Innovations in Market-based Watershed Conservation in the United States

Payments for Watershed Services for Agricultural and Forest Landowners

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landscapes for people, food and nature

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Executive Summary

Water is crucial for many human activities—from agriculture to industry to daily survival—yet water resources in the United States face unprecedented threats from pollution, urbanization, aquifer depletion, and many other challenges. Several of these challenges can be effectively addressed through the actions of private agricultural and forest landowners, and in recent years, a variety of programs and incentives has been developed to foster watershed stewardship on private lands.

One such approach is payments for watershed services (PWS). This voluntary, market-based mechanism offers cash payments or other benefits to landowners in exchange for providing "watershed services" through the adoption of specific agricultural, forestry, or land management practices. Watershed services include ecosystem functions that help protect water quantity or water quality. For instance, landowners may manage water quantity through practices that recharge aquifers, store flood waters, or control the timing and amount of water withdrawals, or they may manage water quality through erosion control or pollution attenuation measures. PWS schemes always include one or more buyers of watershed services (public agencies, private companies, non-governmental organizations, or consumers), one or more sellers (typically landowners or managers), and often project administrators.

Some forms of PWS—such as Conservation Reserve Program payments under the U.S. Farm Bill—are relatively well-known. However, new innovations in PWS have emerged in the past decade and are pointing the way toward watershed protection approaches that might effectively complement existing government conservation programs and incentives for rural landowners. The purpose of this study was to survey these new or emerging PWS project models to understand their scale, characteristics, and future potential. To do so, we surveyed conservation professionals, experts, and others across the country to identify and characterize a range of PWS projects and programs in which municipalities, other local government entities, non-profit organizations, private companies, and individuals are buyers of ecosystem services. Because the focus is on innovative PWS practices, this study excludes PWS mechanisms that are already well-known or well-documented, such as Farm Bill programs, water quality trading programs, mitigation banking, tax incentives, and cost-share programs.

Overall we identified 32 PWS schemes that met the criteria for inclusion in this study, plus an additional 108 market-based watershed projects and programs that did not meet these criteria. Public sector buyers, including cities and water utilities, comprised over half (18) of the documented schemes, with private buyers, philanthropic buyers, and eco-labels making up the remainder. Geographically, these projects were widely distributed, with pockets of concentrated activity in the Northeast, Upper Midwest, and Pacific Northwest. Projects tended to address the salient water-related concerns in each part of the country; for instance, water scarcity was the main motivating

factor in western states, while nutrient pollution and water quality deterioration tended to drive PWS in the East.

Buyers of watershed services were motivated to participate in PWS by a variety of factors. Public sector buyers commonly sought to protect the quality and quantity of public drinking water sources, sometimes as a way of reducing water filtration and treatment costs. Some private sector buyers participated in PWS to help cultivate a public image of environmental stewardship. Several PWS schemes were actively soliciting private buyers seeking to protect water resources for their use values (e.g., for irrigation or industrial use), but few such buyers had actually been secured. A personal conservation ethic was the most common motivation for philanthropic buyers and consumers purchasing eco-labeled products.

Landowners who provide watershed services also had a multitude of reasons for participating in PWS schemes. Financial benefits—either direct cash payments or gains made through improved agricultural yields and input use efficiency—were quite important. However, cash payments alone were usually not sufficient to motivate behavioral change, particularly since many PWS payments were rather small. A strong stewardship ethic also influenced many of the landowners, who understood the necessity of maintaining a healthy environment for the continued productivity of their land and way of life. Payments often served as an enabling factor through which landowners could justify carrying out management practices they had hoped to implement but could not otherwise afford.

The majority of PWS schemes compensated landowners to adopt watershed-friendly management practices, as opposed to paying based on the verified delivery of watershed services (i.e., measured improvements in environmental quality). The former approach uses management practices as a proxy for watershed services, based on pre-established relationships or assumptions. Robust monitoring is helpful for verifying the assumed linkages between practices and outcomes; however this monitoring component is often neglected due to limitations of time and money.

While the total scale of PWS from municipal, private, and philanthropic buyers in the United States remains quite small relative to established conservation mechanisms such as conservation easements and Farm Bill programs, the diversity of the PWS models identified by this study suggests that PWS has wide applicability and significant potential for scaling up. Perhaps the greatest challenge to doing so is to identify and elicit payments from beneficiaries of watershed services, many of whom are accustomed to enjoying such services for free. Growing water scarcity and increasing water demand in the coming decades are likely to increase buyer demand for watershed services, but so, too, can regulations, incentives, and the continued implementation of pilot programs that demonstrate the feasibility of PWS models. Finally, many of the surveyed PWS schemes are supported by state or federal grants, seed funding, or technical assistance that is channeled through local organizations.

Continuation or expansion of these sources of support will likely remain important for the future growth of the PWS field, even as growing numbers of buyers from the private sector and local water utilities become engaged.

With numerous pilot projects underway, abundant grassroots innovation from landowners and local conservation organizations, new research and tools to quantify and value watershed services, and increased awareness and acceptance of market-based conservation models, PWS stands to play a growing role in efforts to secure public environmental goods through the responsible stewardship of private lands.

1. Introduction

The average person living in the United States uses about 90 gallons of water at home every day (EPA 2009). American consumers are accustomed to having access to abundant, safe, and affordable water and typically give little thought to the long and complex chain of natural and human processes on which reliable tap water depends.

Yet, dependable access to abundant clean water for energy, agriculture, domestic use, and industry is in jeopardy in many parts of the country. Changing climate and land use patterns increasingly degrade the quantity, quality, and reliability of water supplies. Despite more than $50 billion of investment between 1995 and 2000 in capital improvements to sustain and improve water quality, public water systems still face significant challenges to providing clean water to their customers, often due to degradation of the source of public water supplies (EPA 2009). Reduced water quantity and quality and altered flow regimes also harm native ecosystems and the plant and animal species that inhabit them. The biophysical processes that underlie these challenges include aquifer depletion, reduced winter snowpack, decreased infiltration in agricultural and urban areas, and many others.

Agriculture and forestry on private lands can constitute both a challenge and an opportunity for maintaining water quality and water quantity. While typical production practices such as soil tillage, fertilizer application, and tree cutting may contribute to erosion, water pollution, and other environmental impacts, responsible stewardship of productive lands can provide a wide range of public benefits including carbon storage, flood control, erosion control, wildlife habitat, and recreational opportunities. In recent years, a variety of new and innovative mechanisms has been developed to encourage watershed protection on private agricultural and forest lands through financial incentives to landowners. One such approach is payments for watershed services.

Payments for Watershed Services (PWS)

Payments for watershed services (PWS) encompass a variety of mechanisms by which providers of watershed protection services receive financial compensation from beneficiaries of these services. PWS is a subset of payments for ecosystem services (PES), an increasingly widely-used market-based approach to environmental conservation and management. According to a common definition of the term, PES consists of "voluntary transactions in which a well-defined environmental service (or a form of land use likely to secure that service) is bought by at least one buyer from a minimum of one provider, if and only if the provider continues to supply that service" (Wunder 2005). PES is often defined using the following criteria:

1. The market transaction is enacted voluntarily.
2. The transaction pertains to well-defined ecosystem services, or land use or management practices that are likely to produce such services.
3. The ecosystem services are being purchased by a willing buyer or buyers.
4. The ecosystem services are being sold by a willing seller or sellers.
5. The payment is contingent on the environmental benefits (or practices) actually being provided ("conditionality").
6. The payment secures ecosystem services that would not otherwise be provided through legal or regulatory requirements or customary practices ("additionality") (ten Brink 2009).

While this idealized definition of PES is helpful for understanding the concept, the reality is that many ecosystem service payments referred to as PES do not meet all of these criteria.

PWS is the subset of PES that pertains to watershed services, which may include water quality protection or enhancement (including erosion, pollution, and sediment control), water quantity management (including flood control and in-stream flows), groundwater infiltration, and similar processes. For example, a common form of PWS is an upstream-downstream transaction in which a downstream user such as a water utility pays upstream landowners to institute water-friendly land management practices in order to improve or maintain downstream water quality.

PWS has been in use for many years, and hundreds of projects and programs from around the world have been documented. Stanton *et al.* (2010) identified 216 PWS programs in 24 countries, including 10 in the United States. This same study estimated that PWS transactions in 2007 totaled over $9 billion, of which 55% represented government programs, 9% represented private or other non-governmental programs, and 36% represented a mix of mechanisms. A tripling of PWS transactions is expected by 2050 (Ecosystem Marketplace 2008). Some large PWS programs, such as Conservation Reserve Program payments under the U.S. Farm Bill, have been in use for many years, at a significant scale. However, in most places, the adoption and use of PWS as an ecosystem management tool is in its early stages, consisting mainly of one-off or pilot projects and programs that affect relatively few people and relatively little land. See Box 1 for a brief overview of the current state of knowledge on PWS in the United States.

Box 1: State of Knowledge of PWS in the United States

While a comprehensive literature review is beyond the scope of this report, it is worth highlighting a few recent publications that have shed light on PES, and particularly PWS, in the United States. The present study has been designed to complement, these other recent assessments. For additional background information, please refer to the publications cited throughout this report.

State of Watershed Payments: An Emerging Marketplace (Stanton *et al*. 2010). This study provides a broad, systematic inventory of PWS activities worldwide. The report estimates the size and scope of payments to protect or restore watershed services, and examines future opportunities and challenges. An earlier report, *All That Glitters: A Review of Payments for Watershed Services in Developing Countries* (Porras *et al*. 2008) examines PWS in developing countries specifically.

Guide to Environmental Markets for Farmers and Ranchers: A Practical Guide to Ways Agricultural Producers Can Profit from the Growing Environmental Marketplace (Stuart and Canty 2010). This guide for farmers and ranchers provides an introduction to environmental markets and the ways in which agricultural operators can take advantage of them. The guide focuses on credit-based activities in Washington state, but much of the material is informative for farmers and ranchers in any part of the country. For example, the guide profiles the types of environmental markets that are currently active in the United States and details how each market works and how farmers and ranchers can get involved. The American Farmland Trust also has a set of guides on conservation options for farmers in different states (Connecticut, Ohio, Kentucky, South Carolina, and the Rocky Mountain states), which explain the various public programs that support environmental stewardship.

Taking Stock: Payments for Forest Ecosystem Services in the United States (Mercer *et al*. 2011). This report from Ecosystem Marketplace and the U.S. Forest Service examines public, voluntary, and compliance-driven payments for carbon sequestration, watershed protection, and biodiversity habitat protection from U.S. forests.

Ecosystem Services: Quantification, Policy Applications, and Current Federal Capabilities (Scarlett and Boyd 2011). This report details existing federal policies and programs that drive or support analysis and measurement of ecosystem services. With its emphasis on federal programs, this report complements the present study, which focuses on non-federal payment programs.

From Forest to Faucet (Weidner and Todd *2011*). This analysis identifies areas important to surface drinking water quality, examines the role of forests in protecting surface drinking water, identifies threats that may affect the ability of forests to provide clean surface drinking water in the future, and identifies opportunities for PWS.

Collectively, these studies provide very good information on PWS definitions and mechanisms in general. They also provide helpful assessments of certain categories of PWS in the United States—particularly federally funded programs. However, some important gaps remain in the knowledge of PWS in the United States. Perhaps most critically, PWS funded by private sources and non-federal public sources have not been systematically inventoried or assessed, nor have the opportunities, constraints, and potential for such forms of PWS been evaluated. This study seeks to fill this critical gap in knowledge about market-based watershed protection mechanisms in the United States.

PWS schemes involve a few key sets of actors: sellers of ecosystem services, buyers of ecosystem services, and in many cases intermediaries or project administrators who manage the activities and facilitate payments. In most PWS programs in the United States, the sellers are private landowners; the buyers are government agencies, non-government organizations (NGOs), or private individuals and corporations; and intermediaries are most often NGOs, academic institutions, or local

government bodies (Mercer *et al.* 2011). Agricultural and forest landowners that participate in PWS are usually motivated to do so for a combination of personal/ethical reasons (i.e., a desire to be good stewards of land and water) and economic reasons (i.e., payments or other benefits provided as a result of their participation) (Burke and Dunn 2010).

Report Overview

This report proceeds in five sections. Following this introduction, Section 2 describes the study scope and methodology. Section 3 summarizes findings on the scale and extent of PWS in the United States, as well as key characteristics of these watershed protection schemes. Section 4 discusses implications of these findings for scaling up effective market-based watershed management approaches. Section 5 is the literature cited. As a companion to this report, information on the location and characteristics of the surveyed PWS projects is available through the online Conservation Registry (www.conservationregistry.org).

2. Project Overview and Methodology

The goal of this study is to understand the current use and future potential of PWS in which municipalities, other local government entities, non-profit organizations, private companies, and individuals purchase ecosystem services to promote watershed protection through private land stewardship in the United States. To date little has been documented about this segment of PWS. While there are a few well publicized examples—such as the New York City and Santa Fe watershed protection programs—many more initiatives are underway as a result of the efforts of municipalities, water utilities, conservation interests, and industrial or agricultural water users. To investigate this diverse field of practice, we conducted a systematic survey to identify and characterize projects and programs from across the United States. We collected a common set of spatial and non-spatial data attributes for all PWS schemes and analyzed these data to identify patterns, trends, and key opportunities and constraints to the greater and more effective use of PWS in the future. The project has three principal outputs:

1. A spatially explicit inventory of the identified PWS schemes in the United States, which has been incorporated into the Conservation Registry, a publicly available online repository of conservation projects in the United States (www.conservationregistry.org). The Registry data created for this project describe the features of the identified PWS schemes and may be found by entering the search term "PWS" or "payments for watershed services" from the Registry homepage. The PWS inventory is intended as a "living" database: managers of the PWS schemes identified by this project are the owners of the data and may update it as needed, while new PWS schemes can be added as they are identified or initiated.

2. This report, which complements the Conservation Registry entries by describing overall findings and interpreting their significance.

3. A PWS brief for policy-makers, natural resource managers, and farmers and forest owners that communicates key findings and implications from this study, as well as opportunities for engaging in PWS to meet various conservation and land management objectives.

This study is intended for five major audiences: 1) professionals from the public, private, and non-governmental sectors working to mainstream market-based approaches to environmental management; 2) policy-makers, including the U.S. Department of Agriculture (USDA) and its stakeholders; 3) farmers, ranchers, and forest owners interested in environmental stewardship; 4) professionals that support farmers, ranchers, and forest owners, including conservation districts and extension officers; and 5) professionals engaged in water management and watershed protection, such as water utility managers and watershed organizations.

PROJECT SCOPE

The project focused on a subset of PWS in the United States that met the following criteria.

Ecosystem Services: We included schemes that seek to protect watershed services for human use and ecosystem conservation. In most cases, PWS seeks to protect or manage water quality (e.g., sediment control or nutrient management), water quantity (e.g., flood mitigation or in-stream flow control), or both. We also surveyed PES schemes where the primary focus was non-watershed ecosystem services, but significant watershed co-benefits were provided.

Sellers: We included private agricultural and forest landowners as sellers of ecosystem services.

Buyers: We included a full range of buyers other than federal agencies. These consisted of:

- Public and quasi-public agencies such as water utilities and conservation districts, which seek to secure environmental benefits on behalf of their ratepayers, taxpayers, or society at large;
- Private buyers, including those that seek to secure clean and reliable water supplies for commercial operations and those that seek to protect the environment to improve their corporate image;
- Philanthropic buyers, which are typically non-profit conservation organizations or individual donors; and
- Consumers paying indirectly for watershed services by purchasing eco-certified products that include water-friendly criteria.

In addition to these criteria, we excluded certain other types of projects and programs because they lacked many of the characteristics of true PES or because they have already been well characterized in other studies. Specifically:

- Regulatory programs without a market-based mechanism were excluded because they are not considered to be PES.
- Regulatory-based trading programs such as nutrient trading schemes, mitigation banking, and transfer of development rights were excluded because they are documented elsewhere.
- Land purchases for conservation purposes were excluded because such projects constitute real estate transactions rather than PES. Most programs that seek to protect watersheds through the acquisition of conservation easements were excluded for the same reason, and because the use of conservation easements in the United States has been documented by the Land Trust Alliance and others. However, we included several projects in which

conservation easements were used as a legal mechanism, specifically to protect watershed health while permitting the continuation of agricultural or forestry activities.

- Tax incentives (e.g., income, property, and estate tax provisions that encourage conservation outcomes) were excluded because information on such programs is already publicly available.

- Federal-only programs (e.g. Farm Bill programs) were excluded, as these mechanisms are well described elsewhere (EPA 2011).

- PWS schemes funded by federal and state grants were included as long as they supported innovative mechanisms or activities (e.g., new technologies and approaches under Conservation Innovation Grants and public-private partnerships).

- State-level programs were included, as long as they went beyond traditional cost-shares.

- Loans, education, and technical assistance without payment were excluded.

While we attempted to be as objective as possible in circumscribing the survey effort according to these criteria, the wide diversity of PWS project models meant that we encountered some ambiguous cases in which a PWS project did not fall clearly within or outside of the scope of this study. In these cases, we generally included the case in our initial assessment.

METHODOLOGY

In an effort to complement and expand upon prior research on PWS, we employed both systematic and opportunistic survey methods to identify the largest possible number of PWS schemes that met the above criteria. Program data and other information about PWS in the United States were collected through the following five methods:

1. **Interviews with experts and key informants:** Our initial objective was to clarify the state of knowledge about PWS in the United States, determine existing knowledge gaps, and identify key sets of actors involved in such PWS schemes. To do so, we interviewed 31 experts in PES and market-based environmental stewardship, identified through the authors' professional networks and recommendations of colleagues and early interviewees. These interviews provided information on: a) the range of PWS practices in the United States; b) specific candidate projects and programs to include in the survey; c) key gaps in the state of knowledge about PWS in the United States; and d) additional contacts for subsequent interviews.

2. **Literature review:** We reviewed published papers, gray literature, and websites related to PWS in the United States.

3. **Structured nationwide survey:** Based on the general characterization of the PWS field provided by the first two sets of activities, we developed and implemented an online survey to canvass professional organizations, networks, and others to identify PWS projects and programs on which the authors could follow up subsequently. The survey was announced through the e-mail lists and newsletters of relevant organizations, and through other targeted channels.[1]

4. **Data collection on specific PWS schemes:** Representatives of all relevant PWS programs and projects identified through the expert interviews, literature review, and online survey were contacted by phone or e-mail to collect more detailed information. For each scheme, we collected data in the following categories: general information, geographic information, actors involved, implementation status, compensation, watershed services provided, benefits and drawbacks, and ancillary effects of PWS. These data were entered into a Microsoft Excel spreadsheet. Additional qualitative aspects of each PWS scheme—including unique features, innovations, and lessons learned—were noted separately for subsequent analysis.

5. **Field work:** We conducted four site visits (one in Florida, one in Vermont, and two in Washington) to obtain a deeper understanding of how each PWS scheme functioned and to understand the more subjective benefits and challenges related to landowner participation and program management. During each field visit we interviewed the program managers and sellers (in all cases these were agricultural landowners) and visited sites where management practices were being implemented.

Initial research confirmed that there were no existing repositories, networks, or clearinghouses that have compiled data on the segment of PWS that is the focus of this study. Furthermore, it became clear that PWS is not always called by that name. For these reasons, the survey required an iterative process in which candidate schemes were identified and investigated in a limited way to determine whether they were indeed PWS. For those schemes that met the criteria for this study, we proceeded with full data collection. Thus, we collected and analyzed data at two levels:

[1] The following groups agreed to announce the survey to their members or stakeholders: Association of State Flood Plain Managers, Association of State Drinking Water Administrators, Association of Metropolitan Water Agencies, American Water Resources Association, National Association of Conservation Districts, National Association of Clean Water Agencies, Groundwater Foundation, Ground Water Protection Council, North American Lake Management Society, American Water Works Association, and National Rural Water Association. We also solicited responses to the survey from hundreds of conservation districts (including state and district offices) and farm bureaus. Additionally, we circulated information about the survey through a brochure, through EcoAgriculture Partners' newsletters and website, and at the Community on Ecosystem Services conference in Arizona in December 2010.

- Tier 1: We identified candidate projects and programs for which we entered basic descriptive data into the PWS inventory.

- Tier 2: Based on this information, we applied the criteria stated above to identify those schemes that fell within the scope of this study. For these projects and programs, we collected the full suite of data.

Although we sought to develop an inventory that is as comprehensive as possible, given the wide breadth of PWS activities and the lack of centralized information, it is likely that the inventory does not capture all such PWS schemes. We invite readers to contribute any missing or updated information to the Conservation Registry online platform. This can be done by any party and at any time.

3. Key Findings

The segment of PWS practice surveyed here is still very much in its early stages of development, with numerous pilot programs and innovative place-specific projects, but little evidence of replication or scaling-up of effective PWS models. We identified 140 schemes in our Tier 1 inventory, of which 32 met the criteria described in the Project Scope (see Table 1). Although the number of such schemes identified is larger than in previous reports, it is still modest at a national scale. In addition, many of the schemes we identified are in pilot or early implementation stages.

Geographic Distribution

The 32 PWS schemes in the Tier 2 inventory represent all regions of the country, with concentrations in the Northeast, Upper Midwest, and Pacific Northwest (see Figure 1). Table 1 provides basic information about these 32 projects and programs, while more detailed descriptions are available online through the Conservation Registry.

The focus of PWS schemes generally reflects the range of water-related concerns in different parts of the country. Scarce water resources and complex rights to water based on historical claims cause water quantity to be a greater concern in the West. On the other hand, the Midwest and Northeast face greater concerns with nutrient pollution, often related to the concentration and types of farming activities.

Looking more broadly at the 140 schemes in the Tier 1 inventory (which includes other PWS and PWS-type activities beyond the scope of this study), the western U.S. overall, and Oregon in particular, are hotspots of activity. We also identified numerous cost-share and other NRCS or conservation district programs, with high rates of enrollment in the Midwest, especially Minnesota and Illinois. The eastern U.S. has been the focus of much of the nutrient trading activity, particularly in the Chesapeake Bay watershed and surrounding areas. Surprisingly, we identified very few activities in the arid and semi-arid states in the Southwest, despite intense competition for water

Table 1. Key characteristics of the PWS schemes in the Tier 2 inventory

Projects are organized first by buyer type and then alphabetically by state. For additional information on each PWS scheme, see the Conservation Registry.

Name	State	Description	Status	Motivation	Buyer	Seller	Service
Public Buyers							
Mokelumne Watershed Project	CA	Funds provided to landowners for forest fire management.	Planning phase	Fire threats to drinking water; avoiding filtration costs	Intended buyer: water utility	Forest and agricultural landowners	Water quality for human consumption
Colorado River Water Bank	CO	Ranchers lease their water rights on a short-term or seasonal basis.	Planning phase	River flow has dropped and is nearing minimum flow rate required by law	Intended buyers: municipalities, conservation groups, and other farmers	Ranchers	Water quantity for human consumption and irrigation
Denver Water Forests to Faucets Program	CO	Fire management practices are funded in priority areas of U.S. Forest Service lands.	Active	Fire threats to drinking water; avoiding filtration costs	Water utility	U.S. Forest Service (private lands also eligible)	Water quality for human consumption
Republican River Project	CO	Payments were made to farmers to adopt water-saving irrigation technology and to compensate for any loss in yields.	Payment period is complete	Concern about increasing water scarcity	Conservation district	Corn producers	Water quantity for human consumption and in-stream habitat
Florida Ranchlands Environmental Services Project (FRESP)	FL	Ranchers were compensated for implementing water retention and nutrient management practices.	Pilot completed	Drainage of nutrient-laden runoff into coastal waters, and subsequent eutrophication	NGOs, research institutions, and state government agencies	Cattle ranchers	Water quality (nutrient loads) and water storage capacity on land
Northern Everglades and Estuaries PES Program	FL	Ranchers receive funds for proposed projects to manage phosphorous and increase water storage. This program is a scaled-up version of FRESP.	Rancher applications under review	Drainage of nutrient-laden waters into coastal waters, and subsequent eutrophication	Water management district	Cattle ranchers	Water quality (nutrient loads) and water storage capacity on land

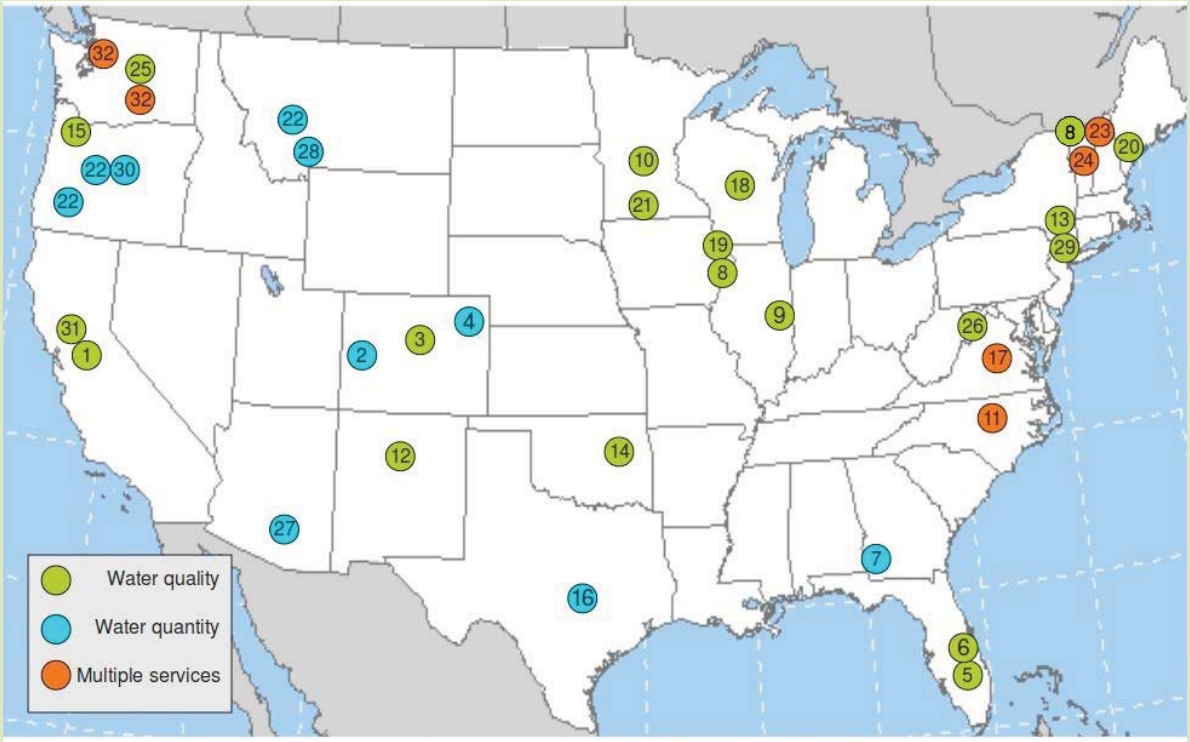
Name	State	Description	Status	Motivation	Buyer	Seller	Service
Flint River Basin	GA	Farmers can apply for payments to defray cost of adopting water-saving technology and practices.	Active	Impending water shortage, with potential increase in irrigation costs	NGO and USDA	Farmers	Water quantity for irrigation
Performance-based Incentives for Agricultural Pollution Control – Approach I	IA, VT	Farmers received payments based on increases in efficiency of phosphorous use.	Pilot completed	Widely recognized water quality issues in focal watersheds	NGO	Farmers	Water quality for wildlife habitat and human use
Upper Salt Fork Watershed Project	IL	Farmers receive payments per acre depending on nutrient management practice.	Active	Nutrient pollution in the Mississippi Basin and Gulf of Mexico	Conservation district and NGO	Farmers	Water quality for wildlife habitat and human use
Conservation Marketplace of Minnesota, Cold Spring	MN	Farmers are compensated for practices that reduce nitrogen runoff, and for lost revenue resulting from decreased fertilizer use.	Active	City of Cold Spring nearing federal nitrate limits in water under the Safe Drinking Water Act	City	Corn farmers	Water quality for human consumption
Upper Neuse Clean Water Initiative	NC	Forest owners are compensated through the purchase of working lands conservation easements.	Active	Sedimentation levels threaten drinking water quality	Land trusts	Forest landowners	Water quality for human consumption
Santa Fe Watershed Management Plan	NM	Fire management practices are funded in priority areas of US Forest Service lands.	Active	Fire threats to drinking water; avoiding filtration costs	City	U.S. Forest Service (private lands also eligible)	Water quality for human consumption
New York City Source Water Protection Program	NY	Watershed Agricultural Council provides technical assistance, funding for watershed-friendly management practices, and cash payments.	Active	Sedimentation and nutrient pollution threaten drinking water quality	City	Dairy and crop farmers	Water quality for human consumption

Name	State	Description	Status	Motivation	Buyer	Seller	Service
City of Tulsa Source Water Protection	OK	Farmers receive payments for conservation easements in riparian areas.	Active	Phosphorous levels are causing eutrophication of waterways	City and the Farm Service Agency	Livestock and crop producers	Water quality for wildlife habitat and human use
Clean Water Services	OR	Farmers plant riparian buffers to shade streams.	Active	Thermal pollution resulted in violations of thermal loading regulations	Water utility	Private landowners	Water quality for wildlife habitat
Edwards Aquifer Protection Program	TX	Ranchers receive payments for easements that allow continued grazing.	Planning phase	Current and future threat of water scarcity	City	Ranch owners	Water quantity for wildlife habitat and human consumption
Forest to Faucets Program	VA	Compensation covers riparian planting, site stabilization, and other management practices undertaken by forest landowners.	Pilot phase	Loss of forest cover leading to sedimentation that impairs drinking water quality	Virginia Department of Forestry	Forest landowners	Water quality for human consumption
Phosphorous Reductions Incentives Program	WI	Farmers are compensated to reduce phosphorous use through improved fertilizer application efficiency.	Planning phase	Phosphorous levels impairing waterways, leading to eutrophication	Conservation district	Farmers	Water quality for wildlife habitat and human use
Private Buyers							
Performance-based Incentives for Agricultural Pollution Control – Approach II	IA	Payments are allocated to farmers based on decreased phosphorous, nitrogen, and sediment runoff from practices.	Pilot phase	Widely recognized water quality issues in focal watersheds	Local watershed council (multi-stakeholder group)	Farmers	Water quality for wildlife habitat and human use
Crooked River Watershed	ME	Project covers costs incurred by farmers for practices that limit runoff.	Planning phase	Sedimentation and nutrient pollution leading to water impairment	Intended buyer: commercial water users	Forest, farm, ranch, and dairy owners	Water quality for wildlife habitat and human use

Name	State	Description	Status	Motivation	Buyer	Seller	Service
Ecological Commodity Pay Package (ECoPayPack)	MN	Farmers receive payments to cultivate and sell woody plants as biofuel feedstocks.	Planning phase	Nutrient pollution in surface water; market opportunities to produce and sell biofuel feedstocks	Intended buyer: private entities	Soy and corn farmers	Water quality for wildlife habitat and human use
Water Restoration Certificates	MT, OR	Farmers generate and sell certificates for in-stream water quantity achieved by water efficiency gains.	Active	Current and future water scarcity	Private entities (hotels, breweries, etc.)	Small-scale farmers	Water quantity for wildlife habitat and human use
Upper Connecticut River Watershed	NH, VT	Through a reverse auction mechanism, private landowners may propose and receive payments for watershed improvement projects.	Planning phase	Desire to maintain recreation and habitat resources	Intended buyer: private companies	Small-scale farm and forest landowners	Water quality and quantity for wildlife habitat
White River Partnership Landscape Auction	VT	Projects proposed by farmers were bid upon and funded at an auction.	Landscape auction completed	Desire to maintain health of watershed and rural lifestyle	University, community members, local businesses	Farm and forest landowners	Water quality for wildlife habitat and human use
Cullers Run Watershed	WV	Priority land parcels were targeted for payments and technical assistance for management practices that reduce nitrogen runoff.	Pilot phase completed	Nitrogen pollution leading to impairment of waterways	Research institute	Farmers	Water quality for wildlife habitat and human use
Entiat River Habitat Farming	WA	Orchard owners are compensated for lost income and maintenance costs from riparian buffers.	Planning phase	Endangered salmon and habitat threatened by water quality degradation	Intended buyer: private companies	Orchard owners	Water quality for wildlife habitat
Philanthropic Buyers							
Conserve to Enhance	AZ	Pilot project allows consumers to donate money from water savings to a restoration project.	Pilot phase	Current and future water scarcity	Water users	Currently a single landowner	Water quantity for wildlife habitat and human use

Name	State	Description	Status	Motivation	Buyer	Seller	Service
Montana Water Project	MT	Ranchers lease their water rights or are compensated for irrigation efficiency improvements.	Active	Current and future water scarcity	NGO	Ranchers	Water quantity for wildlife habitat and human use
Common Waters Fund	NY, NJ, PA	Funding is provided for development of forest stewardship plans and to defray the cost of management practices.	Pilot phase	Sedimentation and nutrient pollution leading to impairment of waterways	Water users	Forest landowners	Water quality for human use
Project Blue Water	OR	Fund from ratepayer donations goes directly to purchasing in-stream water rights from small-scale farmers.	Active	Endangered salmon threatened by water scarcity	Water users	Small-scale farmers	Water quantity for wildlife habitat
Eco-Certifications							
Water and Wine	CA	Grape growers benefit from outreach and marketing efforts and technical assistance for water conservation and storage practices.	Active	Endangered salmon threatened by water scarcity	NGO and wine consumers	Grape growers	Water quantity for wildlife habitat and irrigation
Salmon Safe Certification	OR, WA, CA	Producers benefit from outreach support and specialized market access for practices that maintain healthy aquatic habitat.	Active	Endangered salmon threatened by water scarcity and pollution	Consumers of agricultural products	Farmers and grape growers	Water quantity and quality for wildlife habitat

Figure 1. Map of PWS schemes in the Tier 2 inventory.



1. Mokelumne Watershed Project
2. Colorado River Water Bank
3. Denver Water Forest to Faucet Partnership
4. Republican River Project
5. Florida Ranchlands Ecosystem Services Project
6. Northern Everglades PES Program
7. Flint River Basin Project
8. Performance-Based Incentives – Approach I
9. Upper Salt Fork Watershed Project
10. Conservation Marketplace of MN
11. Upper Neuse Clean Water Initiative
12. Santa Fe Watershed Management Plan
13. New York City Source Water Protection
14. City of Tulsa Source Water Protection
15. Clean Water Services Thermal Loading Offsets
16. Edwards Aquifer Protection Program
17. Virginia Forest to Faucet Program
18. Phosphorus Reductions Incentives Program
19. Performance-Based Incentives – Approach II
20. Crooked River Watershed Project
21. Ecological Commodity Pay Package
22. Water Restoration Certificates
23. Upper Connecticut River Basin Project
24. White River Partnership Landscape Auction
25. Entiat River Habitat Farming
26. Cullers Run Watershed Project
27. Conserve to Enhance Program
28. Montana Water Project
29. Common Waters Fund
30. Project Blue Water
31. Water and Wine
32. Salmon Safe Certification - Stewardship Partners

PWS Buyers and Their Motivations

PWS buyers included a wide range of public and private actors, motivated by a desire to protect water resources for a variety of public and private purposes. Eighty-four percent of buyers sought to enhance environmental quality for public benefit, which includes human water consumption and wildlife habitat. Economic gains or cost savings drove 38% of buyers, while 16% of buyers identified experimentation and innovation as important motivations. The sum of these percentages exceeds 100% because some buyers have multiple motivations.

Public sector buyers

Thirty-nine percent of public schemes stemmed from a desire to reduce the costs of water treatment and filtration for public water supplies by protecting upstream water quality. PWS may be an attractive option when the cost of watershed protection payments is less than the cost of

filtration that would be required if surface water quality were diminished. Even when a filtration system is already in place, watershed management may decrease costs: for example, Todd and Weidner (2010) found that a 10% decline in forest cover can lead to as much as a 20% increase in chemical water treatment costs.

Cost-benefit analyses, while infrequently used in most non-public PWS schemes, are routinely conducted in public utility cases. Because of the high cost of constructing and maintaining water filtration plants, the consideration of alternatives involving "green" infrastructure instead of "gray" infrastructure can result in large savings. For instance, in perhaps the best-known example of PWS in the United States, New York City spends $167 million per year to encourage landowners in the Catskills watershed to adopt best management practices. By doing so, the City has thus far avoided the need to build a filtration plant that would have cost $6 billion in capital infrastructure plus $250 million per year in operation and maintenance costs. In water utility PWS schemes, the immediate buyer is typically a government entity or drinking water utility, but ratepayers usually provide the ultimate funding source.

Among public buyers, preemptive action to avert potential regulation (39% of public schemes) also figured prominently, particularly among cities or regions plagued with nutrient runoff problems. In the West, ensuring the future reliability of public water sources is a critical driver, accounting for 17% of public schemes, such as those in Yuma County in Colorado, and the city of San Antonio, Texas. Clean Water Services, a public water treatment company in Oregon, was the only identified PWS scheme to mitigate thermal loading (in this case, to protect salmon populations).

Private sector buyers

Eight of the identified PWS schemes involve private businesses as buyers of ecosystem services to help secure or maintain their business interests in clean, abundant water. However, while these programs seek to attract private sector buyers at a larger scale, all are currently in the start-up phase, during which they are funded primarily or exclusively by grants or foundations. Of the PWS schemes with private sector buyers, half are addressing the future possibility of regulation (largely in relation to endangered salmon and nutrient pollution), while a conservation ethic or corporate social responsibility drive another 38%.

The ultimate intended buyers in these schemes include private entities such as breweries, hotels, biofuel refineries, and sporting groups. For instance, the Water Restoration Certificates program developed by the Bonneville Environmental Foundation is seeking to recruit buyers in the hotel and beverage industries. Payments from these buyers, as well as technical assistance supported by program funds, would be channeled to private landowners to help conserve priority water resources.

Philanthropic buyers

Several PWS schemes were funded by the voluntary contributions of water users to support watershed enhancement projects. One example is Project Blue Water in Oregon, led by the Deschutes River Conservancy and focused on increasing in-stream flow through the lease of in-stream flow water rights. The project started through the initiative of the quasi-public Avion Water Company and is sustained through voluntary contributions of ratepayers. The donated funds go into the Deschutes River Conservancy leasing program, which works with about 200 landowners each year. Interestingly, only about half of the participating landowners receive payments. The rest participate because they derive value from retaining their water rights pursuant to Oregon law, which requires such rights to be forfeit if they are not exercised every five years. Leasing water rights for in-stream use fulfills this requirement and allows the right-holder to maintain the option to use the water in the future.

For the purpose of this report, pilot testing of novel PWS mechanisms funded by grants and NGOs is included in the "Private buyers" categories where the ultimate goal is to establish self-sustaining PWS schemes supported by private buyers.

Eco-certification

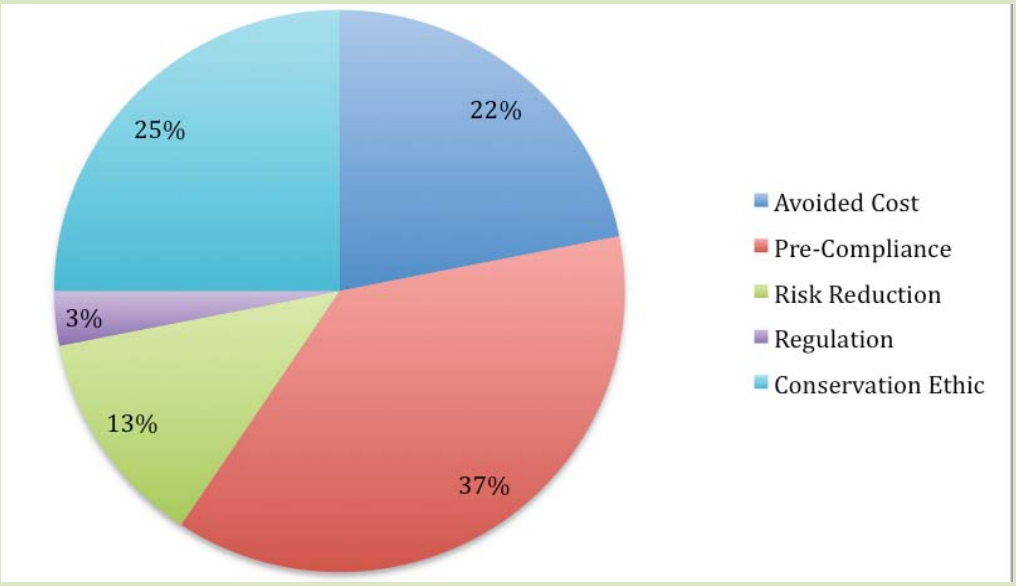
Voluntary eco-certification offers farm and forest producers an opportunity to differentiate their products and demonstrate a commitment to environmental protection. Eco-labels have traditionally been analyzed in the context of a PES framework (Wunder 2005) as they may provide an indirect economic incentive for providing ecosystem services. Producers typically receive a price premium for eco-labeled products, along with access to specialized markets. By purchasing eco-labeled products, consumers provide indirect financial support for the ecosystem services that the label seeks to protect.

For example, a grocery cooperative chain in the Puget Sound region of Washington State seeks out produce certified as Salmon Safe for its environmentally-conscious consumer base. This certification aims to protect water quality and aquatic habitat for salmon. Trout Unlimited's Water and Wine initiative focuses on preserving in-stream flows for salmon habitat by increasing water-use efficiency on vineyards. Not only do the water conservation measures save landowners money in the long run; outreach and marketing support provided by Trout Unlimited also provides grape growers additional assistance for selling their wines.

Buyer motivations

Overall, PWS buyer motivations fall into a handful of categories: avoided costs, risk reduction, regulation, pre-compliance, and a conservation ethic. Avoided cost drivers are those in which PWS is used to prevent the need for a more expensive alternative. Risk reduction refers to efforts to address an impending threat to watershed services, such as a scarce water resource that would impact drinking water or irrigation needs. Pre-compliance consists of pro-active actions to prepare for the possibility of future regulation. Figure 2 depicts the primary motivation of PWS buyers for the 32 PWS schemes in the Tier 2 inventory.

Figure 2. Primary buyer motivation in 32 surveyed PWS schemes



Funding sources for PWS schemes

In addition to surveying the immediate purchaser of watershed services, we identified the ultimate source of funding for each PWS scheme. While this funding source is often the same as the proximate buyer, in some cases it differs (see Figure 3). For instance, water rate payers are usually the ultimate funding source for public PWS initiated by water utilities. Over one-fourth of the schemes obtained funding from multiple sources, often including both federal and private dollars. Private entities and ratepayers comprised the bulk of funding sources for private sector and philanthropic buyers and eco-labels.

Solely government-financed (federal, state, or local) projects constitute over one third of those identified. While this study does not include federal conservation programs *per se*, nearly two-thirds of the surveyed PWS schemes received some form of funding, technical assistance, or both, from

the federal government (Figure 4). These funds were provided through a variety of grants from different federal agencies, channeled through intermediaries such as local conservation organizations or public or quasi-public agencies. The 35% of PWS projects with no federal support tended to involve public utilities, cities, or private entities as buyers of watershed services. Note, however, that landowners receiving such payments may also be eligible for (and receive) financial and technical assistance from federal sources, separate from the PWS project.

Figure 3. Ultimate sources of funding in 32 surveyed PWS schemes

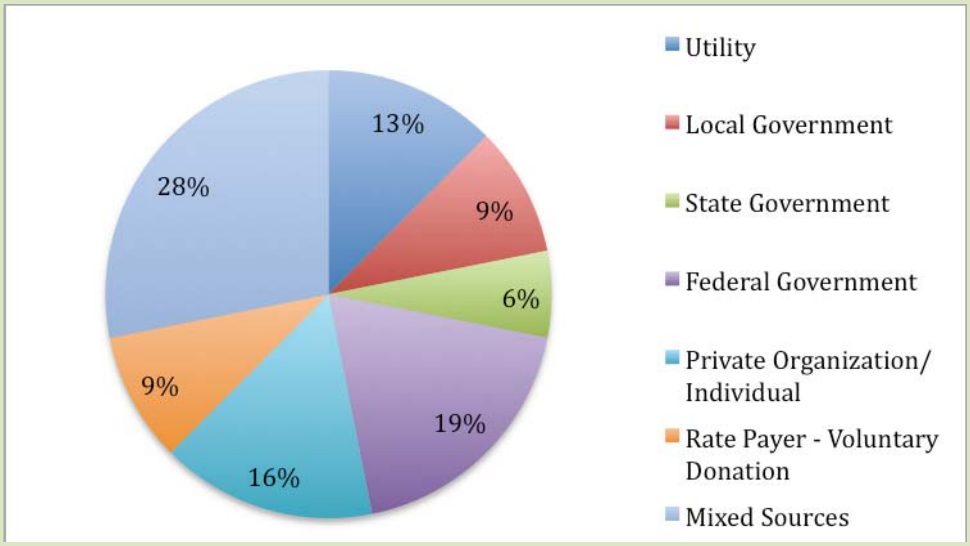
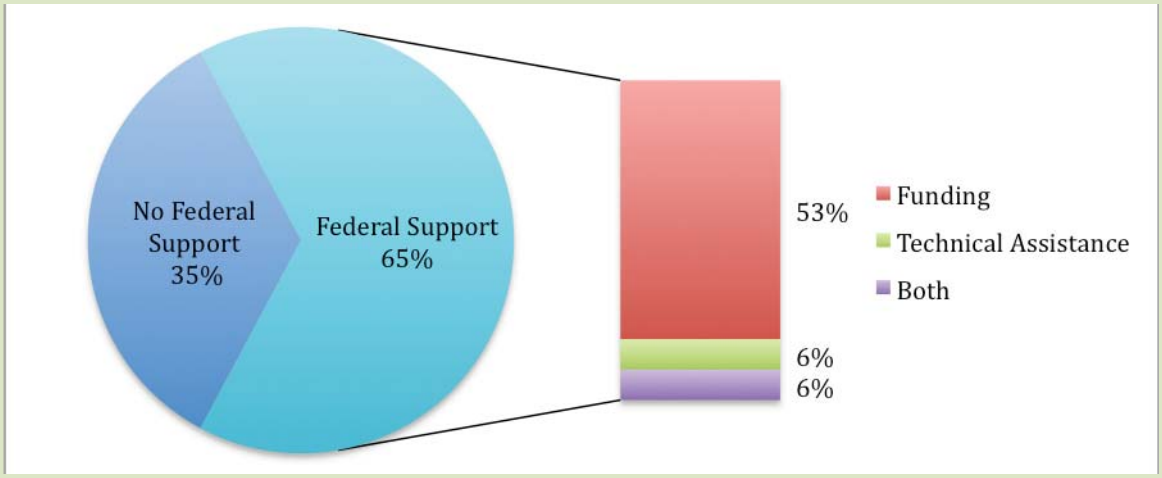


Figure 4. Federal role in 32 surveyed PWS schemes



PWS Sellers and Their Motivations

Consistent with prior studies of PES, we found that landowners usually have multiple reasons for participating in PWS. These reasons include cash payments, various non-cash financial benefits (e.g., new infrastructure or physical improvements to land, increased agricultural yields or reduced costs associated with the adoption of new practices), access to information and technical assistance, personal interest in environmental stewardship, and other intangible values and objectives. The relative frequency of these motivations is depicted in Table 2.

Table 2. Primary and secondary seller motivations for participating in PWS

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%

* Total exceeds 32 (number of schemes in the Tier 2 inventory) because some sellers had multiple secondary motivations.

While cash payments were reported as the primary seller motive in 41% of schemes, environmental stewardship is also important for sellers. In fact, the combined primary and secondary motivations for stewardship (78%) exceed that of the cash payment (60%). Despite the importance of cash payments as a motivating factor in most PWS schemes, such payments alone are unlikely to attract sellers since payment amounts are often quite small. Rather, they may act as the final enabling factor: for landowners that have a predisposition toward environmental stewardship, a program that covers the cost of such stewardship, with even a modest bonus payment, can encourage a landowner to adopt practices that they had wanted to, but could not justify without the payment. Cash payments may also be necessary to cover the initial investment cost for practices that are likely to yield long-term financial as well as environmental benefits (Scherr *et al.* 2007).

Our interviews revealed that the environmental stewardship ethic could motivate sellers at several different levels (see Box 2). At a personal level, environmentally sound stewardship is often a source of pride: several landowners mentioned the satisfaction they gain from seeing streams return to the healthier condition of their childhood and knowing that the land will continue to produce for future generations. Many landowners and managers also perceive farm and forest sustainability to be closely linked to their livelihood, and landowners understand measures that need to be taken on their land in order to ensure that sustainability (see Box 3). Finally, some farmers see the provision of

ecosystem services to be a responsibility they owe to their community and society at large. That said, a stewardship ethic alone is often not sufficient to enable the adoption of better management practices, especially when there are costs involved.

In addition to cash payments and environmental stewardship, agricultural and forest landowners consider non-cash financial benefits when contemplate participation in PWS. These benefits include infrastructure improvements, stability in production resulting from better practices, savings in time and labor (e.g. conservation tillage practices), reductions in input costs (e.g. less fertilizer), and higher yields that may result from sustainable practices. With some such practices (e.g. infrastructure improvements) that improve yields or profitability, farmers should benefit even in the absence of PWS. Non-cash financial benefits can be significant, and may reduce the level of cash payment needed to motivate landowners to participate in PWS.

Access to technical assistance may also be a key driver of landowner participation in PWS, and the benefits of such assistance can be significant. For example, farm analyses and farm management plans that are provided free of charge as a part of PWS programs can result in significant yield increases and improvements in farm sustainability. Therefore, even if the actual PWS payment is small, the landowner may benefit substantially.

When making the decision of whether to enroll in PWS, landowners may consider not only the annual economic value of the benefits offered, but also how these fit into an overall strategy of risk management, cash flow, and flexibility in operations. Some experts and program managers reported that the regularity of payments was a strong incentive for sellers. In other words, even if the payment is small, landowners can count on receiving it at specific times, which reduces risk and may stabilize cash flow.

Box 2. White River Partnership Landscape Auction, Vermont

On a snowy morning in March, I traveled to Royalton, Vermont, to meet Mary Russ of the White River Partnership (WRP). WRP works to improve the health of the White River watershed by engaging landowners and the local community in restoration and education. In summer 2010, the organization carried out a landscape auction funded by an NRCS Conservation Innovation Grant, in which landowners from around the watershed proposed projects on which auction attendees could bid. While Europe and Australia have experience with landscape auctions, the model was largely untried in the United States. Landscape auctions seek to enhance ecological benefits while preserving a rural way of life. Farmers propose projects that accomplish these goals, but are not necessarily solely based on cost-efficiency for a specific service.

After Mary gave me an overview of the auction, its participants, and key outcomes, we headed up the road to Fat Rooster Farm. Jen Megyesi operates the farm's 30-plus acres, which support sheep, cows, chickens, a llama, and about two acres of vegetables. Trained as a wildlife biologist with experience working for the U.S. Fish and Wildlife Service, Jen understands her farm as an ecosystem that supports flows of water and wildlife, not just meat, milk, and produce. Field health, water flow patterns, invasive species, native and endangered wildlife, and bird habitat all factor into farm management decisions, such as when and where to pasture her livestock.

Jen Megyesi on the snow-blanketed Fat Rooster Farm

One of the projects Jen proposed for the WRP auction was a "floating" riparian buffer and easement that would automatically move with the course of the river as it meandered across her land from year to year. For Jen, the auction offered a way of funding improvements she had planned for the land, but would not be able to implement without additional funds. Jen's neighbor Carl Russell felt the same way. He works land that has been in his family since 1938 and focuses his priorities more on making the land's production sustainable than on maximizing profit.

There are many farmers like Carl and Jen that are conservation-minded, but do not necessarily have the opportunity to experiment with innovative management practices in the context of their usual operations. For both farmers, the most compelling motivation to participate in the auction was the desire to act on their conservation ethic and serve as an example for others; the auction provided the funds to allow this to happen.

Case study researched and written by Rachel Friedman

Box 3. Restoring Old Florida with New Money

A slow drive on a rainy day around Mud Lake on Rafter T Ranch in central South Florida feels like a step back in time. Mud Lake, just three feet at its deepest, is reminiscent of the slowly flowing "river of grass" that was the Everglades before engineers and developers channeled its water into tight canals and levied Lake Okeechobee. Here, cormorant and anhinga roost atop the dozen cypress stands scattered around the 154-acre lake. The Audubon Society recently visited and counted nearly 50 bird species.

Mud Lake, and its resident flora and fauna, did not exist before Rafter T's owner and manager, Jimmy Wohl, enrolled in the Florida Ranchlands for Environmental Services Project (FRESP). "Bottom line," says Jimmy, "there's been a lot of money spent out here that we didn't provide, and it's brought a lot of benefits to us and to the environment." FRESP has paid Jimmy to maintain Mud Lake as a retention pond, part of a larger on-ranch water management system. Ranch production has not been affected by the improvements in ecosystem health. In fact, these changes have created the potential for commercial tourism.

FRESP was initiated in 2005 by the World Wildlife Fund, ranchers, researchers, and state and federal agency partners as an innovative mechanism to encourage ranchers to be good stewards of the land. The project uses a payment for ecosystem services model to encourage ranchers to adopt economically viable water management practices that contribute to ecosystem restoration in the northern Everglades. Payments assist ranchers in keeping more water on the land longer, to improve filtration of nutrients such as phosphorus that pollute downstream waters. Eight ranches participated as part of this pilot project. As of 2011, the original FRESP pilot project has been scaled up in the form of the Northern Everglades Payments for Environmental Services Program, administered by South Florida Water Management District.

Long aware of the high phosphorus levels and other water quality issues in the area, Jimmy immediately signed on when FRESP was launched. In harmony with natural water flows, he built a series of simple culvert-and-board structures that allow for easy management of on-ranch water. In addition to the highly visible increase in native pond life, the FRESP team estimates that Rafter T now retains 850 acre-feet of water (the equivalent of 425 Olympic-sized swimming pools) and almost 700 pounds of phosphorus each year. Perhaps what is so appealing to a natural adaptive manager like Jimmy is that the market- and results-based structure of FRESP allows him the freedom to respond to changing circumstances on the ranch. Many ranchers will agree when he asserts: "I know my land, and I know what it takes to get results, and it's different every day. Pay me to provide ecosystem services, and I'll provide those ecosystem services and then some!"

Case study researched and written by Courtney Wallace

WATERSHED SERVICES AND ASSOCIATED BMPS

Most of the identified PWS schemes explicitly targeted one, two, or three types of watershed protection services. In addition, some schemes had incidental benefits for other watershed protection services (see Table 3). The majority of PWS programs sought to improve water quality through reduced nutrient pollution (53%), regulate water quantity (47%), and/or reduce sedimentation (41%). If ancillary benefits are also included, supporting wildlife habitat, whether for recreation or conservation purposes, also ranks highly (63%).

Table 3. Watershed services (targeted and incidental) sought by PWS schemes

Watershed protection services	Targeted: # of schemes*	Targeted: % of schemes	Incidental: # of schemes	Incidental: % of schemes
Water quality: nutrient pollution mitigation	17	53%	5	16%
Water quantity regulation	15	47%	2	6%
Water quality: reduced erosion/sedimentation	13	41%	7	22%
Wildlife habitat support	7	22%	13	41%
Water temperature control	2	6%	0	0%

* Total exceeds 32 (number of schemes in the Tier 2 inventory) because many PWS schemes targeted multiple watershed services.

PWS programs provided payments for a wide range of management practices, including infrastructure improvements (50%), livestock fencing (34%), riparian buffers (53%), afforestation or planting (34%) (see Table 4). The great majority of programs offer participating landowners a menu of options from which to choose. However, some require specific practices. For instance, riparian buffers were obligatory in 13% of schemes, while fire management practices such as thinning and prescribed burning were mandatory in 9% of schemes. Three of the schemes also required the creation of a farm management plan to target best management practices.

Table 4. Best management practices in PWS schemes

Management practices	# of schemes*	% of schemes
Riparian buffer vegetation	17	53%
Infrastructure	16	50%
Livestock fencing	11	34%
Afforestation/planting	11	34%
Fertilizer management	8	25%
Cover crops	8	25%
Irrigation/water-use efficiency	6	19%
Fire management	5	16%
Waste management	4	13%
Conservation tillage	4	13%
Change in crops	4	13%
Wetland restoration	3	9%
Invasive species removal	2	6%

* Total exceeds 32 (number of schemes in the Tier 2 inventory) because PWS many schemes target multiple watershed services. Depending on the scheme, these practices are often offered as a menu of options from which landowners can choose.

MONITORING AND IMPACT ASSESSMENT

For the most part, the inventoried PWS schemes did not place a strong emphasis on monitoring and impact assessment. Because it is typically expensive and complex to demonstrate relationships

between field-level best management practices and changes in water quantity and quality, only a few of the identified PWS schemes attempted to document project impact at this level. Instead, most programs were predicated on previously-documented or inferred linkages between land use, agricultural management practices, and water quantity and quality based on prior research. Where these linkages are well documented, the practices themselves may serve as proxies for ecosystem service provision that are sufficiently precise that monitoring of practices is an adequate substitute for monitoring of ecosystem services.

Table 5. Monitoring activities of PWS schemes
Projects are organized first by buyer type and then alphabetically by state. For projects still in the planning phase or early stages of development, planned monitoring activities and entities are included.

PWS Scheme	Monitoring Activities	Monitoring Entity (role)
Mokelumne Watershed Project	Plans to include water quality monitoring at watershed level	Utility (buyer)
Colorado River Water Bank	Plans to include stream flow tests as well as streamside walks at project sites for qualitative assessment	Municipalities (buyer)
Denver Water Forest to Faucet Partnership	Field verification of adoption of practices; sediment load measurements	U.S. Forest Service (seller)
Republican River Project	Annual monitoring of crop yields and agricultural water use; baseline monitoring of well levels	Landowner (seller); Yuma County Conservation District (buyer)
Florida Ranchlands Environmental Services Project (FRESP)	Comprehensive water quality and phosphorous loads testing at sites; water quantity tracking	FRESP team (buyer and project administrator)
Northern Everglades and Estuaries Payments for Ecosystem Services Program	Water quality and phosphorous loads testing at sites; water quantity tracking	Florida Department of Agriculture and Consumer Services; Florida Department of Environmental Protection; NRCS (technical assistants); South Florida Water Management District (buyer)
Flint River Basin	None planned	Not applicable
Performance-Based Incentives for Agricultural Pollution Control - Approach I	Phosphorous index measurements at the field level	Winrock International; University of Vermont; Iowa State University Extension (project administrator)
Upper Salt Fork Watershed (part of Mississippi River Basin Initiative)	Nutrient runoff measurements on several fields to assess impacts on water quality	Champaign County SWCD (buyer); University of Illinois (technical assistant)
Conservation Marketplace of Minnesota - Cold Spring Project	Monitoring wells were installed for future groundwater monitoring; plans to use Nutrient Tracking Tool in the future	NRCS/City; Crop Consultant (technical assistants)
Upper Neuse Clean Water Initiative	Annual site visits to assess easement compliance	Land trust (technical assistant)
Santa Fe Watershed Management Plan	Field verification of adoption of practices; sediment load measurements; ongoing U.S. Forest Service research and monitoring	U.S. Forest Service (seller)
New York City Source Water Protection Program	Site visits and construction inspections	Watershed Agricultural Council (project administrator)

PWS Scheme	Monitoring Activities	Monitoring Entity (role)
City of Tulsa Source Water Protection	Annual site visits for easements	Land trust (technical assistant)
Clean Water Services	Site visits to assess plant diversity and invasive species; canopy cover assessment with GIS and LiDAR	Utility (buyer); contractors (technical assistant)
Edwards Aquifer Protection Program	Plans to include stream flow tests around watershed; conservation easement site visits	Edwards Aquifer Authority; land trust (technical assistant)
Virginia Forests to Faucets Initiative	Comprehensive water quality monitoring at project sites	VA Department of Forestry (seller)
Phosphorous Reduction Incentives Program	Phosphorous index measurements at the field level	Conservation District (buyer); Wisconsin Department of Natural Resources; University of Wisconsin-Steven's Point (technical assistants)
Performance-Based Incentives for Agricultural Pollution Control - Approach II	Phosphorous index measurements, Cornstalk Nitrogen Test, Sediments, long-term water quality monitoring at sites	NRCS ; Iowa State University Extension (technical assistant); Winrock International (project administrator); Farmer (seller)
Crooked River Watershed Project	Anticipated to include general water quality monitoring	Currently Manomet Center for Conservation Sciences; anticipated to shift to land trust (project administrator)
Ecological Commodity Pay Package (EcoPayPack)	To be determined	To be determined
Water Restoration Certificates (WRC)	Anticipated to include documentation of water use and tracking of in-stream flow rates	Local land and water trust (technical assistant)
Upper Connecticut River Basin Project	To be determined	Forester and landowner (seller)
White River Partnership Landscape Auction	Site visits to verify implementation of proposed practices	White River Partnership or easement holder (buyer)
Cullers Run Watershed Project - Lost River Watershed	Water sampling; baseline data for watershed already exist	Cacapon Institute, West Virginia University (project administrator)
Conserve to Enhance	To be determined	To be determined
Common Waters Fund	Site visits to verify implementation of proposed practices	Common Waters Fund partners; regional forestry expert (technical assistants)
Montana Water Project	Site visits to verify adoption of practices	Trout Unlimited (project administrator)
Project Blue Water	To be determined	Anticipated to be land trusts (project administrator)
Entiat River Habitat Farming	Fish numbers throughout watershed are already being monitored	Hydropower plant (buyer)
Water and Wine	Document in-stream flows at watershed level	Conservation Organization (project administrator)
Salmon Safe Certification - Stewardship Partners	Annual site visits; re-certification assessments every three years	Conservation Organization (project administrator)

Monitoring of practices was accomplished in various ways, including self-reporting and field inspections. In addition to the use of proxies, some PWS schemes did conduct monitoring of water quality and quantity, although such monitoring typically did not document cause-and-effect relationships between the practices resulting from PWS and the observed watershed attributes. Field monitoring activities included annual inspections and property walkthroughs, streamflow testing, sediment load measurements, water quality testing, nutrient runoff measurements, land cover inspections through satellite imagery, and soil testing. PWS scheme managers were frequently concerned that funding did not cover baseline measurements, thus making it difficult to demonstrate impact over time. See Table 5 for a summary of monitoring activities in each PWS scheme.

An additional challenge associated with PWS monitoring is that changes in watershed characteristics may be mediated over large spatial and temporal scales. Most of the identified PWS schemes are modest in size, and the collective impact of each program, while not insignificant, may be difficult to disentangle from other changes taking place in the watershed simultaneously. Some of the management practices encouraged by PWS programs may not show results on environmental health for years, while others (e.g. reduced fertilizer usage) may affect water quality almost immediately. These factors are additional reasons why most of the identified PWS schemes chose to focus on monitoring practices as proxies for environmental benefits.

4. Discussion and Implications for the Future of PWS

As documented by this study, there is a wide range of emerging PWS models for watershed protection and management in the United States. The aggregate scale of the 32 PWS schemes identified through this research is much smaller than that of other watershed protection tools, such as conservation easements or Farm Bill conservation programs. In addition, many of the identified PWS schemes are still in the planning phase or were implemented as small-scale pilot programs.

However, these approaches have considerable potential for wider application to foster cost-effective environmental stewardship of private lands. Some of the larger PWS schemes illustrate that PWS can provide an effective approach to watershed protection over large scales. For example, the New York City source water protection project achieved 93% participation of landowners in the targeted areas of the 1,900 square mile watershed, thus enabling the watershed to continue to provide clean, unfiltered water to New York City's residents. However, even the smaller PWS projects tend to be designed and implemented to support watershed functions and services operating at larger scales.

Among the most promising findings of this study was the high level of local leadership and innovation emanating from landowners and local organizations, tapping into local knowledge bases, and building trust through community networks to initiate effective watershed protection projects. The Colorado River Water Bank and Entiat River Project are both examples of schemes born out of innovative thinking by producers who sought to meld their deep understanding of the land with financial realities of farm management and ecosystem service markets to develop feasible watershed management approaches. In many cases, PWS incentives were structured to harness the creativity of landowners by using performance measures or reverse auctions to enable landowners to design and develop the most cost-effective, context-appropriate methods for reaching watershed protection goals.

The fact that PWS often represents locally-derived, context-specific solutions to local water-related problems means that many of the PWS models identified in this study cannot likely be copied or replicated widely without modifications. However, lessons and experiences from this first generation of projects can inform local actors in other watersheds to design their own customized solutions that draw on elements of PWS program design that have already been tested and applied elsewhere.

Although the PWS approaches documented in this study have been much less widely used than several other watershed protection mechanisms, they can nonetheless be an important complement to traditional conservation approaches. Compared to land acquisition, for instance, PWS may be less expensive, more flexible, and more consistent with local interests in maintaining rural lifestyles,

private property ownership, and active agriculture and forestry uses. Although PWS shares elements in common with conservation easements (and conservation easements were used as a legal tool in some of the surveyed PWS schemes), PWS is generally a superior tool for ensuring the pro-active adoption of specific best management practices on private lands.

There is significant potential for expanding the effective use of innovative PWS practices in the United States. To do so, however, several challenges will need to be addressed and opportunities harnessed to formulate self-sustaining PWS projects. Perhaps most critically, ecosystem services buyers must be motivated to participate. At present, many watershed service beneficiaries either are not aware that they rely heavily on such services, are not aware that such services may be in jeopardy because of inadequate watershed stewardship, or do not feel compelled to compensate ecosystem service providers because they can continue to receive the services for free.

In the case of some private buyers (e.g., industrial and agricultural water users) or philanthropic buyers, demand for watershed services may be motivated through educational or outreach campaigns demonstrating, for instance, the critical natural resource constraints on specific business sectors (hydropower, irrigated crop production, etc.) or the level of consumer demand for responsible corporate behavior with regard to watershed protection. Private philanthropic buyers are mostly motivated by a conservation ethic, which can also be cultivated through education, outreach, and awareness campaigns.

In other instances, public policies may be the most effective way of spurring buyer demand. For instance, buyers in many of the identified PWS schemes were motivated by current or impending regulations. To the extent that new watershed protection regulations are proposed or implemented, PWS may become more prevalent as a cost-effective means of complying with such regulations. The interest of public sector buyers in PWS is likely to increase as water resource scarcity and growing water demand place increasing stress on public drinking water supplies and other publicly-managed water resources.

Given that federal and state grants and cost-shares were a key funding component for many of the surveyed PWS schemes, the future availability of such grants—as well as the ability of PWS project implementers to access and creatively leverage such funds—will likely strongly influence the future growth of PWS. To the extent that PWS is shown to be a cost-effective and societally beneficial approach to watershed protection, the increased use of public funds for this purpose should be promoted.

Based on our surveys, landowner interest is not a major constraint for scaling-up effective use of PWS. In general, landowners were inclined to participate in PWS for a variety of reasons, with cash payments, non-cash benefits, and intangible goals all playing a prominent role as motivating factors.

Monitoring and impact assessment to link land management practices to improvements in environmental quality remains a weak link in PES in general, and the PWS schemes in this study were no exception. However, to put this issue into perspective, it is important to note that many other conservation approaches (e.g., Farm Bill conservation programs, conservation easements, and land acquisition) face the same challenge, and often make little real effort to link conservation payments or activities to measurable improvements in conservation objectives. In fact, many of the identified PWS schemes (particularly the pilot projects) were conducting substantial monitoring to characterize baseline conditions, evaluate the effect of different management practices on specific ecosystem services, and assessing the feasibility of the project model. This type of project monitoring, combined with scientific research on the relationships between land management practices and watershed functions and services, is essential to establish an evidence base that will bolster the credibility of PWS and improve future program design and targeting.

This study revealed a few critical knowledge gaps and directions for future research and innovation on PWS. First, follow-on surveys will be helpful for tracking the evolving practice of PWS in the United States. Based on the methodology and infrastructure set up by this project, updates may be implemented in a decentralized manner by encouraging PWS project managers to upload project data to the Conservation Registry. To this end, the Conservation Registry site should be publicized and promoted within the relevant communities of practice. Second, research on the economics and relative cost-effectiveness of PWS as a watershed protection approach would be valuable both to inform the design of future PWS schemes and to guide policy choices related to watershed management. For instance, research that explores the question "under what circumstances is PWS the most cost-effective option for meeting water quality or water quantity objectives" could assist policymakers in designing incentives and allocating public funds to achieve the greatest conservation benefit at the lowest cost. Reliable data on financial aspects of PWS schemes were generally not available through interviews, and would require additional dedicated study of this specific aspect.

Finally, additional research is needed to develop and test tools that facilitate low-cost monitoring of the impacts of land management practices on ecosystem services across multiple spatial and temporal scales. While field monitoring will always be necessary—and participatory approaches may be developed to enable landowners to self-report environmental changes in a more rigorous manner—remote sensing technologies, GPS, and other tools will also need to be deployed more effectively. Methodologies must also consider effects of management practices within the wider landscape and watershed context.

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