbon, air and water quality (Emerton and Bos 2004). In the presence of a set market price for a resource, such as agricultural land, some ecosystem service values can be transferred from known values of tangible goods supplied from the land.

Payment for ecosystem services (PES) programs are designed to prevent degradation to watersheds and the valued ecosystem services they provide through resource protection. In PES programs, downstream consumers directly (through user fees) or indirectly (through taxes) pay for the hydrologic or other ecosystem services they receive; the payment funds are used to compensate landowners for conservation activities, land acquisition and/or restoration (Greenwalt and McGrath 2009). Frequently, watershed protection efforts and PES programs are implemented in response to degradation or existing water quality issues. PES programs can be used to encourage investment in healthy, functioning systems, prior to degradation to protect vital services for human benefit and to prevent future costs of restoration or water treatment. PES programs are generally not able to provide a comprehensive evaluation of land or ecosystem services; rather they develop a market value for compensation amounts to landowners who implement conservation activities instead of the conventional land use.

One of the most recognized payment-for-services programs in the United States is the United States Department of Agriculture's (USDA) Conservation Reserve Program (CRP). This program provides monetary compensation to agricultural producers who take highly erodible or environmentally sensitive (i.e. riparian habitat, sensitive, threatened or endangered species habitat) pasture or cropland out of use for an agreed upon amount of time, frequently 10-15 years. The enrolled land is managed for conservation through planted cover crops or trees to prevent erosion and runoff during the time that it is out of agricultural use. The farmers who volunteer to participate in this program are monetarily compensated by the USDA for the land taken out of production. This program demonstrates a scenario in which market forces have enabled ecosystem services provided by protected land to have greater or equal value than the economic value from agricultural production. Long-term studies of the CRP program have found that by retiring over 34 million acres of environmentally sensitive and highly erodible cropland since 1986 and diverting tens of millions of other acres out of active use and into conservation (Figure 1), large improvements in water quality have been documented through the reduction of nutrient and sediment run-off (Sullivan et al. 2004). Researchers have estimated that the CRP reduces soil erosion by 750 million tons per year (Feather et al. 1999), resulting in millions of dollars in economic benefits to farmers and to downstream communities (Sullivan et al. 2004). The increased water quality has positive effects on recreation and wildlife habitat, improving wildlife viewing (Table 3) (Sullivan et al. 2004, Feather et al. 1999). In addition to the enhanced ecosystem services provided by CRP protection, farmers gain economic benefits as well. Researchers have documented increases in the value of market sales of farm commodities, cost benefits for public utilities and recreational opportunities and reductions in commodity deficiency payments (fines to landowners who can't repay loans due to low crop yields/profits) (Table 4) (Feather et al. 1999).

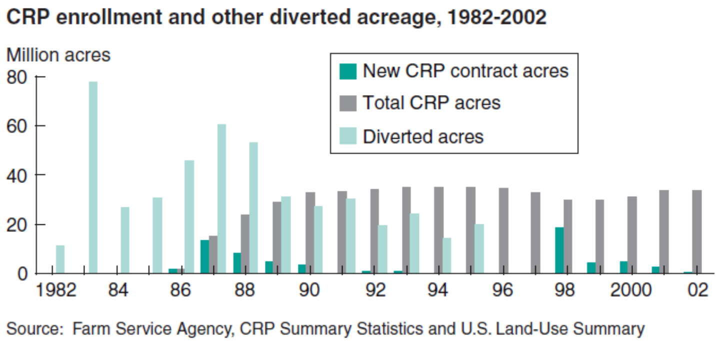

Figure 1. CRP enrollment and other diverted crop acreage (Sullivan et al. 2004)

Farm production region[1]	Distribution of CRP enrollment		Estimated annual nonmarket benefits from:			
			Wildlife viewing	Pheasant hunting	Total wildlife benefits	
	Total	Wildlife			Overall	Per acre
	Percent of total		*$ Million*			*Dollars*
Northeast	0.6	0.5	8	—	8	45
Lake States	7.8	16.3	113	19	132	52
Corn Belt	14.7	15.6	213	35	249	52
Northern Plains	26.2	44.5	33	30	63	7
Appalachia	2.8	1.0	36	—	36	41
Southeast	4.6	1.5	60	—	60	40
Delta	3.6	2.5	47	—	47	40
Southern Plains	15.4	1.2	135	—	135	27
Mountain	19.3	12.0	3	2	6	1
Pacific	5.1	4.9	1	—	1	1
U.S.			650	87	737	22

–Indicates that the impact was not estimated.

Source: Each region's percentage of national acreage using conservation practices related to wildlife habitat (establishing permanent wildlife habitat, shallow water area for wildlife, wildlife food plots, riparian buffers, wetland restoration, and rare and declining habitats) is based on 2001 enrollment (Barbarika, 2001). Benefit estimates are derived from Feather et al. (1999), adjusted for inflation to represent 2000 dollars and rounded to the nearest million dollars.

Table 3. Wildlife-related annual CRP benefits (Sullivan et al. 2004)

Estimated costs and benefits of the Conservation Reserve Program[1]

	Type of Cost Benefit	Benefit/ <cost>	Source
Public		Million Dollars	
	Public works[2]	3,029	Ribaduo
	Air Quality[3]	548	Ribaduo et al., Huszar et al.
	Recreation[4]	8,676	Ribaduo et al., John et al.
	Commodity Credit Corporation cost savings	17,850	Young and Osborn
	Increased Food Costs	<18,950>	Young and Osborn
	Direct Program Costs	<23,700>	Young and Osborn
Private			
	On-farm Income[5]	20,300	Young and Osborn
	Timber production[6]	5,400	Young and Osborn
	Establish Cover Crops	<1,600>	Young and Osborn
	Increased soil productivity	1,600	Ribaduo
	Irrigation ditch maintenance	41	Ribaduo
	Reduced industrial costs[7]	1,021	Ribaduo

[1]Costs and benefits for the entire program over a 10-year period discounted at a 4 percent rate. All estimates are based on the anticipated enrollment of 45 million acres when the analyses were conducted unless otherwise noted.
[2]Includes cost savings associated with reduced maintenance on roadside ditches, navigation channels, water treatment facilities, municipal water uses, flood damage, and water storage.
[3]Includes reduced health risks and cleaning costs associated with blowing dust
[4]Included sportfishing, small-game hunting, non-consumptive viewing, and waterfowl hunting. The latter two categories are based on the prevailing 34 million 34 acre CRP
[5]Estimates vary from $9,200-$20,300 million
[6]Estimates vary from $4,100-%5,400 million
[7] Includes reduced costs associated with industrial uses, steam cooling, and flood damage.
Source USDA, ERS.

Table 4. Estimated costs and benefits of the USDA's conservation reserve program (Feather et al. 1999)

The CRP is a popular program for farmers because of the individual economic benefits they gain, but the economic benefits may be appreciated in the greater community as well. In Oklahoma, CRP payments and payments for conservation easements were found to generate economic activity. Economists found that for each dollar spent on conservation funding by the government, an additional $0.46 was generated state-wide. In 2008 $39.2 million in direct payments were distributed to farmers and ranchers from the government for compensation. The conservation programs had an estimated impact of $57.2 million dollars throughout the state of Oklahoma in 2008 (Schideler 2009). The additional revenue is typically spent in the local economy through purchasing conservation project materials locally and from wages and salaries for contractors and conservation employees; these purchases and wages were identified as economic activity that would not have otherwise happened without CRP payments (Schideler 2009).

PES programs have been established in many places in the U.S. and throughout the world. Many of these programs have been implemented over several years or even decades, giving researchers data to examine implementation over time and determining which approaches may be the most effective. Examining successful PES programs, such as the USDA's CRP, can assist in developing PES programs that focus on the protection of high-quality watersheds and riparian areas and provide the greatest economic benefits.

PES programs in the US, particularly the CRP, have commonly focused on a reactive or restoration-focused approach by taking environmentally sensitive areas out of production and protecting them after degradation occurs. PES programs can be used for protection goals through a focus on preventing impairment through protecting high quality lands and/or important ecological areas. Stewardship activities including conservation easements and land trust acquisitions are examples of how proactive PES programs are implemented. The CRP program has taken steps in this direction; in 2011 the USDA put a record number of acres into conservation programs and in 2012 added 20,000 acres specifically to benefit the health of the Chesapeake Bay watershed (USDA 2012). Currently the CRP is an important tool for protecting intact prairie and grassland habitat. In many agricultural states, land in conservation reserve is vital to curbing habitat loss for sensitive and endangered species like the sage grouse (Wambolt et al. 2002). The Government Accountability Office estimates that an average plan to recover threatened or endangered species costs $15.9 million; the CRP program can play a role in offsetting and preventing those costs (US GAO 2006).

Payments for ecosystem services programs that address watershed protection are well-established in Latin America; a successful PES program in Costa Rica focuses on the protection of upstream forested watersheds and farmland for the benefits received by the more populous and urbanized downstream areas. Costa Rican forest law officially recognizes the role of forests in protecting hydrological services (Pagiola 2008). Some of the areas enrolled in the program are of high quality; some were clear-cut in previous decades and are under reforestation. Over 4,400 farmers and forest owners participate in this program that has helped curb deforestation while maintaining the livelihoods of agricultural and forestry workers by compensating them for conservation. Nearly 300,000 hectares of upstream watersheds were preserved under the program between 1997 and 2005 (Pagiola 2008). To enroll in the program, a landowner must certify with the government that their land meets particular conservation requirements. Upon certification, the landowners receive payments to keep their land out of production. The payments are partially generated by user fees downstream (hydroelectric power, other utility companies, bottling companies, tourist industry, etc.) and substantially by taxes from fossil fuel use. On average participants in the program have higher farm incomes than non-participants (Zbinden and Lee 2004). There is some evidence that the payment for services program may help alleviate poverty in the upstream areas (Pagiola 2008). Similar programs are active in the Northern Andean region of South America where The Nature Conservancy has set up a water fund in which the more populated downstream communities pay into to support the ecosystems services provided by protecting healthy watersheds upstream. These programs help minimize the conflict between maintaining upstream livelihoods and preserving healthy intact systems that can provide clean water to downstream communities.

PES programs are popular in many places around the world because they offer compensation or incentives to landowners to conserve valuable resources that benefit a larger population. These programs tend to be long-term and have been shown to help generate much needed income in rural areas. However, there are issues with establishing and perpetuating sources of compensation. It is difficult to establish a long-term funding source, or to use taxes to pay for landowner compensation over time, especially if the programs wane in political popularity.

In a study of US involvement in PES programs, 32 active programs were surveyed to find the motivation for buying into the programs, or funding the payments to landowners (Figure 2), the source of payment (Figure 3) and the reason landowners chose to participate (Table 5). On average, public buyers participated to avoid future costs associated with future restoration and regulation; the programs were largely funded by utilities and government entities; landowners participated for the cash payments received and because of the sense of land stewardship it gave them from participating. A stewardship ethic was frequently found as a source of pride for a landowner, however it was not a powerful enough motivation without monetary compensation (Majanen et al 2011). This comprehensive study captures the potential that these programs have to address the economic benefits of conserving land and to incentivize ecosystem protection actions.

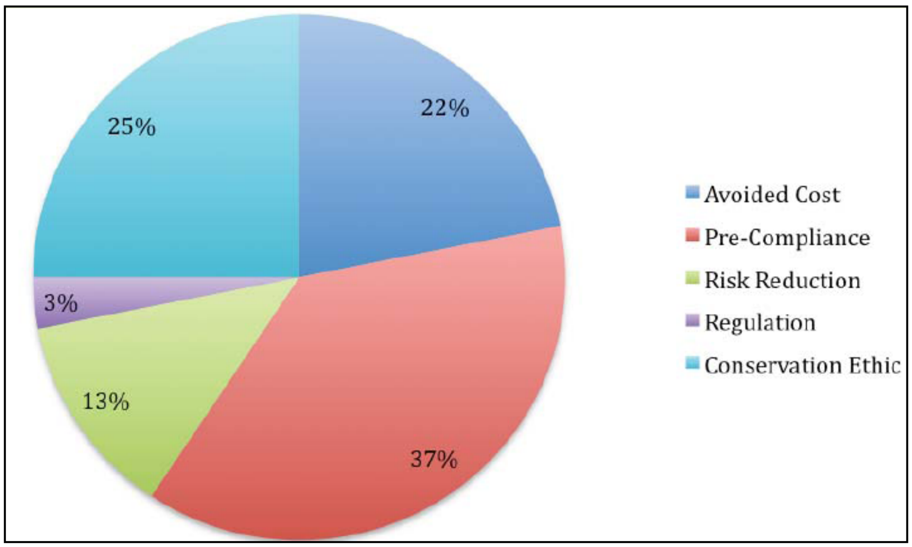

Figure 2. Primary buyer (PES project funder) motivation in 32 surveyed PES schemes (Majanen et al. 2011)

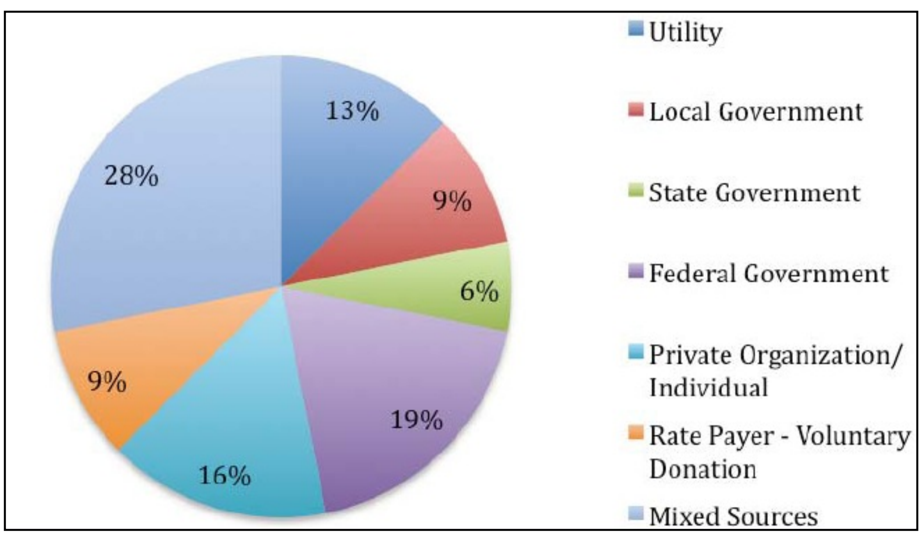

Figure 3. Ultimate sources of funding in 32 surveyed PES schemes (Majanen et al. 2011)

Seller motivation	Primary motivation: # of schemes	Primary motivation: % of schemes	Secondary motivations: # of schemes*	Secondary motivations: % of schemes
Cash payment	13	41%	6	19%
Access to technical assistance	2	6%	10	31%
Other non-cash financial benefits	6	19%	6	19%
Land stewardship / environmental ethic	9	28%	16	50%
Social / community interests	2	6%	0	0%

Table 5. Primary and secondary seller motivation for participating in PES programs (Majanen et al. 2011)

Some PES programs are developed through markets for conservation-credit trading. Similar to enrollment in other voluntary programs, landowners receive payments for implementing conservation practices. These payments are funded by the purchase of environmental credits by polluters, developers, or other entities that may be altering the landscape. Wetland mitigation banking, forest carbon sequestration, land conservation and nutrient trading are all part of an emerging marketplace across global, national, regional and local scales. In market-based transactions, the person or organization responsible for altering the landscape purchases credits by paying another entity to protect or restore land through a variety of methods, and a market emerges that defines the value of the traded ecosystem service. Some trading programs have a cap, or a set threshold of pollution or alteration that cannot be exceeded within the market and credits must be traded below the cap boundary. "Uncapped" trading markets are based on the purchase of offsets by polluters without limits on the amount of activities or pollution that can be offset. Currently, trading markets are mildly active in the United States, with burgeoning nutrient trading programs developing for the Chesapeake Bay and the Ohio River, among other locations. When the marketplace is more established and baseline conditions, credits and measurable environmental improvements can be certified in a cohesive and comprehensive manner, it is likely that credit trading will play an important role in payment-for-services based conservation. All PES valuation methods require long-term monitoring to verify that the economic and ecological benefits are being accounted for and maintained.

Stated Preference Approach: Willingness to Pay

The stated preference approach is unlike other valuation methods that are based off of consumer behavior. This approach asks consumers their preference about cost and valuation. The most well-known examples of this approach are contingent valuation and willingness to pay (Emerton and Bos 2004).

Willingness to pay (WTP) studies attempt to assign monetary value to an ecosystem service based on willingness to pay for something that may be currently available for free or little cost; these studies capture the environmental externalities associated with market transactions for other goods and services. The willingness of a group or individual to pay for a service is determined through survey responses. Survey participants are asked to identify a range of dollar amount values they are willing to pay for ecosystem services, such as scenic beauty, wildlife habitat, recreation access or clean water protection. This method of valuation is based on the economic principle that dollar values will emerge from what entities are willing to pay for a specific service (Salzman 2010). However, monetized values estimated thus far have not been able to fully capture the range of economic benefits of intact ecosystem services to people or communities.

In a WTP study in Steamboat Springs, CO, an area that relies on its tourist economy, researchers found that each resident was willing to pay between $36 and $72 to protect 25 percent of existing ranchland in specific valleys, and $107 to protect 25 percent of the ranchland in the whole county. This came to only about $50 per acre, which would not approach the cost to buy up large parcels of land for protection (Grossman and Watchman 2006). Although the amount that residents were willing to pay for conservation was not enough for actual conservation, the survey still portrayed a desire to support conservation efforts within the community. The findings were shared with the community residents and other stakeholders and were used to influence new land use planning rules that encouraged cluster development to preserve open space based on community interest in protecting these areas (Grossman and Watchman 2006).

Results from a taxpayer survey in the Catawba River Basin in North Carolina found that residents were willing to pay an average of $139 per taxpayer for five years, totaling to $75 million for all taxpayers to protect the current levels of water quality (through nutrient, land use and stormwater management planning) across all the counties in the river basin (Eisen-Hecht and Kramer 2002). Researchers compared the cost of protecting water quality within the basin to the cost of achieving water quality goals through infrastructure and best management practices (BMP) implementation. They found that over a five year period, the protection of aquatic resources saved approximately $95 million dollars over the costs of water quality implementation practices (Eisen-Hecht and Kramer 2002). The WTP survey provided an opportunity for the researchers to communicate their findings with the local community, and inform residents about the cost savings associated with protection.

In a 1993 WTP study, Martha’s Vineyard, Massachusetts residents reported a willingness to pay an average of $131 a year to protect island tidal ponds for ecological benefits (Karou 1993). Willingness to pay studies like these and others can be a useful tool for conservation groups and policy makers. The information collected can be used to help gauge a community’s interest in conservation practices, or the results of a survey could be used as a platform for community outreach and education. The data can also be used to help shape environmental policy, such as development practices and to inform local government of alternative development options with community support. However, there are many weaknesses associated with this form of ecosystem service valuation and how the studies are applied. Willingness-to-pay studies are hypothetical scenarios presented to survey takers, who may not respond in the same manner when faced with an actual decision to raise taxes or pay a user fee. As with many types of ecosystem valuation studies, after a WTP study is completed there is no guarantee that the data will be used as a tool to make decisions. There are several examples where WTP survey information collected has been used to pass referenda, or used in a presentation to influence local government officials, yet often there is no guarantee of conservation action after a study is completed. In many cases there is a disconnection between study findings and application. Additionally, these studies may be most useful in areas where residents have a capacity to pay.

Cost-Based Approach: Cost Avoidance

A cost-based approach to ecosystem service valuation examines market trade-offs, ecosystem service replacement costs, future mitigation costs, or other future avoided costs to society when an ecosystem is maintained for its goods or services (Emerton and Bos 2004). In this approach, the cost of replacing an ecosystem good or service, after it has been altered, degraded or eliminated from the natural system, is used as an indicator of value, which is frequently used to communicate a cost savings through maintenance of ecosystems services. It is important to note that while cost-avoidance studies are able to assign a monetary value to an ecosystem service or good, this approach is generally accepted as representing the lower bounds of actual value.

An effective strategy to prioritize the inclusion of healthy watershed protection in local and regional decision-making is to communicate the cost-savings estimates of conservation activities in comparison to land conversion costs and the costs of constructing new infrastructure to replace lost ecosystem services. If cost-savings estimates are made available, governments are better equipped to make decisions that accurately reflect the economic and ecological consequences of their land use decisions. From an economic perspective, healthy watersheds provide a great deal of marketable goods (clean drinking water) and non-marketable goods (biodiversity, storm protection.) The United Nations Economic Commission for the European Union has noted that a loss of these goods and services is a loss of capital assets (Goldberg 2007.) Informing land use decision makers about the loss of capital assets from land conversion may inspire an interest in conservation options as a way to avoid future costs. Cost avoidance studies have been used for decades; they have been found to be most effective as a communication tool when the estimated cost for replacing an ecosystem service reflects a realistic substitution that provides the same quality and magnitude of service (Pagiola et al. 2004).

The valuation techniques discussed in this paper, although limited to local case studies, can be used to show examples of how calculating avoided costs or potential replacement costs can be used to demonstrate economic benefits from protection. In comparison to other common ecosystem valuation techniques, cost avoidance studies have been demonstrated as the most effective communication tool to relay the economic benefits associated with conservation (Greenwalt and McGrath 2009). However, it is important to remember that while avoiding degradation has an inherent value on its own, evaluating costs avoided by not causing harm does not truly measure the value of the benefits provided by a functioning, healthy ecosystem (Grossman and Watchman 2006). Even though cost avoidance is a meaningful and useful communication tool, similar to other valuation methods, it does not adequately describe the true value of ecosystem services.

A large body of literature supports the economic benefits gained through avoided future costsfrom the implementation of “green infrastructure,” both in terms of conservation of large-scale hub and corridor natural areas (Figure 4) and in terms of smaller-scale use of low-impact development practices for storm water management (CNT 2010). Protecting high quality areas that contain functioning components of an ecosystem allow for natural processes such as water filtration, nutrient cycling, water storage and recharge to occur. All of these services can be very expensive to recreate through “grey” or built infrastructure, compared to costs of watershed protection (Hanson et al. 2011). In order to function properly into the future, drinking water treatment plants are recognized as assets that must be invested in over time to maintain and improve operations. If we approach healthy watershed protection in the same manner and treat these watersheds as natural capital that may need investments through increased protection and/or restoration, many societal needs can be provided at a lower cost over time (Cosman et al. 2012).

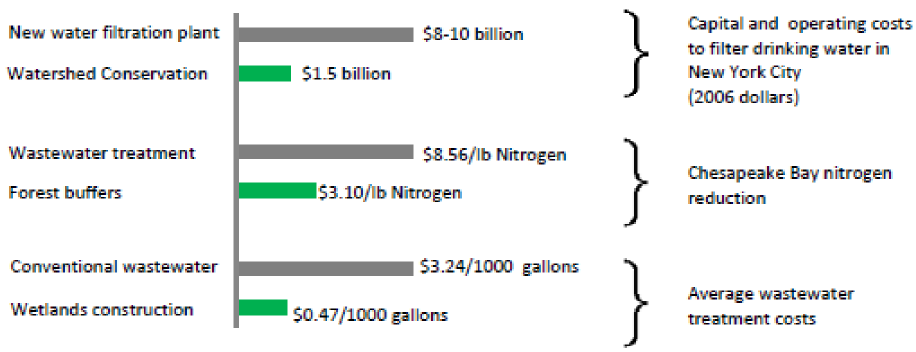

Figure 4. Cost Differences between green and gray infrastructure to provide ecosystem services (Hanson et al. 2011)

Economic Benefits Provided By Intact Ecosystem Services

Clean Drinking Water

Meeting state and federal water quality standards for nutrient and sediment loads can be economically and strategically challenging at any scale of government. From a market perspective, open space is often viewed as unused land that squanders the potential for development revenues (which are lucrative in the short-term) rather than as a means for meeting and maintaining water quality standards, providing clean drinking water, reducing nutrient impairments, and avoiding water treatment costs (Benedict and McMahon 2002.) Many cities and regions around the world are taking a cost-saving and environmentally beneficial approach to providing clean water to their citizens for generations into the future through land conservation, specifically the protection of highly functioning, healthy watersheds. In a study of 27 US water suppliers, researchers found that protection of watersheds used for drinking water sources can reduce capital, operational and maintenance costs for drinking water treatment. In a watershed with 60% forest cover, costs for water treatment were found to be half of the costs for a watershed with 30% forest cover and one-third of the cost of a watershed with 10% cover (Table 6) (Postel and Thompson 2005).

Share of forested watershed	Treatment costs per 3,000 m^3	Average annual treatment costs	Cost increase over 60% forest cover
60%	$29	$297,110	
50%	$36	$369,380	24%
40%	$46	$465,740	57%
30%	$58	$586,190	97%
20%	$74	$746,790	151%
10%	$91	$923,450	211%

Table 6. Percent forest cover and predicted water treatment costs based on 27 US water supply systems treatment of 22 million gallons per day, the average daily production of water suppliers surveyed. (Postel and Thompson 2005)
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Source water protection as a water treatment strategy is popular because it is cost-effective and because of the mounting threats to public health by impaired waters. The Edwards aquifer in Texas provides parts of Austin and San Antonio with their drinking water. In recent years, both cities have voted for bond measures that generate $65 million from each city for the protection of the aquifer, rather than invest in new treatment technologies (AWWA 2004). Two hundred thousand residents in Portland, Maine receive their drinking water from the Crooked River Watershed. Protection of the forested, high quality watershed provides clean drinking water that does not need filtration, saving the residents of the city tens of millions of dollars (Hanson et al. 2011.) Forests that provide clean drinking water to downstream residents also provide infiltration capacity, water storage and flood protection.

Perhaps one of the most notable cost avoidance success stories in the United States is the development of New York City's watershed protection plan to provide clean drinking water to the city. Facing unacceptable levels of water pollution in the city's drinking water supply in 1997, the city opted out of building a new filtration plant and instead boldly invested in their natural capital, saving billions of dollars (Turner and Daily 2008.) New York City invested in the protection and restoration of the Catskill-Delaware watershed, which now provides clean drinking water for 90% of the city's population at a rate of roughly 6.8 *billion* liters (1.8 billion gallons) of water a day. The land acquisition and management costs from 1997 to 2008 were about $2 billion; the cost of the new filtration plant that was needed was estimated at $8 billion, with an additional estimated $300 million for yearly operational costs (Turner and Daily 2008.) New Jersey has also purchased forest land for water filtration purposes at a cost of $55 million, far less than the cost of a filtration plant to service a population of that size (Goldberg 2007.) Cities such as Seattle, WA, Boston, MA, Portland, OR, Portland, ME, Bogota, Colombia, Quito, Ecuador, several cities in Brazil, Berlin, Germany and dozens of others have reported saving millions of dollars annually through watershed protection activities (Postel and Thompson 2005) (Dudley and Stolton 2003).

Aging Water Treatment Infrastructure

Between the years 1982 and 2002, the U.S. spent over $1 trillion (in 2001 dollars) on drinking water treatment and supply and wastewater treatment and disposal (US EPA 2002.) Although this amount is high, it may not be adequate for future needs; water infrastructure is aging, with many pipes surpassing their useful lifespan decades ago. The population is growing and population centers have shifted geographically; current treatment practices are not always enough to adequately treat drinking water, and investment in infrastructure has sharply declined from the 1970s to today (US EPA 2002.)

The EPA periodically conducts clean water needs surveys (CWNS). This survey estimates the investment capital needed over the next twenty years for wastewater treatment; the 2008 report identified the official clean water needs as $298.1 billion, with very large increases from the 2004 needs identified for stormwater treatment (US EPA 2008). The EPA considers these estimates as under-valued due to self-reporting from treatment plants based on current compliance standards (US EPA 2002.) The EPA also periodically conducts a clean drinking water needs survey; in 2007 the survey found that the total nationwide infrastructure need is $334.8 billion for the 20-year period from January 2007 through December 2026; this covers source water, treatment, distribution and storage needs (Table 7) (US EPA 2009b). The EPA estimates that the gap between actual capital investments and capital investments needed is between $73 billion and $177 billion under a no revenue growth scenario; they estimate the gap to be much lower ($10 billion gap) under a revenue growth scenario (US EPA 2002.) In a more recent estimate from 2009, the American Society of Civil Engineers recommends $255 billion in infrastructure investments over five years for drinking water and wastewater treatment. They estimate the gap in spending and needs to be around $11 billion (ASCE Report Card).

System Size and Type	Need (in billions of 2007 US Dollars)
Large Community Water Systems (serving over 100,000 persons)*	$116.30
Medium Community Water Systems (serving 3,301-100,000 persons)*	$145.10
Small Community Water Systems (serving fewer than 3,000 persons)	$59.40
Non-for-Profit Noncommunity Water Systems+	$4.10
Total State Need	$324.90
American Indian and Alaska Native Village Water Systems+	$2.90
Costs Associated with Proposed and Recently Promulgated Regulations	$7.00
Total National Need	$334.80

Table 7. Total national 20-year need for clean drinking water infrastructure needs in billions of 2007 dollars. Note numbers may not be total due to rounding. *"Large" and "Medium" systems are defined differently for this assessment than for previous assessments. + Based on 1999 assessments, converted to 2007 values (US EPA 2009b)

These staggering costs have the potential to cause an economic burden on local governments and communities, especially in challenging economic times. Protecting intact watersheds and valuing them for their contribution to ecosystem service provision will be an important component to investing in future infrastructure costs. Investing in the protection of high quality watersheds has a lower economic burden than investing only in the construction of grey infrastructure and the benefits of protection can be sustainably provided into the future.

Controlling Erosion, Runoff and Flooding

Stormwater runoff and combined sewage overflows are costly and problematic issues that affect both urban and rural areas. Excess surface water runoff from precipitation events can be very expensive to treat and store and can be subject to regulatory oversight. A watershed's ability to regulate water flow is lessened with increased alterations to the natural hydrologic regime, such as an increase of impervious surface within the watershed. During flood events, altered systems can experience more extreme responses than unaltered systems. According to the USGS, urbanization increases the volume of water in peak flows by up to 200 percent in 100-year flood events, 300 percent in 10-year flood events, and by 600 percent in 2-year flood events (Konrad 2003). High-volume flood events occurring with a greater than expected frequency affect local economies. The USDA estimates that the floodwater-related cost of erosion on downstream users as between 46.10 to $6.40 per ton of sediment, while other organizations value the cost up to $11/ton (NADC 2010.) These costs can become substantial at the watershed level, especially combined with the costs of water quality degradation, loss of property, crops and housing values that are associated with increased sedimentation. In 2007, the NRCS estimated that 960 milllion tons of sediment were eroded by water, costing billions of dollars a year in restoration and loss of ecosystem services (NADC 2010.) Some of these costs could be avoided through watershed protection.

Floods cause at least an average of $4 billion of damage per year in the United States, (Salzman et al. 2001). Protecting undeveloped riparian land and intact healthy watersheds can be effective flood protection that is significantly less expensive than traditional means of flood control (Salzman et al. 2001). Riparian and upland vegetation allows water to slowly infiltrate into the soil by slowing down surface flow velocities. Traditional engineering approaches to minimize flood impacts can be costly to install and maintain over time and can be highly disruptive to the landscape. Intact riparian areas and forests store and slowly release large volumes of water and minimize the costly impacts from flood damage erosion, sedimentation and nutrient pollution. A healthy watershed will reduce the area and impact of a flood, minimize the economic burden on public drainage infrastructure, reduce erosion, sedimentation, and pollution treatment needed after a flood, and can increase groundwater recharge (Johnston et al. 2006). Intact wetlands store and capture excess storm water to minimize flooding. The existing wetlands surrounding Boston have been attribute with avoiding $42,111 (adjusted to 2012 dollars) per acre per year based on the role they play in preventing flood damage alone (Myers 1996). In an Illinois study, researchers found that a 1% increase in wetlands along a stream corridor was associated with a 3.7% decrease in flood volumes (Salzman et al. 2001). With the increased frequency of extreme weather conditions expected due to climate change, many communities are faced with paying for substantial damage and costly repairs. These costs are most often borne by the government and taxpayers; protecting intact ecological systems increases the resiliency of a system and reduces impacts from flooding and storm impacts.

Revenue Generating Benefits of Protecting Healthy Watersheds

Property Values and Value-Added Amenities

Studies throughout the United States have shown that people are willing to pay a premium on property near open space. Even in difficult economic times, home buyers value property with access to nature. A 2010 study in Southeastern Pennsylvania estimates that open space enhances home values in that region by $16.3 billion and generates $240 million annually in property tax revenues (PDCNR 2010). Green space, in terms of parks, natural areas and protected land has a positive effect on property values. Higher property values translate into higher property taxes paid by homeowners and greater revenues for a community. A study in Greenville, SC found that home owners close to green space pay an average of 13% higher property taxes compared to similar home types in other locations. In Philadelphia, PA a 30% premium was observed on houses fronting green space and a 10% increase on homes within a quarter of a mile from green space. In Boulder, CO, city officials estimate that nearly $50 million extra dollars annually are received by the city from increased home values and subsequent property tax revenue due to new open space acquisitions (Donjek 2009). Figure 5 shows that property values are almost always valued at a premium when they are associated with some percentage of open space. The values do begin to decline when approaching over 70% open space. This may be due to the fact that an area is very rural or uninhabited, or that it may not be possible or desirable to build there. The graph is skewed toward the left, showing the highest property values in relation to open space when it is in lower demand, but not gone. When looking at this graph it is important to remember that the open space adjacent to development is not just contributing to property values, but also to several other valued ecosystem services. Increased home values can be found on residences near greenways or corridors of natural green infrastructure (Kroeger 2008b). Homes in Oregon, Maryland, Ohio and Virginia have been found to have higher property values and to sell faster on the market when near green space (Nelson 1986; CBP 1998; Kimmel 1985; American Hiking Society 1990). A study in Michigan found increased revenues from property taxes between 2-6% for homes near walking/biking trails and greenways (LPI 2008). Because of the declining availability of state and federal funds, many states have grown more dependent on property taxes as a source of revenue (Donjek 2009). Preserving healthy watersheds by protecting open space and incorporating greenways, trails and parks into development plans has the potential to increase local tax revenue.

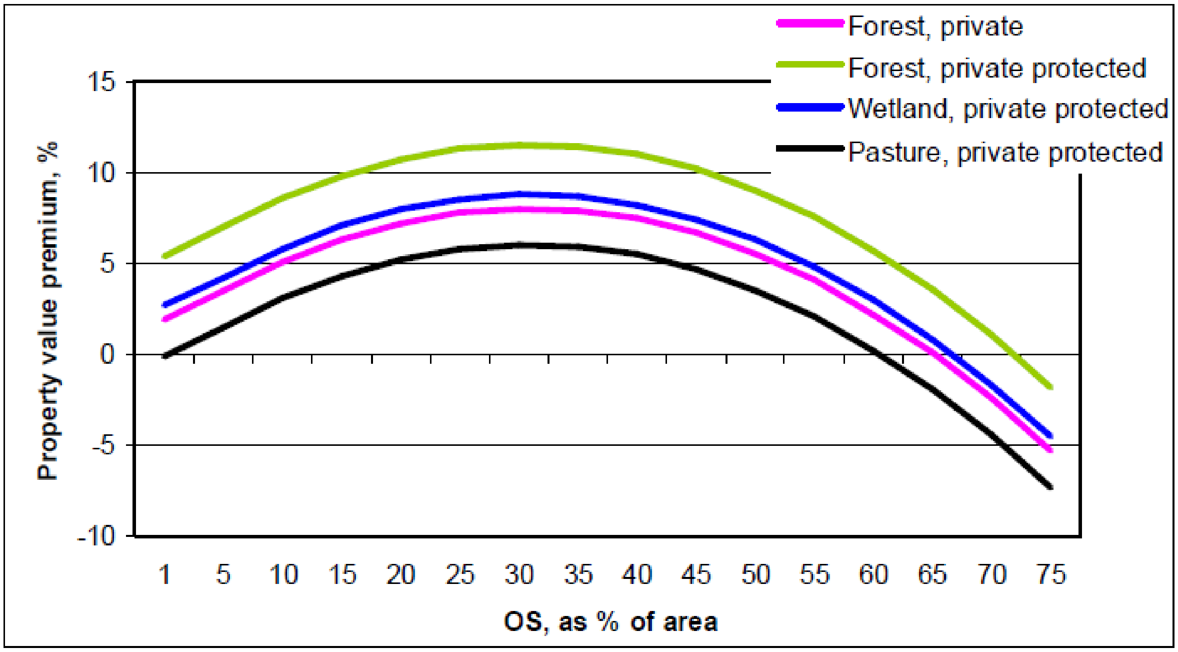

Figure 5. Property value premiums related to percent open space (OS) (Kroeger 2008b)
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People value living near healthy waters because of the recreational and aesthetic values. The EPA's National Lake Assessment reported on studies in both Maine and Minnesota that show that homes near lakes with higher water quality were associated with higher property values (EPA 2010.) In Minnesota, losing a one-meter depth of clarity in a lake is associated with a change of property values by tens of thousands of dollars (EPA 2010.) The aggregate effect of an increase in property values attributed to good water quality on a single lake equates to millions of dollars per lake (Michael et al. 1996). Several more recent studies show that water quality or natural habitat affects housing prices in other regions of the country too; a rise and fall in property values is closely associated with good and poor water quality or natural habitat along waterfront properties (Dodds et al. 2009; Poor et al. 2007; Ara et al. 2006; Landry and Hindsley 2011). Maintaining the presence of healthy waters can raise the tax base and increase the desirability of an area, generating more local revenue. In urban areas, communities value proximity to trees and other natural amenities available in urban areas. A study in Portland, OR of over 3,000 urban homes found that a tree directly fronting a person's home added an average value of $7,593 to that home's price; the study also found that canopy cover from a tree also increases the price of adjacent homes without tree cover compared to homes with no tree cover (Donovan and Butry 2008). Two studies in Athens, Georgia have documented increased property values from the presence of trees in urban areas in (Anderson and Cordell 1988) and saw increased retail spending in areas with higher tree density (Wolf 2004).

Trees in urban areas, especially urban forests, can contribute to the reduction of runoff and storm water, lessening the economic burden of the local treatment facilities. Urban forests have been linked to improved air quality, increased recreation access, reduced stress, desirable communities and energy efficiency (Dwyer et al 1992.) The nonprofit organization American Forests estimates that trees in the nation's metropolitan areas contribute to $400 billion worth of storm water retention alone, by eliminating the need for expensive storm water retention facilities (Benedict and McMahon 2002). Urban trees have also been shown to reduce summertime energy costs by reducing the need for air conditioning by providing shade. By shading the western and southern sides of a home with tree cover, the carbon emissions from electricity use can be decreased by 31% over 100 years (Donovan and Butry 2009). Forests outside of urban areas significantly contribute to human health in urban and suburban areas. Intact forested land filters out air pollution and contributes to human health and well being by reducing human exposure to harmful pollutants (Hein 2011).

Conservation Development

Protecting healthy watersheds requires that riparian systems within a watershed remain connected across the landscape; if new development is to occur within a watershed, conservation development practices can alleviate some of the negative environmental effects. Conservation development provides long-term economic benefits to communities because it is cost-effective, ensures provision of ecosystem services and prevents land fragmentation. Conservation development has emerged as a strategy that maintains natural, green infrastructure by clustering development in less sensitive areas, preserves open space and protects the most vital areas for ecosystem services to take place. Economic benefits from conservation development can be seen by developers, homebuyers, governments and society (Pejchar et al. 2006).

Traditional development requires intensive additions of utility and road infrastructure, which can be expensive. During the recent recession and the housing market decline, some of the largest economic impacts were observed in the housing prices in sprawling, outlying suburban neighborhoods (Dannenberg et al. 2011). Sprawl development may not be a profitable model for future development. A New Jersey study found that maintenance costs for roads and other public facilities could be reduced by $400 million per year if development were to occur in a more compact manner (Benedict and McMahon 2002). The National Association of Home Builders found that the average cluster home development costs 34% less to develop than a conventional subdivision (Pejchar et al. 2006). Less supporting infrastructure (roads, utilities) is required to build cluster developments, minimizing costs for developers and local governments. Additionally, citizens in many areas have shown they are willing to pay a premium to live in a conservation development, which could raise the potential for greater revenues (Pejchar et al. 2006). Costs for fire and police services are minimized in conservation development because of the higher accessibility of homes by emergency services. Often, the cost of providing community services to new residential development exceeds the revenues generated from the development. In a review of almost 100 communities across 21 states, researchers found that for every $1 million received from residential development revenues, an average of $1.16 million was expended for services for that new development (Figure 6) (Crompton 2007). The conversion of open space into new residential communities can increase the financial burdens on communities, rather than alleviate them (Crompton 2007).

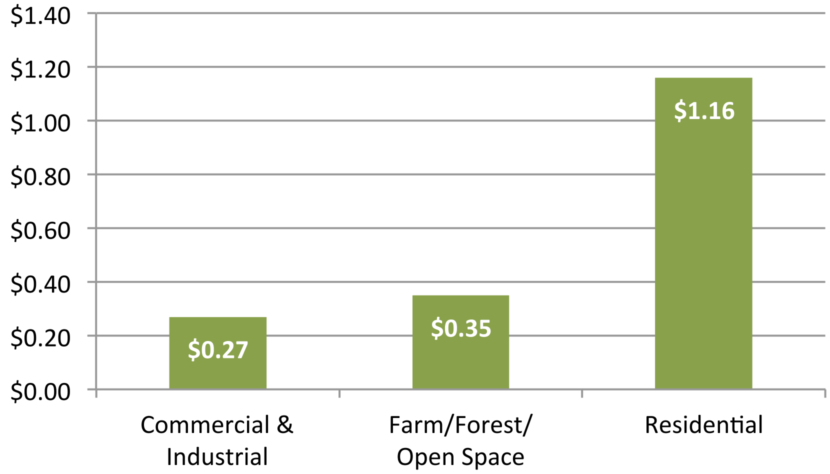

Figure 6. The median cost to provide public services to different land uses per dollar of revenue raised (n=98 communities) (Crompton 2007)
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A review of 40 years of fiscal impact studies showed that “smart growth” or conservation development, consumes 45% less land, costs 25% less for roads, 15% less for utilities, 5% less for housing, and costs 2% less for other fiscal impacts than traditional sprawl development (Burchell and Listokin 1995). Current development practices are not always economically beneficial over time to local governments, nor to the residents of a community, yet these practices continue because they yield high short-term profits. The hidden costs of constructing new infrastructure do not materialize until the future. In a 1998 report on homes in Prince William County, Virginia, it was estimated that each new sprawl-developed home cost the local government $1600 more than is returned in taxes and revenues (CBF 2000). Calculations have shown in counties of Maryland and Virginia that for every dollar generated from new sprawl development between $1.11 and $1.22 have to be spent on services and infrastructure for these new homes, signifying that protecting agricultural and forest land can be more profitable for the local communities than development (CBF 2007).

Many parts of Virginia have experienced rapid growth and development in the last few decades. Few of Virginia’s new housing developments implemented the concepts of conservation development. If conservation development practices were used, over $300,000 could have been saved per 45-acre medium density residential site from reduced costs for infrastructure, storm water retention, grading, clearing, and erosion control (VDCR 2001). In a Virginia study modeling four different residential developments using conservation development practices, all four developments were projected to save at least $200,000 in infrastructure costs while building the same number of units (Table 8) (VDCR 2001). In addition, other direct and indirect cost savings were observed under the conservation development scenarios through reduced pollution entering water ways and reduced heating and cooling costs attributed to a higher density of trees and less pavement. The higher density of trees and other vegetation may also provide greater relief from stormwater runoff volumes.

Case Study	Percent of Natural Areas Conserved	Percent Reduction in Impervious Cover	Percent Reduction in Stormwater Impacts			Percent Reduction in Total Infrastructure Costs
			Runoff	N Load	P Load	
Fields at Cold Harbor Hanover County	80.4	25.3	12.2	6.4	6.4	47.2
Governor's Land, James City County	49.3	21.7	14.3	17.5	17.3	14.5
Rivergate, Alexandria	0*	32	30	25	28	49
The Arboretum III, Chesterfield County	5.1	12	19.7	36	37.1	N/C
* - Open space area is maintained as landscaped parkland. N/C - Not Calculated.						

Table 8. Benefits of better site design (conservation development) in 4 Virginia case studies (VCDR 2001)

Like in Virginia, many cities, suburbs and rural areas in the southeastern United States have experienced rapid growth in the last thirty years without many geographical boundaries to curb sprawl development. In a 1997 study of Atlanta, GA it was found that a 20% loss in trees and other vegetation in the metropolitan region provided a 4.4 billion cubic foot increase in stormwater runoff. It was estimated that at least $2 billion would be required to build containment facilities capable of storing the excess water (American Forests, as cited in US Water News 1997). Over a decade later, Atlanta, as many other cities in the southeast and in the US, is struggling to find ways to manage excess storm water. Conservation development incorporates low-impact development (LID) practices that manage storm water in the environment and protects the natural landscape. LID practices benefit local communities, but also benefit communities downstream through decreased flood frequency and area, reduced water treatment and storage infrastructure, improved water quality because of less sedimentation and erosion, improved biological integrity and increased groundwater recharge (Johnston et al 2006). All of these benefits have strong economic implications; LID practices can reduce property damage, energy use and the need for costly infrastructure and treatment (CNT 2010).

Conservation development or “smart growth” strategies help communities protect their natural resources and strengthen communities. Smart growth developments enjoy market stability over time, indicating their acceptance by consumers (US EPA 2011). Buyers are also willing to pay a premium for conservation developments that protect critical open space and agricultural areas (US EPA 2011). Even after the economic downturn, communities invest in their futures by protecting their valued natural resource assets and preventing uncontrolled growth because protecting open space is a quality of life issue for many communities. Story County, Iowa is one of the most rapidly growing counties in Iowa. This county is embracing smart growth strategies specifically to invest in its cost-saving principles and to maintain a high quality of life for residents (APA 2012).

Some of the most significant economic benefits to property values come in the form of reducing the potential for property damage from flooding (Johnson et al. 2006). Many cities across the country have experimented with the use of conservation development, watershed protection and green infrastructure protection as economically and environmentally sustainable flood protection. In a conservation development in Illinois, researchers found that the reduction of property damage from floods has increased property values by as much as 2.5%. On average, conservation developments save between $6,700-9,700 per acre in reductions from damages resulting from a 100-year flood event (Johnston et al. 2006). There are also significant costs avoided with respect to stormwater infrastructure repair and development. In Missouri, the city of Arnold has purchased floodplain properties and replaced them with riparian, greenway corridors. The city has dramatically reduced its demand for disaster relief and funding for flood damage repairs (Benedict and McMahon 2002). Wetlands in Massachusetts have been estimated to prevent over $40 million dollars in flood damage state-wide annually (Benedict and McMahon 2002).

In Napa, California, residents took a novel approach to flood control. After enduring dozens of major floods that caused hundreds of millions of dollars in damage, residents pushed for a new way to manage flood hazards. They invested in their watershed by restoring riparian corridors and protecting functionally intact waterways. They also removed levees and other existing structures out of the floodplain. This undertaking was an expensive endeavor requiring significant investment from the residents of the city. The adoption of a "living river approach" began in the 1990s and over time has revitalized the city's economy, improved tourism, recreation, property values and drawn millions in private investments (Turner and Daily 2008). Although many cities may not have the capacity for an undertaking such as Napa's, their achievements point to the many possible economic benefits gained through the protection and restoration of natural areas.

Recreation and Tourism

Recreation and tourism are billion-dollar industries in the United States. There are strong connections between a healthy tourist economy and a healthy environment. Fishing is one of the most profitable recreation and tourism sectors in the nation. According to the American Sportfishing Association (ASA), more people in the United States fish (30 million) than play golf (24.2 million) or tennis (10.2 million). The 30 million anglers in the United States generate approximately one million jobs and over $45 billion in retail sales annually (Table 9)(Southwick Associates 2008). Every year millions of anglers travel to their preferred fishing destinations and spend money in local economies (Tables 10 and 11) (Southwick and Associates 2008). High quality waters that have intact and protected headwaters, estuaries and other key habitats for egg laying, rearing and mating are essential for the recreational fishing industry to function.

	All Fishing	Freshwater	Saltwater	Great Lakes
Anglers	29,952,000	25,035,000	8,528,000	1,506,000
Expenditures/ Retail Sales	$45,335,939,822	$31,182,648,546	$11,051,345,543	$2,524,266,182
Total Multiplier Effect (Eco. Output)	$124,959,419,804	$87,954,360,057	$30,327,313,593	$7,089,230,140
Salaries, Wages and Business Earnings	$38,359,742,317	$26,468,323,702	$9,407,680,614	$2,189,490,038
Jobs	1,035,639	709,508	263,898	58,291
Federal, State and Local Taxes	$16,359,116,653	$11,495,751,764	$4,017,148,753	$910,327,447

Table 9. Various types of economic benefits from fishing (Southwick Associates 2008)

	Total Expenditures	Number of Anglers
Florida	$4,412,241,741	2,767,000
Texas	$3,366,961,760	2,527,000
Minnesota	$2,832,442,963	1,427,000
California	$2,677,352,981	1,730,000
Michigan	$2,099,582,373	1,394,000
Pennsylvania	$1,794,966,426	994,000
Wisconsin	$1,754,539,873	1,394,000
South Carolina	$1,492,735,367	810,000
North Carolina	$1,204,118,689	1,263,000
Missouri	$1,179,604,443	1,076,000

Table 10. Top 10 states ranked by angler expenditures (Southwick Associates 2008)

	Total Non-Resident Expenditures	Number of Non-Resident Anglers
Florida	$1,002,619,157	885,000
Wisconsin	$599,378,653	381,000
Arizona*	$586,514,636	92,000
Minnesota	$409,704,010	319,000
South Carolina	$370,652,772	283,000
United States	$8,953,864,300	6,494,000

*The AZ expenditures are likely affected by outlier data. Use with caution.

Table 11. Top 5 non-resident fishing destination states ranked by retail sales (Southwick Associates 2008)

To have a healthy fishing industry (recreational or commercial), a healthy fish habitat is necessary. Coastal areas of the eastern U.S. and the Gulf of Mexico that support healthy oyster reef populations have enhanced fish and large crustacean populations (Peterson et. al 2007). Protecting and restoring oyster reefs protects both the recreational and tourism-based fishing industries by protecting important fish habitat. In addition to the economic benefits to the fishing industry, these reef ecosystems help maintain and improve water quality through filtration and provide coastal stability and protection through the dissipation of wave energy (Peterson et al 2007). Destruction of habitat such as oyster reefs or a decline in water quality due to sedimentation or pollution can negatively affect tourism and commercial fishing. The EPA estimates that stormwater runoff costs the commercial fish and shellfish industries approximately $17 million to $31 million per year in lost revenues (US EPA, 1999).

Rural areas near forest land or other types of open space often depend on tourist spending from those drawn to the area for hunting opportunities. The hunting industry relies on healthy ecosystems that support habitat for abundant wildlife. In West Virginia the hunting industry created 6,246 jobs, which accounts for $243 million a year in retail sales and has a total impact statewide of almost $400 million (Benedict and McMahon 2002). West Virginia also receives hundreds of millions of dollars a year from fishing, wildlife viewing and other outdoor recreation. A recent study from Utah estimated that the annual economic benefits from hunting in the Great Salt Lake area wetlands as $97.1 million. Hunting also supports 1,600 full-time jobs and is attributed to $157 million in cumulative hunting-related expenditures. The study also found that hunters value hunting in natural wetland vegetation because it provides better hunting opportunities and higher yields. (Duffield et al. 2011). Much of the economic gain from outdoor recreation and tourism in West Virginia, Utah and other places comes from out-of-state tourists attracted to the large parcels of undeveloped land; these tourists value healthy unfragmented ecosystems and their spending helps generate jobs, tax revenue and conservation support through hunting and fishing license fees (Benedict and McMahon 2002). In a 2003 study, the Outdoor Industry Association found that the outdoor recreation economy contributed $730 billion annually to the economy, supported 6.5 million jobs and generated $88 billion in federal and state tax revenues (Figure 7). The tax influx supports local government programs and communities. Clearly, the outdoor recreation industry contributes significantly to the nation's economy and depends on the maintenance of the country's natural resource assets.

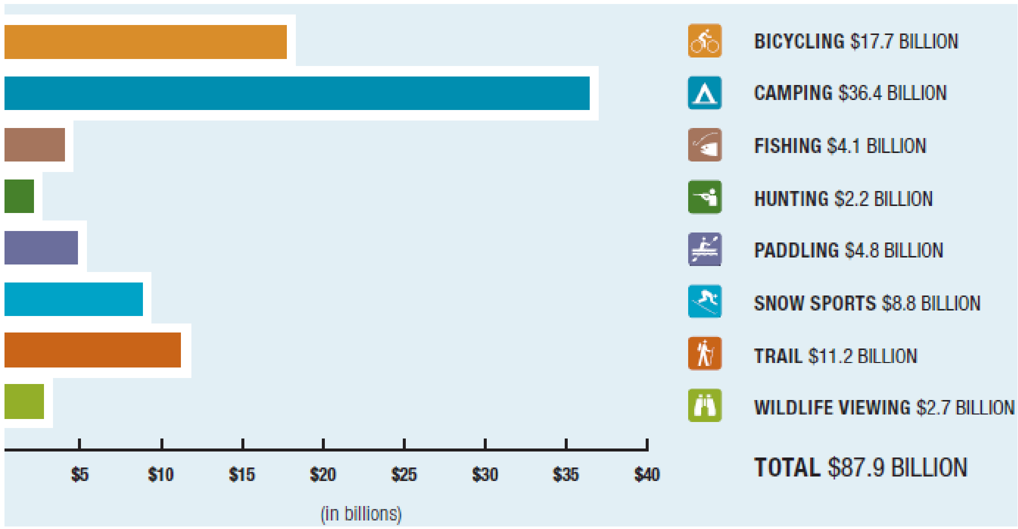

Figure 7. Combined federal and state taxes generated by activity category (Outdoor Recreation Foundation 2003).
Reprinted with permission from the Outdoor Industry Foundation

Climate Change Adaptation

Intact, healthy watersheds with protected riparian corridors and floodplains are expected to be more resilient to the effects of climate change. Communities that do not take steps to address the possible effects of climate change on their resource availability are likely to be at a competitive disadvantage in the future (Donjek 2009). A study projecting the effects of climate change in Boston by looking at population and economic growth estimates under different climate scenarios, found that the current water supply system's reliability would decrease by 20% by 2100 under no climate change adaptation strategy. The study found that connecting the regional water supply system by protecting the green infrastructure network, water supply reliability would show almost no decrease (Agrawala and Fankhauser 2008). The protection and restoration of wetlands, infiltration areas and increased wastewater treatment were identified as appropriate adaptation strategies (Agrawala and Fankhauser 2008). This example may be representative of the issues facing many northeastern cities that are projected to increase population size and subsequent pressures on water needs.

In some regions water supply is expected to decrease, while in others it is expected to increase through greater amounts of precipitation. Areas that are expected to have less available water will need to minimize runoff and encourage infiltration and water storage. Areas facing the challenge of dealing with larger quantities of water will have to be capable of holding and treating greater amounts of storm water. Cities that have preserved their green infrastructure and protected healthy watersheds will be better equipped to adapt to variability in precipitation events and will likely not face the same economic burdens as those without such land conservation in place.

Most frequently, the costs of climate change adaptation are discussed in two manners: implementing mitigation now (through the cost of reducing CO_2 concentration in the atmosphere), and the costs of future adaptation. Although both methods are important, mitigation can be politically contentious, and future adaptation costs are impossible to estimate. Because there is a large degree of uncertainty in the effects of climate change, the most efficient way to account for the impacts is to increase the flexibility of ecosystems now so that they may function and retain resiliency under a wider range of climatic conditions (Fankhauser et al. 1999). Expenses associated with recovery from extreme weather impacts increased by a factor of six between the 1997 and 2007 (Smith et al. 2008). Emerging weather trends exhibit increased frequency of large storm events; this trend is projected to continue. Protecting intact, functioning riparian corridors and floodplains can reduce storm damage costs now and under future climate scenarios. Protection as an adaptation measure will minimize the future costs of building new infrastructure to address climate change impacts.

Health Benefits and Quality of Life Benefits

The EPA acknowledges the links between water quality, air quality and toxic exposures to human health (EPA 2003). People frequently come into contact with air pollutants, toxic algal blooms and bacteria in water supplies that pose potential health risks. In 2008, the healthcare costs attributed to environmental disease in children in the United States was $76.6 billion (Trasande and Liu 2011). Common childhood diseases associated with environmental degradation and exposure to toxic chemicals are cancers, endocrine disruption, asthma, learning disabilities, and attention deficit disorder. Not all of these diseases can be prevented by the presence of clean and healthy watersheds alone; however, living in a healthy watershed can greatly reduce a child's risk of exposure to pollutants. The economic benefits to the healthcare system from minimized environmental degradation have the potential to greatly outweigh the costs of pollution prevention, especially when the costs are examined over time (Trasande and Liu 2011).

When people think of human health and the environment, they often think of the negative health effects from an impacted environment, rather than the positive impacts that a healthy environment can have on human well being. There are social and health benefits related to the proximity of people to nature, parks, walking trails and biking trails. Health benefits occur from both increased physical activity and stress relief (Donjek 2009). These health benefits have the potential to provide significant cost savings in health expenditures (Tzoulas et al. 2007). People are more likely to exercise if they have easy access to recreation areas like parks, trails, greenways and forests. People who exercise regularly are generally healthier, have fewer insurance claims and spend less time in hospitals, thus their societal health care costs are lower (cited in US NPS 1995). In addition to the physical health benefits, many studies have found mental health benefits for those who have access to nature. Students have exhibited lower stress levels and reduced levels of attention deficit disorder when they are exposed to green spaces (Wells 2000).

Chesapeake Bay Watershed: An in-depth look at the economic impacts of development choices and the benefits associated with protecting at the landscape scale

The Chesapeake Bay Watershed encompasses 64,000 square miles, spanning New York, Pennsylvania, Virginia, Maryland and Washington, D.C. (Figure 8). The Chesapeake Bay watershed is home to the largest estuary in the United States. The degraded environmental quality of the Chesapeake Bay has drawn federal attention, especially due to the EPA's implementation of a TMDL for the bay. Meeting water quality goals is estimated to cost $19 billion (Chesapeake Bay Commission 2004). The Chesapeake Bay watershed did not meet its 2010 nutrient and sediment load reduction goals set in the 2000 Chesapeake Agreement, due in most part to the negative environmental impacts from new development within the watershed (Figure 9) (EPA 2007). Although they make significant contributions to the bay's poor quality, point source pollution and agricultural run-off pollution have declined over time due to regulations and best management practices. However, non-point source pollution from urban and suburban development has increased over the past decade and does not fall under the same scrutiny as agriculture and forestry practices (CPB 2004). Many significant pollution impacts are carried to the bay by streams from sources that are far from the bay. Residential development occurring in the upper portions of the Chesapeake Bay Watershed contributes to its pollution problem. The bay clean-up efforts economically affect areas that may not have an obvious connection to the bay, making behavioral change difficult.

Figure 8. Chesapeake Bay watershed, USGS http://pubs.usgs.gov/fs/fs15099/

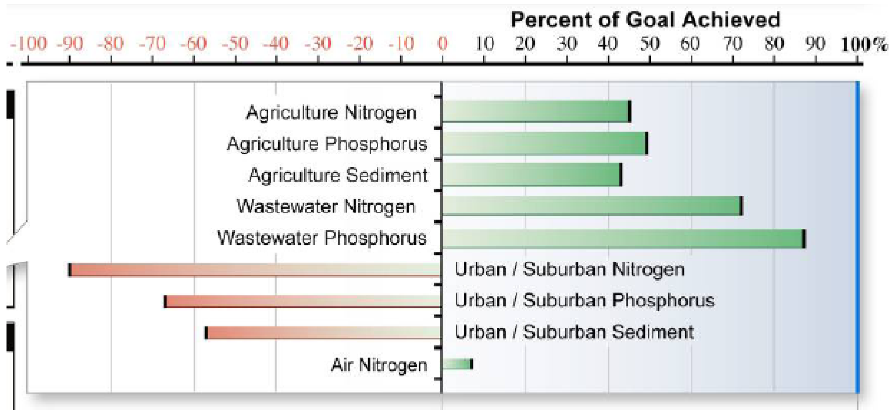

Figure 9. Chesapeake Bay restoration efforts: Percent of 2010 goals achieved in priority areas (EPA 2007)

Although the Chesapeake Bay is impaired, it still generates significant economic activity locally and regionally. The Chesapeake Bay watershed provides numerous recreational activities for the densely populated mid-Atlantic region. In Maryland, Virginia and Pennsylvania, roughly 8 million wildlife watchers spent $636 million, $960 million, and $1.4 billion, respectively on trip-related expenses and equipment in 2006 (Chesapeake Bay Foundation 2010). These estimates do not include other economic benefits such as job creation from the tourist industry. Recreational boating generates jobs and revenue within the Chesapeake Bay watershed: In Maryland an annual $2.03 billion of spending and 35,025 jobs are attributed to recreational boating; similarly, Pennsylvania residents spend $1.7 billion on boating (Chesapeake Bay Foundation 2010.)

Economic losses due to the decline in fisheries resources in the Bay are substantial. Between 1994 and 2004, seafood harvest values in Virginia declined 30% (Chesapeake Bay Foundation 2010). The decline in the viability of commercial fisheries leads to a decline in jobs and tourist visitation (Chesapeake Bay Foundation 2012). For example, the decline in the blue crab population by more than half from 1990 to 2008 resulted in an estimated $640 million loss in the commercial and restaurant industry (Chesapeake Bay Foundation 2012). The economic losses are not restricted to the tidal regions of the Bay watershed; fishing in Pennsylvania has been affected by degraded stream habitat, restricting fishing from historical areas (Chesapeake Bay Foundation 2010).

Due to increased population and development, some areas in the Chesapeake Bay watershed have lost large percentages of tree cover. Tree canopy cover in the Chesapeake Bay watershed has declined from 51% in 1973 to 39% in 1997. Within the watershed the high-growth areas of Charlottesville, VA and Harrisburg, PA have lost 5.3 and 7.5 million acres of tree cover, respectively (American Forests 2002). The loss of tree cover and increase of impervious surface in Charlottesville, VA has led to a 19% increase in storm water from every 2-year precipitation event, about 3-billion cubic feet of water. In Harrisburg, the loss of tree cover has led to an 8% increase in storm water from each 2-year precipitation event, about 1 billion cubic feet of water (American Forests 2002). The loss of tree cover and ensuing increased storm water has economic impacts in these cities. The cost of building the infrastructure to treat and store all of the excess water is on the order of billions of dollars for each city (general costs are about $2/cubic ft of stormwater needing treatment). The loss of tree cover in these areas also decreases the air quality, potentially increasing local health care costs and making it more difficult and costly to meet federal regulatory standards. Protecting remaining forests in the Chesapeake Bay is a cost-effective method to improve environmental quality in local areas and in the Bay watershed.

Many negative economic effects have been associated with the decline in the Bay's health. The effort to calculate the economic benefits associated with its protection has been rarer, although one could argue that through protection, the costs associated with negative impacts would be avoided. However, within the entire Chesapeake Bay watershed, there are still many healthy streams, rivers and sub watersheds throughout Pennsylvania, Virginia, Maryland and New York. These healthy watersheds are crucial to maintaining and improving the health of the Chesapeake Bay and provide the vital support network needed for bay restoration to be successful. Protecting the healthy areas within the bay watershed will minimize future environmental and economic impacts. There are many innovative solutions being explored to ensure conservation of healthy areas, minimize impacts and regulate the amount of pollutants entering the bay. Specifically, innovation has been tied to the investigation of nutrient trading markets and registries to leverage the economic impacts of protecting and restoring the bay. The problems in the Chesapeake Bay are complex. To address these issues in a holistic and economic perspective, it is essential that protecting healthy watersheds be part of any comprehensive restoration effort.

Conclusion

Protecting highly functioning aquatic ecosystems and their supporting landscape networks is a cost-effective way to provide the multitude of services needed to meet society's needs. Development pressures will continue, but they must be balanced with the understanding that we cannot afford to lose our nation's remaining healthy systems. Without healthy systems in place restoration efforts become difficult and are often unsuccessful. Increasingly, studies show that the economic value of intact ecosystems exceeds that of lands converted to areas for intensive economic use (deGroot et al. 2009). A global study examining four different biomes that were converted from a natural state to a developed state were evaluated; in all four cases researchers demonstrated that the long-term economic benefits of an intact ecosystem were far greater (by billions of US dollars) than the short-term economic gains from land conversion, due mostly to the loss of non-marketable goods and services (Balmford et al. 2002). These studies are not a condemnation of development outright, but rather they are a call to protect the healthy and sensitive places so that we may rationally use the land while reaping the greatest ecological and economic benefits and maintaining the greatest number of options for the future.

Citizens of the United States overwhelmingly care about environmental protection. Between 1994 and 2004 over 75% of conservation referenda on ballots were passed in the United States, signifying strong support for conservation (Banzhaf et al. 2006). In 2008, residents of Minnesota voted to raise their sales tax for the next 25 years for habitat and water quality protection; In 2006 Missouri residents voted to dedicate a portion of their sales tax to soil and water conservation; Arkansas has had a 1/8th cent sales tax dedicated to conservation efforts for over a decade. In a 2011 national Gallup Poll, nearly 80% of people said they worry about pollution of lakes, rivers, streams and drinking water. The public cares about the environment. The number of waters listed as impaired in the United States is not declining. Environmental hazards are numerous, especially those that affect water quality. When areas fall into poor environmental health and exhibit minimized functionality of natural processes, they become very difficult and expensive to restore. Society has to invest enormous sums of money in technological alternatives to replace the ecosystem services lost (Barnes et al. 2009). Well managed, healthy forests and watersheds provide clean, high quality water with fewer pollutants than water from other catchments (Dudley and Stolten 2003). There are many challenges associated with assessing the actual economic value of an ecosystem service, and they are almost always undervalued (Dudley and Stolten 2009). However, if local, state and regional officials are provided with information that can assist in understanding the potential economic savings that can occur through strategic watershed protection, conservation activities may be more popular and feasible in government budget planning.

To communicate the economic benefits of protection, it is necessary to promote partnerships between conservationists and landowners, establish baseline ecological data, discuss zoning issues, communicate existing case studies, and to create good demonstration projects for credibility. For the greatest impact on conservation, ecologically, prioritizing the highest quality watersheds for protection is more successful than small piecemeal efforts, or restoring degraded stream segments, especially with limited funds (Halpern et al. 2006).

There is resistance to establishing monetary values for ecosystem services because it is difficult to capture the total value and there is always the potential to risk under-valuing the services. However, assigning value to ecosystem services is a necessary and important tool to demonstrate the economic value being lost to society. Ecosystem evaluation is a field that requires great amounts of innovation; developing communication tools that can relate tangible value to ecosystem services will be meaningful in protecting healthy watersheds. With the projected future market-based trading schemes, we have to ensure that credits for carbon, water quality, nutrients, etc. address the protection of whole systems; it is necessary to integrate economics and ecology. It is possible that people can make profits from market trading, payments for ecosystem services, and that landowners can be compensated for conserving land. However, the important message is that conservation provides myriad economic and social benefits at the local level. Protecting these systems will provide society with greater economic security, healthy, bountiful fisheries, a higher quality of life and clean drinking water. We can no longer afford not to protect the critical life support network of healthy watersheds that still remain.

References:

Agrawala, Shardul and Samuel Frankhauser (Eds.). 2008. Economic aspects of adaptation to climate change: costs, benefits and policy instruments. Organization for Economic Co-Operation and Development. 138.

Ainsworth, Steve and Paul Jehn. 1996. "Source water protection: What's in it for you?" Public Management. 78(2).

American Hiking Society. 1990. "Pathways across America."

American Forests. 2002. "Regional ecosystem analysis: Chesapeake Bay Watershed: Charlottesville, VA and Harrisburg, PA areas (Calculating the Value of Nature)."

Anderson, L.M. and H.K. Cordell. 1988. "Influence of trees on residential property values in Athens, Georgia (USA): A survey based on actual sales prices." Landscape and Urban Planning.15: 153-164.

APA (American Planning Association). 2012. Story County community planning assistance team. "A strategic story: A framework for Story County economic development." http://www.planning.org/communityassistance/teams/storycounty/pdf/finalreport.pdf

Ara, Shihomi, Elena Irwin, and Timothy Haab. 2006. "The influence of water quality on the housing prices around Lake Erie." Selected Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Long Beach, California, July 23-26, 2006. http://ageconsearch.umn.edu/bitstream/21275/1/sp06ar05.pdf

Aronson, James, James N. Blignaut, Suzanne J. Milton, David Le Maitre, Karen J. Esler, Amandine Limouzin, Christelle Fontaine, Martin P. de Wit, worship Mugido, Philip Prinsloo, Leandri van der Elst and Ned Lederer. 2010a. "Are socioeconomic benefits of restoration adequately quantified? A meta-analysis of recent papers (2000-2008) in Restoration Ecology and 12 other scientific Journals." Restoration Ecology. 18(2), 143- 154.

Aronson, James, James N. Bilgnaut, Rudolf S. de Groot, Andre Clewell, Porter P. Lowry II, Paddy Woodworth, Richard M. Cowling, Daniel Renison, Joshua Farley, Christine Fontaine, David Tongway, Samuel Levy, Suzanne J. Milton, Orlando Rangel, Bev Debrincat, and Chris Birkinshaw. 2010b. "The road to sustainability must bridge three great divides." Annals of the New YorkAcademy of Sciences. 1185, 225-236.

ASCE Report Card. Accessed from web May 18, 2011. http://www.infrastructurereportcard.org/fact-sheet/drinking-water

AWWA (American Water Works Association) 2004. "Conserving forests to protect water." Opflow. 30(5). http://www.slcgov.com/utilities/NewsEvents/pdf/Op0504_1.pdf

Balmford, Andrew, Aaron Bruner,2 Philip Cooper, Robert Costanza, Stephen Farber, Rhys E. Green, Martin Jenkins, Paul Jefferiss, Valma Jessamy, Joah Madden, Kat Munro, Norman Myers, Shahid Naeem, Jouni Paavola,Matthew Rayment, Sergio Rosendo, Joan Roughgarden, Kate Trumper, R. Kerry Turner. 2002. "Economic reasons for conserving wild nature." Science. 297, 950-53.

Banzhaf, Spencer, Wallace Oates, James N. Sanchirico, David Simpson and Randall Walsh. 2006. "Voting for Conservation: What is the American electorate revealing?" Lincoln Institute of Land Policy and the University of Colorado at Boulder.

Barnes, Martina C., Albert H. Todd, Rebecca Whitney Lilja, and Paul K. Barten. 2009. "Forests, water and people: drinking water supply and forest lands in the Northeast and Midwest United States." NA-FR-01-08. Newtown Square, PA: US Department of Agriculture, Forest Service, 84.

Benedict, Mark A. and Edward T. McMahon. 2002. "Green infrastructure: smart conservation for the 21st century." Renewable Reosurces Journal. 20(3), 12-17.

Bernhardt, E.S., M.A. Palmer, J.D. Allan, G. Alexander, K.Barnas, S.Brooks, J.Carr, S. Clayton, C. Dahm, J. Follstad-Shah, D. Galat, S. Gloss, P. Goodwin, D. Hart, B. Hassett, R. Jenkinson, S.

Katz, G. M. Kondolf, P.S. Lake, R. Lave, J.L. Meyer, T.K. O'Donnell, L. Pagano, B. Powell, and E. Sudduth. 2005. "Synthesizing U.S. river restoration efforts." Science. 308: 636-637.

Burchell, Robert W., and David Listokin. 1995. "Land, infrastructure, housing costs and fiscal impacts Associated with Growth: The Literature on the Impacts of Sprawl versus managed growth." Lincoln Institute of Land Policy: Cambridge, MA.

Chesapeake Bay Commission. 2004. "Cost-effective strategies for the bay: Smart investments for nutrient and sediment reduction."

Chesapeake Bay Foundation. 2012. "The economic argument for cleaning up the bay and its rivers." http://www.cbf.org/Document.Doc?id=591

Chesapeake Bay Foundation. 2000. " Land and the Chesapeake Bay." Chesapeake Bay Program: Annapolis, MD.

Chesapeake Bay Foundation. 2007. " Land and the Chesapeake Bay." Chesapeake Bay Program: Annapolis, MD.

Chesapeake Bay Program. 1998. " Economic benefits of riparian forest buffers." Fact sheet 600-613-1

CNT (Center for Neighborhood Technology.) 2010. "The value of green infrastructure: A guide to recognizing its economic, environmental and social benefits." http://www.cnt.org/repository/gi-values-guide.pdf

Cosman, David, Rowan Schmidt, Jennifer Harrison-Cox, and David Batker. 2012. "How water utilities can spearhead natural capital accounting." Solutions Journal. 2(6): 28-31.

Crompton, John L. 2007. "The impact of parks and open spaces on property taxes."The Economic Benefits of Land Conservation. Ed. Constance T.F.de Brun. The Trust for Public Land. 1-12.

Dannenberg, Andrew L., Howard Frumkin, and Richard J. Jackson. (Eds.) 2011. Making healthy places. Pp 448.

deGroot, R.S., R. Alkemade, L. Braat, L. Hein, L. Willmen. 2009. "Challenges in integrating the concept of services and values in landscape planning, management and decision making." Ecological Complexity. 7: 260-272.

DeSantis, Amanda and Janet Ranganathan. 2011. "Investing in Nature for economic growth (Part I of II)." Environmental Leader: Environmental and Energy Management News." Accessed from the web August 25, 2011. http://www.environmentalleader.com/2011/07/26/investing-in-nature-for-economic-growth-part-i-of-ii/

Dodds, Walter K., Wes W. Bouska, Jeffrey L. Eitzmann, Tyler J. Pilger, Kristen L. Pitts, Alyssa J. Riley, Joshua T. Schloesser and Darren J. Thornbrugh. 2009. "Eutrophication of U.S. fresh waters: Analysis of potential economic damages. Environmental Science and Technology. 43(1): 12-19.

Donjek, Inc. 2009. "Fiscal and Economic Impact of open Space." Saint Paul, MN: Presentation to Embrace Open Space Quarterly Meeting May 28, 2009, 6.

Donovan, Geoffrey H. and David T. Butry. 2008. "Market-based approaches to tree valuation." Arborist News. 17:52-55.

Donovan, Geoffrey H. and David T. Butry. 2009."The value of shade: Estimating the effect of urban trees on summertime electricity use." Energy and Buildings. 41: 662-668.

Dove, Eric, Kasi Johnson and Matt Keener. 2008. "The value of protecting Ozark streams: an economic valuation of stream bank stability for Phosphorus reduction." Springfield, Missouri: Olsson Associates and Watershed Center Report, 21.

Dudley, Nigel and Sue Stolten. 2003. "Running pure: the importance of forest protected areas to drinking water." Washington, D.C.: World Bank/WWF alliance for forest conservation and sustainable use, 114.

Duffield, John, Chris Neher, and David Patterson. 2011. "Utah waterfowl hunting: 2011 hunter survey. Hunter attitudes and economic benefits. Bioeconomics, Inc. http://www.fogsl.org/images/stories/2011/Duck_Final_Executive_Summary-6-29-2011.pdf

Dwyer, John F. E. Gregory McPherson, Herbert W. Schroeder, and Rowan A Rowntree.1992. "Assessing the benefits and costs of the urban forest." Journal of Arborculture. 18(5).
Eisen-Hecht, Jonathon I. and Randall A. Kramer. 2002. "A cost-benefit analysis of water quality protection in the Catawba Basin." Journal of American Water Resources Association. Vol. 38(2). 453-465.
Emerton, L. and E. Bos. 2004. "Value: Counting ecosystems as and economic part of water infrastructure." IUCN. Gland, Switzerland and Camberidge UK. Pp88.
Ernst, Caryn. 2004. Protecting the source: land conservation and the future of America's drinking water. San Francisco, CA: Trust for Public Land, Water Protection Series, 56.
Feather, Peter, Daniel Hellerstein and LeRoy Hansen. 1999. "Economic Valuation of Environmental Benefits and the Targeting of Conservation Programs: The Case of the CRP," U.S. Dept of Agr., Economic Research Service. AER-778, April.
Fankhauser, Samuel J., Joel B. Smith and Richard S.J. Tol. 1999. "Weathering climate change: some simple rules to guide adaptation decisions." Ecological Economics. 30:67-78.
Goldberg, Jeffery. 2007. "Economic valuation of watershed systems: a tool for improved water resource management." Guatemala City, Guatemala: Organization of American States, Department of Sustainable Development. Background note for the VI inter-American dialogue on water resource management, August 15, 2007, 15.
Greenwalt, Travis and Deborah McGrath. 2009. "Protecting the City's Water: Designing a Payment for Ecosystem Services Program." Natural Resources & Environment. Summer 2009: 9-13.
Grossman, Elizabeth and Laura Watchman. 2006 "Assessing the wealth of nature: Using economic studies to promote land conservation instead of sprawl." Produced in collaboration with Resources for the Future and Island Press. Defenders of Wildlife, Washington, DC.
Halpern, Benjamin S. Christopher R. Pyke, Helen E. Fox, J. Chris Haney, Martin A Schlaepfer, and Patricia Zaradic. 2006. "Gaps and Mismatches between global conservation priorities and spending." Conservation Biology. Vol 20(1): 56-64.
Hanson, Craig, John Talberth and Logan Yonavjak. 2011 "Forests for water: Exploring payments for watershed services in the US South." World Resources Institute Issue Brief, Issue 2. Pp15.
Hein, Lars. 2011. Economic benefits generated by protected areas: the case of the Hoge Veluwe Forest, the Netherlands. Ecology and Society. 16(2): 13.
Johnston, Douglas M., John B. Braden and Thomas H. Price, P.E. 2006. "Downstream economic benefits of conservation development." Journal of Water Resources Planning and Management. 132(1), 35-43.
Kaoru, Y. 1993. "Differentiating Use and Nonuse Values for Coastal Pond Water Quality Improvements." Environmental and Resource Economics. 3(5):487-494.
Kimmel, M.M. 1985. "Parks and property values: An empirical study in Dayton and Columbus, Ohio." Thesis: Miami University, Institute of Environmnetal Sciences, Oxford, Ohio.
Konrad, C.P. 2003. Effects of urban development on floods. Fact sheet 076-03. Washington, DC: U.S. Geological Survey. Online at: http://pubs.usgs.gov/fs/fs07603/
Kroeger, Timm. 2008a. An Assessment of the economic benefits provided by conservation lands: five case studies of conservation opportunity areas identified in state wildlife conservation strategies project overview and summary of findings. Prepared for the Doris Duke Charitable Foundation. Washington, DC: Defenders of Wildlife. 13pp.
Kroeger, Timm. 2008b. "Open space property values premium analysis." National Council for Science and the Environment: 2006 Wildlife Habitat Policy Research Program, Defenders of Wildlife.
Landry, Craig E. and Paul Hindsley. 2011. "Valuing beach quality with hedonic property models." Land Economics. 87(1):92-108.
Limburg, Karin E., Robert V. O'Neill, Robert Costanza, and Steven Farber. 2002. "Complex systems and valuation." Ecological Economics. 41(3): 409-420

LPI (Land Policy Institute). 2008. Comprehensive Study on Economic Valuation, Economic Impact Assessment, and State Conservation Funding of Green Infrastructure Assets in Michigan. East Lansing, Michigan: Report #CS-2008-01, 108.
Majanen, Terhi, Rachel Friedman and Jeffrey C. Milder. 2011. "Innovations in market-based watershed conservation in the United States: Payments for watershed services for agricultural and forest landowners." Prepared for US Endowment for Forestry and Communities, Inc. and US Department of Agriculture, Office of Environmental Markets. EcoAgricultural Partners. Pp40.
Michael, Holly J., Kevin J. Boyle and Roy Bouchard. 1996. "Water quality affects property prices: A case study of selected Maine lakes. Maine Agricultural and Forest Experimentation Stations: Misc. report.University of Maine: Pp18.
Myers, Norman. 1996. "Environmental services of biodiversity." Proceedings of the National Academy of Sciences, USA. 93: 2764-2769.
NADC (National Association of Conservation Districts). 2010. "Conservation benefits Putting value where it belongs." October Pp35.
Nelson, A.C. 1986. "Using land markets to evaluate urban containment programs." American Planning Association Journal. 52(2): 156-157.
Outdoor Industry Foundation. 2003. "The active outdoor recreation economy." http://www.outdoorindustry.org/images/researchfiles/RecEconomypublic.pdf?26
Pacific Rivers Council. 1993. "Entering the Watershed: An action plan to protect and restore America's river ecosystems and biodiversity". A report to congress by the Pacific Rivers Council.
Pagiola, Stefano, Konrad vonRitter, and Joshua Bishop. 2004. "Assessing the economic value of ecosystem conservation." Environment Department paper no. 101. The World Bank Environment Paper.
Pagiola, Stefano. 2008. "Payments for environmental services in Costa Rica." Ecological Economics. 65: 712-724.
Pejchar, Liba, Peter M. Morgan, Margaret R. Caldwell, Carl Palmer, and Gretchen C. Daily. 2006. "Evaluating the potential for conservation development: biophysical, economic, and institutional perspectives." Conservation Biology. 21(1), 69-78.
Peterson, Charles H. Jonathon H. Grabowski and Sean P. Powers. 2003. Estimated enhancement of fish production resulting from restoring oyster reef habitat: quantitative valuation. Marine Ecology Progress Series. Vol. 264. 249-264.
PDCNR (Pennsylvania Department of Conservation and Natural Resources). 2010. "Return on Environment: The economic values of protected open space in southeastern Pennsylvania." Prepared by the economy League of Greater Philadelphia, Econsult Corporation, Keystone Conservation Trust for GreenSpace Alliance and the Delaware Valley Regional Planning Commission.
Poor, P. Joan, Keri L. Pessagno, and Robert W. Paul. 2007. "Exploring the hedonic value of ambient water quality: A local watershed-based study." Ecological Economics. 60:797-806.
Postel, Sandra L. and Barton H.Thompson. 2005. Watershed protection: capturing the benefits of nature's water supply services. Natural Resources Forum. 29, 98-108.
Qiu, Zeyuan and Tony Prato. 1998. "Economic evaluation of riparian buffers in an agricultural watershed." Journal of the American Water Resources Association. 34(4), 877-890.
Rein, Felicia. "An economic analysis of vegetative buffer strip implementation Case study: Elkhorn slough, Monterey Bay, California." 1999. Coastal Management. 27:377-390.
Ribaudo, M.1989. "Water quality benefits from the Conservation Reserve Program." AER-606. U.S. Dept. Agr., Econ. Res. Serv., Feb. 1989.
Ribaudo, M., D. Colacicco, L. Langer, S. Piper, and G. Schaible. 1990. "Natural resources and users benefit from the conservation program. AER-627. U.S. Dept. Agr., Econ. Res. Serv., Jan. 1990.
Ring, Irene, Bernd Hansjürgens, Thomas Elmqvist, Heidi Wittmer and Pavan Sukhdev. 2010. "Challenges in framing the economics of ecosystems and biodiversity: the TEEB initiative." Current Opinion in Environmental Sustainability. 2(1-2), 15-26.

Salzman, James. 2010. Ed. Roger Meiners. "Designing payments for ecosystem services." PERC Policy Series. No. 48.
Salzman, James. Barton H. Thompson, Jr., and Gretchen C. Daily. 2001. "Protecting ecosystem services: science, economics, and law." Stanford Environmental Law Journal. 20, 309-332.
Schideler, David. 2009. "Economic impact of conservation dollars in Oklahoma." AE-09001 Oklahoma Cooperative Extension Service. Oklahoma State University.
Smith, Elizabeth R. 2000. An overview of EPA's regional vulnerability assessment (ReVA) Program. Environmental Monitoring and Assessment. 64. Pp 9-15.
Smith, Mark P., Roy Schiff, Arlene Olivero, and James MacBroom. 2008. "The active river area: A conservation framework for protecting rivers and streams." The Nature Conservancy. Pp60.
Southwick Associates. 2008. "Sportfishing in America: An economic engine and conservation powerhouse." Product of the American Sportfishing Association with funding from the Multistate Conservation Grant Program, 2007.
Sullivan, Patrick, Daniel Hellerstein, Leroy Hansen, Robert Johansson, Steven Koenig, Ruben Lubowski, William McBride, David McGranahan, Michael Roberts, Stephen Vogel, and Shawn Bucholtz. 2004. Conservation Reserve Program: The Conservation Reserve Program: Economic Implications for Rural America / AER-834 Economic Research Service/USDA. http://ddr.nal.usda.gov/bitstream/10113/34810/1/CAT30925104.pdf
TEEB (The economics of ecosystems and biodiversity). 2008. Interim Report. Pp 65. http://ec.europa.eu/environment/nature/biodiversity/economics/pdf/teeb_report.pdf
Trasande, Leonardo and Tinghua Liu. 2011. "Reducing the staggering costs of environmental disease in children, estimated at $76.6 billion." Health Affairs. 30(5): 863-870.
Turner, R.K. and G.C. Daily. 2008. "The ecosystem services framework and natural capital conservation." Environmental Resource Economics. 39, 25-35.
Tzoulas, Konstantinos, Kalevi Korpela , Stephen Venn , Vesa Yli-Pelkonen , Aleksandra Kazmierczak , Jari Niemela , Philip James. 2007. Promoting ecosystem and human health in urban areas using green infrastructure: a literature review. Landscape and Urban Planning. 81, 167-178.
USDA (United States Department of Agriculture). 2012. "USDA Expands Conservation Reserve Enhancement Program by 20,000 Acres to Benefit Chesapeake Bay Watershed in Mid-Atlantic States." Press Release No. 0174.12. June 1, 2012.
U.S. Environmental Protection Agency. 1998. Federal Register Proposed Rules. 63(6):1536-1643.
U.S. Environmental Protection Agency. 1999. Economic analysis of the final phase II storm water rule. EPA-833-R-99-002. Prepared by SAIC: Reston, VA
U.S. Environmental Protection Agency. 2002. "The clean water and drinking water infrastructure GAP analysis." EPA-816-R-02-020. http://water.epa.gov/aboutow/ogwdw/upload/2005_02_03_gapreport.pdf
U.S. Environmental Protection Agency. 2003. "Building healthy environments to eliminate health disparities symposium." http://www.epa.gov/compliance/environmentaljustice/resources/reports/annual-project-reports/health-disparities-symposium-2003.pdf
U.S. Environmental Protection Agency. 2007. "Evaluation report: Development growth outpacing progress in watershed efforts to restore the Chesapeake Bay." Report No. 2007-P-00031.
U.S. Environmental Protection Agency. 2008. "Clean Watersheds Needs Survey 2008 Report to Congress." EPA-832-R-10-002.
U.S. Environmental Protection Agency. 2009a. "Valuing the Protection of Ecological Systems and Services: A Report of the EPA Science Board." EPA-SAB-09-012. http://yosemite.epa.gov/sab/SABPRODUCT.NSF/F3DB1F5C6EF90EE1852575C500589157/$File/EPA-SAB-09-012-unsigned.pdf
U.S. Environmental Protection Agency. 2009b. "EPA's drinking water infrastructure needs survey and assessment." Fact Sheet. EPA 816-F-09-003 February 2009

U.S. Environmental Protection Agency. 2010. "Healthy lakes and higher property values." EPA 840-F-10-002, Oct. http://water.epa.gov/type/lakes/upload/healthy_lakes_and_higher_property_values.pdf

U.S. Environmental Protection Agency. 2011. "Market acceptance of smart growth." EPA 231-R-10 001. http://www.epa.gov/smartgrowth/pdf/market_acceptance.pdf

U.S. Government Accountability Office (GAO). 2006. Letter to Congressional Requestors: "Endangered Species: Time and Costs Required to Recover Species Are Largely Unknown." April 6, 2006. http://www.gao.gov/assets/100/94110.pdf

U.S. National Park Service (NPS). 1995. Economic Impacts of Protecting Rivers, Trails, and Greenway Corridors: A Resource Book. Rivers, Trails, and Conservation Assistance Section.

US Water News. 1997. "Loss of trees in Atlanta area produces increased storm water costs." Water News, Online. http://www.uswaternews.com/archives/arcquality/7lostre8.html

VDCR (Virginia Department of Conservation and Recreation). 2001. The economic benefits of better site design in Virginia. Technical paper prepared by The Center for Watershed Protection, Maryland.

Wambolt, Carl L., Aaron J. Harp, Bruce L. Welch, Nancy Shaw, John W. Connelly, Kerry P. Reese, Clait E. Braun, Donald A. Klebenow, E. Durant McArthur, James G. Thompson, L. Allen Torell, and John A. Tanaka. 2002. "Conservation of Greater Sage-Grouse on Public Lands in the Western U.S.: Implications of Recovery and Management Policies." Policy Analysis Center for Western Public Lands: PACWPL Policy Paper SG-02-02. http://sagemap.wr.usgs.gov/Docs/sage-grouse_policy.pdf

Wells, N.M. (2000). At home with nature: Effects of "greenness" on children's cognitive functioning. Environment and Behavior (32), 6, pp 775-795. http://eab.sagepub.com/cgi/content/abstract/32/6/775

WHEC (Wildlife Habitat Enhancement Council). 1992. "The economic benefits of wildlife habitat enhancement on corporate lands." Silver Spring, MD.

Wolf, Kathleen. 2004. "Trees and business district preferences: A case study of Athens, GA, U.S." Journal of Arborculture. 306(6): 336-346.

Young, C. E., and C.T. Osborn. 1990. "The Conservation Reserve Program: An economic assessment." AER- 626. U.S. Dept. Agr., Econ. Res. Serv.

Zbinden, Simon and David R. Lee. 2004. "Paying for environmental services: An analysis of participation in Costa Rica's PSA program." World Development. 33(2): 255-272.