Payment For Ecosystem Services:

Structural and Practical Barriers to Success

by

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ABSTRACT

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Payment for Ecosystem Services (PES) represents a conservation tool that compensates landowners for management practices that maintain or enhance production of desired ecosystem services. Unlike regulatory approaches, PES incentivizes rather than penalizes landowners to achieve desired environmental results. Scrutiny of PES programs effectiveness and success is purported by academia, practitioners and associated literature. Defining successful PES programs may be compromised due to inherent structural and practical barriers associated with such programs. Through implementation of interviews, surveys, literature review, and case study analysis, this research identifies, categorizes and analyzes structural, theoretical and practical concerns reported in academia and related journals with goals of deciphering barriers to success. Four categories of economic, environmental, political and social provide a lens for broad analysis, while looking at program type identify specific barriers. Results indicate barriers do exist making definition and operation of successful PES programs difficult.

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Chapter One: Introduction

Growing concern over environmental degradation leading to disruption of vital ecosystem services that provide benefits to society is prompting many governments, environmental groups, and stakeholders involved with natural resource management to look for different approaches to environmental governance. Environmental regulations and social responsibility do not adequately protect ecosystems providing clean air, clean water, carbon sequestration, and maintaining biodiversity. Payment for Ecosystem Services, or PES, is promoted as a novel and efficient approach to environmental governance, with many international and local programs in operation. Paying landowners to partake in management practices that increase desired ecosystem services seems straight forward; however, linking land management practices to environmental outcomes can be difficult. With their recent surge in popularity, concerns have been raised regarding PES programs effectiveness in obtaining their stated goals and missions. Combinations of economic, political, scientific, and social goals make measuring and defining success difficult.

The purpose of this research is twofold: to create a literature review that identifies barriers contributing to the difficulties in operating successful PES programs, and second; to assess if acknowledged barriers constitute high concern to current PES practitioners operating within the United States. Aggregating prominent concerns in the literature and academia will prove useful to current and future PES program stakeholders as program managers and policy makers are provided with one location to access a prioritized list of current PES issues containing explanations of concepts, current standing within journal publications, and a comparison of how program managers operating in the US perceive

these issues. Furthermore, investigation into practical and operational components of PES programs, and current program managers' satisfaction with these components, provides pertinent information in assessing successfulness of PES programs individually and as a whole.

A survey encompassing perceived success of PES programs in relation to their stated mission, satisfaction levels with individual program components, and level of concern associated with potential barriers to establishing, operating, and accurately identifying successful PES programs provides means for comparison between accepted barriers in literature and real life PES applications. Derived from the literature are sixteen structural and theoretical concerns that may pose barriers to operating and defining successful PES program. To be successful, a PES program must collectively address environmental, economic, political, and social concerns, creating a program which provides more of the desired ecosystem service while satisfying the needs of all the stakeholders involved. Through initial literature reviews, two interviews with existing PES programs, and consulting with the Washington State Department of Natural Resources, a list of twenty-three potential practical application barriers was accumulated. Based on these acknowledged barriers, a sixty-seven point survey was constructed and delivered to forty-three PES programs operating within the US, with thirty surveys returned. Finally, six interviews with PES program directors from distinctively different programs goals provide additional qualitative data.

Results indicate structural and practical barriers to defining successful programs do exist, with highest concerns revolving around economic and political issues. Considering only practical barriers, program managers were dissatisfied with transaction

costs, availability of willing buyers, funding for transactions, implementing adaptive management, working with elected officials involved, and motivation of buyers. Validated structural barriers comprise of economic tradeoffs, commodification of nature's services and up-priced resources, working within a collaboration framework, implementing adaptive management, trade-offs due to targeting individual ecosystem services, leakage, adhering to multiple goals, crowding out socially responsible behavior and proving additionally.

This paper continues with an explanation and definitions of PES, laying out historical, theoretical, and background information necessary to understand foundational reasoning. Following, a literature review will provide insight into current structural, theoretical and practical components of PES, detailing each issue with explanations and thought behind concerns. Next, descriptions of methodologies employed in research clarify intent, followed by results, and allowing for discussion and analysis of results on an individual, aggregate, and program specific level. Conclusions and future recommendations close the paper.

Background

Ecosystem services can be defined as benefits that natural ecosystems provide society, such as clean air, clean water, flood mitigation, carbon storage, harboring biodiversity, and recreation. Without benefits of ecosystem services, life would not be possible for human and non-human animals. With an understanding of ecosystem services, PES broadest definition can be comprehended. Ronald Muradian provides the most accepted definition, conceiving PES as "a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land-use

decisions with the social interests in the management of natural resources." (Muradian, Corbera, Pascual, Kosoy, & May, 2010, p. 1205). PES offers a framework allowing for exchange of payment, cash or in-kind, to producers of ecosystem services to maintain or enhance production of desired services with payment costs bore by recipients of services, or provided by government or non-government organization grants.

To exemplify a typical PES program, consider an average city's water utility. A utilities obligation comprises of delivery of clean, potable water to their customers, with water sources typically sourced locally, such as a river, stream or aquifer. To filter water, a city may invest in a water treatment plant, invest in natural capabilities of upland ecosystems for filtration, or most often a combination of both. For this scenario, assume upstream land is working forestlands. If forest owners undertake practices such as clear cutting or selling land for development, a decrease in water quality develops downstream as these land practices increase sediments and pollutants, resulting in increased filtration costs for water utilities. A compromise may be paying forest owners to change management practices protecting riparian and sensitive areas, consequently maintaining or increasing water quality and other desired ecosystem services. Forest owners will appreciate payment to offset harvest loss, and utilities can reduce infrastructure and filtration costs. This very basic analogy encompasses most PES programs. The following diagram illustrates PES in context to water quality issues.

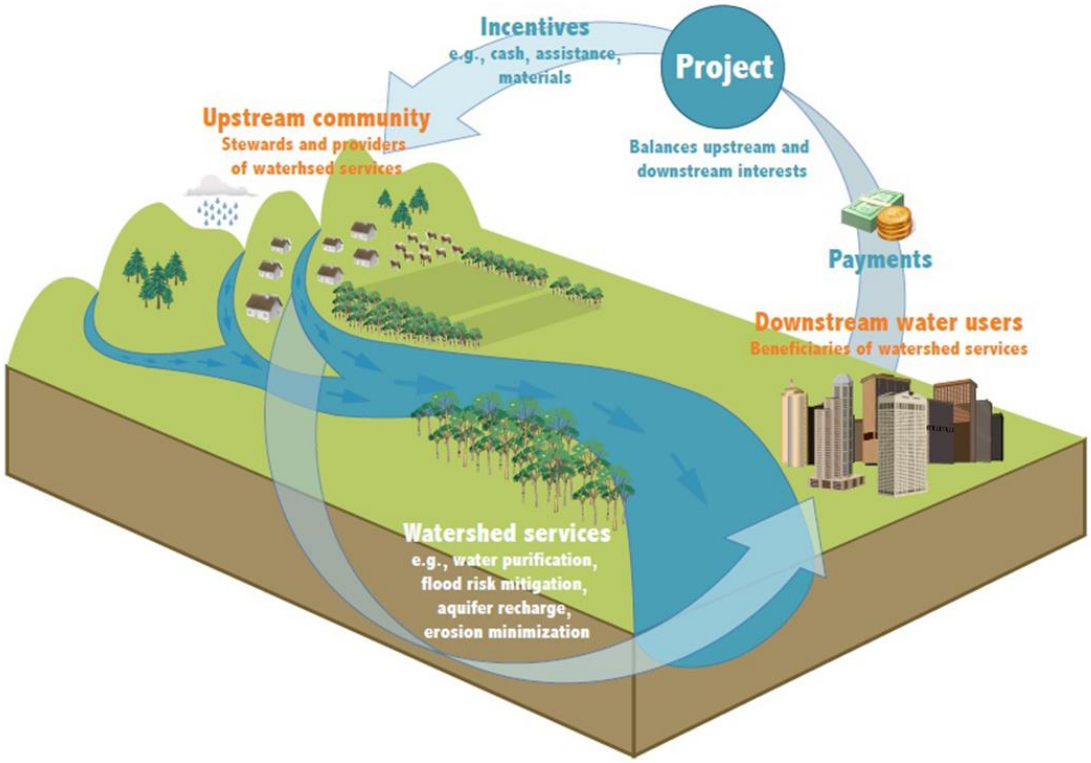

Figure 1 Example of PES programs focusing on water quality and delivery
Diagram courtesy of Foresttrends

Theory and background

PES schemes are centered on Coasean economics, established by Ronald Coase in 1960, with his Nobel Prize winning work, *The Problem of Social Cost*. Coase theorizes that negative externalities, such as environmental degradation, can be alleviated through the powers of markets and posits that externalities become a problem with lack of property rights. The Coase Theorem, as it has become to be known, states "if private property rights are clearly defined by enforceable contracts, then generators and recipients of externalities can, through voluntary exchange, reach an agreement that maximizes human welfare" (Coase, 1960, p. 3). By definition, externalities consist of un-

priced mechanisms within markets. Although many ecosystem products, such as timber, are priced within markets, many ecosystem services, such as water filtration and delivery, are not. Distinguishing the difference lies in the definition of ecosystem goods versus ecosystem services. Low transaction costs and absence of wealth effects must be present to ensure Pareto optimal outcomes, consisting of a condition whereas no actor's situation can be improved without detriment to other actors involved. Coasean theory provides economic framework for PES schemes, however, very few programs are shown to fit within this framework and achieve Pareto optimal results.

Coinciding with the Coase theorem, Garrett Hardin's 1968 article *The Tragedy of the Commons,* featured in *Science,* speaks to problems associated with public ownership of resources. Hardin concedes that human self-interest creates situations where publicly owned resources inevitably degrade from overuse or exploitation (Hardin, 1968). Employing public grazing as a metaphor for this tragedy, Hardin explains how adding one cow to an individual's herd may increase that particular individual's wealth, albeit at expense of other herders' ability to use resources taken by additional cattle. Hardin argues each herder will act in self-interest, adding cattle before the next, leading to a collapse of the field's abilities to sustain pressure from overgrazing and produce hay for further grazing. Overutilization induces a condition where fields cannot sustain continued pressure of cattle grazing, necessitating a reduction in herd levels, leading to smaller herds and more environmental degradation for all cattle herders involved.

By acting in self-interest, ranchers' unsustainable land use prompts personal financial loss and massive degradation to public pastures. Like Coase, Hardin prescribes establishing well-defined, enforceable, and preferably private property rights are

necessary for conservation of environmental resources. With property rights, private right holders can decide whether to use a resource and exclude others or transfer their resource rights to other parties and profit economically, creating a win-win situation for both the environment and the economy (Kosoy & Corbera, 2010).

Coase and Hardin's pioneering work allows for theorizing about ecosystem service's value and their inclusion into markets. With economic and social frameworks set, PES attempts to apply the Coase theorem in practice. Conceptualizing ecosystem services began in the late 1970's, with utilitarian framing of beneficial ecosystem functions as services with goals to increase public awareness about biodiversity conservation (Westman, 1977) (de Groot, 1987). Connecting ideas that ecosystem services provide real and tangible benefits to human society represented overall goals.

Additional work to the concept of ecosystem services includes utilizing economic theory to establish methods of applying economic value to ecosystem services. Robert Constanza et al. pioneered this work with their stirring article, *The value of the world's ecosystem services and natural capital*, released in 1997 in the reputable science journal *Nature*. Constanza's report fully engaged public, political, and scientific worlds by estimating the value services by ecosystems worldwide provide, ranging between US sixteen trillion dollars to fifty-four trillion dollars, with an average of thirty-three trillion dollars. Gross global national product was around eighteen trillion US dollars in 1997, showing the stark reality that world economic vitality relies heavily on unpriced ecosystem services. Questions surfaced regarding research methods and quality of work, however, one thing is certain: their report represented a catalyst for payment of ecosystem services markets and payment schemes.

Constanza's argument for environmental economics and ecological valuation can be summarized by the following excerpt, "Neoclassical economics typically overlook economic contributions of nature's stock by restricting its scope of analysis to those ecosystem goods and services that bear a price. Therefore, systematic undervaluation of ecological dimensions in decision making could be explained given that services provided by natural capital are not adequately quantified in terms comparable with economic services and manufacturing." (Constanza, et al., 1997, p. 254).

Millennium Ecosystem Assessment (MEA) reports followed in 2003 and 2005, consisting of 1400 scientists working in a worldwide concerted effort to work within ecosystem services framework. Ecologists conducted their research within this framework with goals of developing stronger theory and empirical documentation how stocks in nature deliver flow of services. The MEA concluded two-thirds of ecosystem services worldwide were declining. Also noted were effects on developing countries and their abilities to pursue economic interests due to undervaluing of their ecosystem services (Millennium Ecosystem Assessment, 2005). Coase, Hardin, Constanza, and the MEA set groundwork for inception and promotion of PES as an environmental governance option, with programs developing at an exponential pace.

With concepts of ecosystem services and their valuation understood, establishing and defining market-based applications for ecosystem services represented the next challenge. Sven Wunder was first to supply a general accepted definition of PES, concentrating on a purely economic approach, defining payment for ecosystem services with five points:

1. A voluntary transaction where
2. A well-defined environmental service (or a land use likely to secure that service

3. Is being "bought" by a (minimum one) service buyer
4. From a (minimum one) service provider
5. If and only if the service provider secures service provision (conditionality) (Wunder, 2005)

Many working within PES frameworks question inclusiveness of Wunder's definition, (Farley, 2012) (Gowdy & Erickson, 2005) (Gomez-Baggethun, de Groot, Lomas, & Montes, 2012) (Muradian & Rival, 2012) (Norgaard, 2010), possessing specific concerns regarding voluntary mechanisms and conditionality requirement. Ronald Muradian defines PES as: "a transfer of resources between social actors, which aims to create incentives to align individual and/or collective land-use decisions with the social interests in the management of natural resources." (Muradian, Corbera, Pascual, Kosoy, & May, 2010). By broadening PES's scope, Muradian allows for conceptualization of PES that encompasses many more conservation activities and programs. Do complications with defining PES represent a barrier in establishing successful programs? Understanding and agreeing on definitions across disciplines and in environmental conservation communities signifies an important task. When practitioners and academia can agree on a uniform definition of PES, further analysis concerning PES framework can be identified and combatted. With so much discussion and little agreement revolving around definitions of PES, a universal protocol for defining success in PES programs will be difficult, with each program's individuality lending further complication.

Paying for ecosystem services concept in the United States dates began with the Soil Conservation Act, signed by Franklin D. Roosevelt on April 27, 1935 in response to the great Dust Bowl. Farmers were paid subsidies to change their land use practices such

as planting native grasses or implementing less intensive farming practices to reduce erosion. Within three years, erosion was down sixty-five percent, in large part due to the Soil Conservation Act. Although government acted as a willing buyer, a transaction occurs loosely fitting PES's definitions.

According to latest assessments one hundred sixty-seven programs within the United States are identified as PES (Wunder, Engel, & Pagiola, 2008) (Stanton, Echavarria, Hamilton, & Ott, 2010)(www.naturemarketplace.org, 2013). Of these, ninety-eight are conservations banks, which do not directly connect buyers and sellers, and cannot be considered a PES program given Wunder's definition. Many of these programs, approximately half, are in pilot phases or for demonstrative purposes only, leaving less than fifty programs fitting PES's definition operating within the United States.

Conceptualizing PES as a viable option for environmental governance is intuitive; however, many internal structural and practical components of PES programs provide potential barriers to success. Recognizing and alleviating these barriers stands paramount to achieving desired outcomes for PES programs. Full understanding of PES operations allows programs to possess information necessary to obtain maximum efficiency. The following section outlines potential barriers to successful PES definitions and operations as purported by academia and PES practitioners.

Chapter Two: Literature review

Initial reviews of literature associated with PES unveil structural, theoretical and practical concerns, fitting neatly into categories of economic, political, scientific, and social, and was reviewed with the following leading question in mind; "Could this issue constitute a potential barrier to defining and operating successful PES programs in the United States?" Many authors in peer reviewed journals and non-journal publications provide insight for establishing PES programs. Components to establishing successful PES programs are outlined, but from a practical standpoint, often leaving much uninvestigated. (Bennett, Carroll, & Hamilton, 2013), (Eugene Water and Electric Board, 2001) (Evergreen Funding Consultants, January 27, 2009) (Greenwalt & McGrath, 2009) (Institute for Natural Resources, April 2012) (Land, 2011) (Majanen, Friedman, & Milder, 2011) (Patterson & Coelho, 2009) (The Oregon Sustainability Board, December 2010) (Ribaudo, Greene, Hansen, & Hellerstein, 2010) (Stanton, Echavarria, Hamilton, & Ott, 2010) (The Trust for Public Land, 2004) (Willamette Parnership, 2012). Other journals discuss PES in context with disciplines they represent, creating uniquely different perspectives. Issues are discussed by category, and their setting within the literature identified and prioritized in rank order by proportion of mention.

Economic

Prominent economic structural concerns include concepts of trade-offs, leakage, non-excludability and property rights, and stock and flow properties of ecosystem services. Economic trade-offs speak to the concept of opportunity costs. Many researchers are worried payments or incentives offered to sellers do not compensate adequately to offset gains from other management practices, consequently not covering

opportunity costs of other land use actions (Alpizar, Blackman, & Pfaff, 2007) (Gowdy & Erickson, 2005) (Kemkes, Farley, & Koliba, 2010) (Peterson, Hall, Feldpaush-Parker, & Peterson, 2010) (Van Hecken & Bastiaensen, 2010). Consider a small forestland owner as an example. Small forestland owners utilize timber resources as their main source of income, leaving multiple management options ranging from sustainable practices to clear-cutting. Known that clear cutting provide substantial and immediate income, PES would have trouble competing with payments from this activity. Development represents another option, permanently altering the ecosystem, but providing highest revenues to landowners. Curtailing development comprises a main goal of PES programs dealing with forestland owners. Given most PES programs cannot compete financially with opportunity costs, program managers are forced to rely on altruistic behavior and environmental commitment amongst landowners as additional incentive to convince landowners to agree to contracts.

The concept of leakage posits destructive environmental practices alleviated by PES programs in one area will simply resume in unregulated areas, making net environmental gains nullified (Houdet, Trommetter, & Weber, 2012). PES programs prioritize environmental outcomes, specifically at levels of operations or holdings, and leakage can occur when environmentally damaging practices are merely displaced, not reduced (Wunder, Engel, & Pagiola, 2008). Creating a problem at multiple scales, leakage is only relevant when the spatial scope of intervention is lower than that of desired services, and directly affects PES programs dealing with water related issues at local levels unless all land within the watershed are included. For example, a large forest owner may accept payment to reduce logging activities in a watershed desiring to reduce

sedimentation, only to move land clearing operations to areas not under contract. Depending on locations of these holdings, leakage may transpire at local watershed levels, defeating the PES programs purpose, or at neighborhood and global levels. Concerns with leakage are foremost with global carbon sequestration programs, where tracking can be more difficult (Alpizar, Blackman, & Pfaff, 2007). Given global carbon markets sheer size, leakage is difficult to quantify or even detect. At local levels detecting leakage is possible, but as projects scope increase, detection becomes a problem.

Lacking ability to assign property rights, or non-excludability, considers issues with free riding and difficulties assigning property rights, especially when dealing with ecosystem services. Lack of property rights, or being unable to exclude users, can alter ecosystem services functioning in the marketplace (Farley, 2012). As mentioned in discussion of Coase and Hardin's work, lack of property rights makes a situation where non-excludability exists. In an economic sense, non-excludability points to complications with charging all users for ecosystem services provided. PES programs based on carbon sequestration supply a perfect example of non-excludability, since only few pay for the ecosystem service of carbon sequestration, yet the entire world reaps benefits, making most citizens free riders.

Concerns over the stock and flow commodities arise from inabilities to store certain ecosystem services. Unlike typical commodities traded within markets, ecosystem services lack storability and may not be available during times of need, perpetuating a paradox changing how markets can be formed and operated (Brouwer, Tesfaye, & Pauw, 2011). Many traditional natural resources, such as timber, fit tidily

within traditional economics, as they are tangible products with the ability to be stockpiled and delivered when conditions are optimal, whereas many ecosystem services do not. For example, stream temperature reduction might be a desired ecosystem service for means of improving habitat for fish species, yet stream temperature reductions cannot be saved or transferred to another location. Other than carbon sequestration, most PES programs goals associate with ecosystem services that cannot be stocked.

Economic practical concerns identified during research consider four integral components of PES programs, buyers, sellers, transactions involved and funding. Issues with buyers include availability of willing buyers and their motivation. Some PES programs have secured startup funding through government or non-profit grants, easing immediate necessity for willing buyers, however, for PES programs to operate into perpetuity, a diverse and willing group of buyers for the desired ecosystem service must exist. Motivation of buyers is often questioned, given buyers of specified ecosystem services often do not participate in capacities necessary to ensure the PES program is funded and functioning efficiently. A healthy contingent of motivated buyers allows PES to act as a viable solution to environmental governance.

Producers or sellers of ecosystem services should be willing to participate and contractually comply with PES programs. Motivations may vary by program goals and individual seller's needs, and degrees of importance of financial, regulatory, environmental, or other seller goals may affect overall success or programs structure. Producers of targeted ecosystems must comply with contracts and management practices incited by PES programs protocol, yet many programs rely on faith, since ensuring

compliance requires monitoring, adding further expenses. Without ecosystem service producers' compliance, assessing successful PES programs is impossible.

Transactions occur when buyers and sellers agree to participate, and clear transaction mechanisms with low transaction costs are desirable. Transaction mechanisms questions what processes take place in order to procure PES transactions. Increasing parties involved in transactions between buyer and supplier increases costs, compromising efficiency, and possibly confusing participants. Maintaining efficient, simple, and clear processes understandable to all parties involved increases PES programs success.

Transaction costs refer to the funding necessary to produce payment for ecosystem service providers. Costs such as monitoring, ensuring compliance, research and development, and overall program operations consume resources, consequently lowering payments for provided ecosystem services, rendering payments so small they lack competiveness. Funding for transactions and research development are often low, particularly during PES programs inception, however, enough money needs to be allocated to research chosen ecosystems for development of PES protocols and programs.

Social

Social issues should not be overlooked when assessing successful PES programs. Social structural and theoretical issues with PES programs identified include apprehensions with commodification of nature's services and un-priced resources, concern that payments may crowd out socially responsible behavior, that PES programs' structure may incite perverse incentives, and assuring equitable distribution of resources and ecosystem services.

Substantial attention is paid to commodification of nature in the literature, mainly concerning programs operating in developing countries. In regards to ecosystem services, processes of commodification, defined as transforming goods and services to objects meant for trading, involves three steps: first, ecological functioning needs to be narrowed down to the level of an ecosystem service, therefore separating the ecosystem service from the ecosystem as a whole. Second, a single exchange value is assigned to the service, and then third, it links "sellers" and "buyers" of these services in a market or market like exchange (Kosoy & Corbera, 2010). Recent popularity of PES and markets for ecosystem service has spurred many authors to challenge their logic, taking a critical look at consequences, and identifying whose interests pricing and markets serve, and why money and monetary valuation are considered so useful and persuasive as a sign of ultimate worth (Liverman, 2004) (Nelson, 2001) (O'Neill, 2007). Elaborating further, one author peers into power relations and remains concerned that the idea of "selling nature to save it" legitimizes behavior of those who framed policy for their own direct benefit, and advocating for markets is the best strategy to strike a balance between nature conservation and the expansion of capitalism (Farley, 2012). Commodification of nature rests in a value laden world. Obvious are concerns of distribution, power, and the social context of conservation¸ noting environmental conservation as the primary goal. Will the commodification of nature ultimately exclude individuals unable to pay for the ecosystem services of fresh air and water? (Gomez-Baggethun & Ruiz-Perez, 2011) (Liverman, 2004) (Mariola, 2011).

The theory of crowding out socially responsible behavior concerns many researchers, questioning if individuals need payment to partake in environmentally

responsible land management may change the dynamics of human land relationships. (Ariely, Bracha, & Meier, 2009) (Bowles, 2008) (Frey & Oberholzer-Gee, 1997) Originating from work by Richard M. Titmuss, who argues blood donors are not motivated by money but by moral concerns, and adding monetary compensation for donating blood would' crowd out' its supply (Titmuss, 1970). Other studies back up his findings, proposing that using financial incentives can contravene or undermines civic duty (Bowles, 2008) (Frey & Oberholzer-Gee, 1997) (Ariely, Bracha, & Meier, 2009). PES's framework implies incentives will coerce land owners to partake in sustainable land management practices producing an increase in ecosystem services targeted. Do landowners need payment to partake in environmentally sustainable practices? Some authors suggest that by creating economic incentives, conservation market-based mechanisms can induce logic of individualism and competition in societies previously structured upon community and reciprocity values (Clements, John, Nielsen, Dara, Setha, & Milner-Gulland, 2010) (Vatn, 2010). By superseding human's altruistic tendencies with self-interest, involved parties, and public perception, may change the logic from doing what is considered appropriate and start thinking what is individually best to do.

Perverse incentives create situations where irrational behavior may take place. PES schemes generally target individual or limited ecosystem services, and perverse incentives become a problem because payments may tempt some participants to cheat. By incentivizing certain land management activities, mainly restoration projects, land owners may be inclined to partake in destructive activities in order to qualify for restoration payments (Ariely, Bracha, & Meier, 2009). Programs with direct additionality requirements are exceptionally at risk of creating perverse incentives, given

payments are offered only when clear threats of degradation exist, therefore potential applicants may be induced to create such threats (Pagiola & Platais, 2007). Perverse incentives represent the larger problem of cheating, as whenever rules are enacted, or markets available, possibilities for cheating and rule breaking exists. Perverse incentives are well documented in the carbon sequestration markets in developing countries, as some land managers are clear cutting rainforest for wood products producing immediate income, only to be compensated for planting eucalyptus or other non-native species as means of carbon capture. The growth rate of eucalyptus is high, hence the carbon capturing abiltiy, but eucalyptus is very flamable, lending potential to destivistating fires.

Equitable distribution of wealth and services associated with PES concern many, particularly for programs operating in developing countries, since equitable distribution of ecosystem services and payments may preclude marginal populations from participation. A central goal for PES programs operating in developing countries is reducing poverty as well as improving environmental conditions (Porrass, Grieg-Gran, Neves, & N., 2008) (Corbera, Kosoy, & Martinez-Tuna, 2007) (Martinez-Alier, 2002). The millennium assessment furthered discussions around maximizing social equity, maintaining environmental governance, and needs for developing countries to harbor the value of their natural resources without destroying them, and PES was envisioned the solution to these topics. Many articles discuss PES's ability to achieve dual goals of poverty reduction and environmental conservation (Kosoy & Corbera, 2010) (Nelson, 2001) (Potschin & Haines-Young, 2011), however, Corbera et al. make a salient point, conceding excessive focus on economic efficiency make PES "blunt instruments with respect to issues such as procedural fairness and equitable distribution of project

outcomes", which can undermine conservation and environmental stewardship (Corbera, Kosoy, & Martinez-Tuna, 2007, p. 366), The following quote sums up problems with equitable distribution and PES, "distribution of costs and benefits from PES systems need to be carefully considered. Systems should be designed to ensure inclusion of the poor, since they are more dependent on common property assets like ecosystem services. Wealthier nations should be prevented from free riding, and instead pay for services they receive from biodiversity and ecologically productive ecosystems in less developed countries." (Farley & Constanza, 2010, p. 2064). Difficulties with distribution, and inabilities to measure and assess effects could signify a barrier to successful PES programs.

Social related practical components of PES programs include anticipated duration of program operations, community education and outreach, and positive leadership. Anticipated duration of programs can present barriers to long term environmental goals, given many PES programs operate in shorter time frames, 3-5 years, often associating with grant funding. While these programs aid in short term relief, establishing PES programs into perpetuity, therefore locking selected holdings into an environmentally positive management protocol, provides long term solutions to environmental governance and stewardship. Community education and outreach gives stakeholders and the public access to educate themselves about PES programs, their environmental advantages, and individual benefits. Stakeholder and public "buy in" are crucial to for long term success of PES programs. Positive and stable leadership within the PES programs is necessary for success, specifically when dealing with a diverse set of stakeholders, allowing PES programs to operate cohesively.

Political

Political and policy implications are inherent with PES, given most programs receive some government aid, operate within confines of current environmental regulations, and often work directly with government agencies. Policy and political related issues representing possible barriers to success of PES programs include; working within collaboration frameworks, implementing adaptive management, possessing multiple goals, establishing conditionality, and policy coherence and overlap.

Collaborating with multiple stakeholders possessing numerous goals and backgrounds can make establishing a unified mission difficult. Primary issues include reaching consensus, building trust, representation of all stakeholders involved, and achieving solutions which rectify original goals and missions (Chaffin, Mahler, Wulfhorst, & Shafi, 2012) (Duraiappah, 2006) (Fiorino & O'Leary, 2004) (Muradian, Corbera, Pascual, Kosoy, & May, 2010). Although not required, collaboration frameworks are implemented in PES programs given their structure, consisting of stakeholders representing sellers, buyers, government agencies, non-government organizations, the public and program's implementers. Some consider collaboration frameworks all talk and no action, as a review of collaborative estuary conservation programs shows no difference in cooperation between programs operated within collaboration frameworks and those under a command and control protocol (Lubell, 2004). Regardless, collaboration between stakeholders allow for compromises necessary to construct successful PES programs.

Adaptive management refers to the ability to change goals and procedures during operations of PES programs. Operating PES programs alter ecosystem performance, and

when considering data and results associated with specific land practices are ever changing, abilities to adapt programs to new information allows programs to achieve their greatest efficacy (Muradian, Corbera, Pascual, Kosoy, & May, 2010). Adaptive management protocols are not required for PES programs, but are required for many government agency operated programs. Complaints associated with adaptive management protocols are complying with changing targets and working within collaboration frameworks, making consensus challenging. Continually involving all actors involved with PES program decision making in order to adapt can be cumbersome and unlikely. Adaptive management supplies a framework for continual positive evolution of program operations, however, some stakeholders may not be comfortable with this protocol, as standards, practices and contractual agreements are changing, making business operations difficult.

Many authors concede including multiple goals for PES programs, such as combining social and economic agendas, ultimately degrades environmental missions (Deal, Cochran, & LaRocco, 2012) (Pagiola & Platais, 2007), as policies implemented to solve multiple goals can often lose sight of their original intentions (Fiorino & O'Leary, 2004) (McGrory Klyza & Sousa, 2008). PES programs containing multiple goals may lose efficiency.

A key criterion to defining successful PES programs, establishing conditionality, or proving payments are indeed promoting land use change and enhancing ecosystem services, stands paramount to PES's ability to claim success (Claassen, Cattaneo, & Johansson, 2008). Establishing conditionality questions "Are payments truly producing more of the desired ecosystem service?" and proving its existence necessitates multiple

practical components, such as possessing accurate performance measures, assessing contractual compliance, access to baseline data, metrics or quantification of the desired service, and adequate funding.

Lack of policy coherence and overlap induces confusion amongst landowners, especially when conforming to current policies and regulations and can create situations where PES programs and environmental regulation in place are at odds (Norgaard, 2010) (Fiorino & O'Leary, 2004). Landowners must be assured that by participating in a PES program they will still conform to existing and preferably future governmental regulations. Ensuring compatibility between PES and environmental regulation will ease apprehensions of landowners to participate and increase possibilities of success.

Practical political based components of PES representing possible barriers to success include agency partnerships and relationships and working with elected officials. Many PES programs work in tangent with local, state, and federal agencies, such as the EPA, state natural resource departments, and local municipalities' development branches. These partnerships must be fluid, transparent and collaborative to achieve high levels of environmental success. Agencies can provide land owners assurance of compliance with current and future environmental regulations, bolstering value of PES propositions. Relationships with applicable regulatory agencies should be positive and collaborative to reach goals of both regulatory agencies and PES programs. Elected officials are often involved in PES programs, specifically in advocating for their inception. Answering the question of "Are PES program managers and participants generally satisfied with the role of elected officials?" will determine if they perpetuate a barrier for successful PES operations.

Scientific

Goals of most PES programs comprise of conservation and enhancement of selected ecosystem services. Scientific and environmental potential barriers to achieving these goals receive the most attention within literature reviewed, and include targeting individual ecosystem services and the tradeoffs associated, proving additional levels of desired ecosystem services result from PES protocols, connecting land practices to environmental outcomes, and difficulties in establishing performance measures and adequate monitoring.

Environmental impacts of targeting individual or limited ecosystem services are that other ecosystem functioning and services may be altered or degraded given targeting one service will impede or cause unknown consequences to production of other ecosystem services, perpetuated by uncertainties associated with overall ecosystem functioning (Engel, Pagiola, & Wunder, 2008) (Brouwer, Tesfaye, & Pauw, 2011). Many authors have displayed concern around targeting, specifically with the lack of monitoring associated with non-target ecosystem services (Kemkes, Farley, & Koliba, 2010) (Alpizar, Blackman, & Pfaff, 2007).

Additionality, or lack of, refers to ensuring more desired ecosystem service is being produced due to PES programs, with authors questioning, "Does the inception of a PES program truly increase delivery of desired ecosystem service?" (Ferraro & Pattanayak, 2006). Worries that in some cases, payments for adoption of practices occur that would have happened anyway, known as "money for nothing" (Ferraro & Pattanayak, 2006), is exemplified in financial efficiencies of the program, whereas if goals include securing more desired ecosystem services, unmerited payments reduce

funds available to induce efficient land use change elsewhere (Engel, Pagiola, & Wunder, 2008). Combinations of leakage, trade-offs, and policy overlap can make additionality difficult to prove, and an in-depth look at existing policies and governance, landowners' intent, and ecological structure is essential to deciphering levels of additionality, all requiring information and data, adding to transaction and operation costs. Proving additionality can represent a barrier to defining successful PES program as it essentially defines success.

Definitively connecting land management practices to increases or maintenance of desired ecosystem services is difficult, with many practitioners making broad assumptions about beneficial land management activities. (Brouwer, Tesfaye, & Pauw, 2011) A key component of PES programs is relating degrees to which land practices affect specific ecosystem services since PES is based on ideas that specific land management practices can increase or decrease specified ecosystem outcomes. Paying for land practices allows for an easily definable unit of measurement, however, much debate revolves around the scientific validity of land practices affecting ecological outcomes (Maille & Collins, 2012) (Schoenen, 2012) (Fox, 2012) (Wunsher, Engel, & Wunder, 2008).

Regarding issues of ecological conductivity, some authors posit ecosystems properties evolve from interplay of behavioral, biological, physical, and social interactions, which in turn suggests that human managerial interventions like PES can affect ecosystems in both predictable and unpredictable ways, (Kosoy & Corbera, 2010). Others consider that environmental services are frequently not fully defined, and PES implementation proceeds without establishing a clear cut causal relationship between

land-use practices and expected enhancement of targeted environmental services, leading to difficulty in demonstrating efficiency and success (Munoz-Pina, Guevara, Torres, & Brana, 2008). Further concerns point out knowledge about functioning of one type of ecosystem is not transposable to another similar ecosystem, and both human actions and differences in key variables like climate or soil affect structure and delivery of ecosystems services delivered, making modeling future programs after existing protocols cumbersome (Norgaard, 2010).

Some question if PES is warranted at all, given lack of knowledge around ecological processes and outcomes, benefits, and given ecosystem services can be considered social constructs (Farley, 2012). Connecting land practices to environmental outcomes are exemplified at forested watershed levels, as long-standing assumptions that riparian buffers, and overall vegetative cover increase watershed functioning; specifically temperature, filtration, sedimentation and delivery, yet studies have brought this assumption into question in the Pacific Northwest areas of the United States (Grant, Lewis, Swanson, Cissel, & McDonnell, 2008) (Pollock, Beechie, Liermann, & Bigley, 2008).

Accurately measuring and monitoring ecosystem performance under PES management represents a real problem to many programs and is repeatedly tied to lack of funding. Monitoring inherently takes resources from other program components, specifically concerning is erosion of payments to providers of ecosystem services (Brouwer, Tesfaye, & Pauw, 2011), and must take place in order to ensure provision of services is indeed happening (additionality and conditionality of payments) (Engel, Pagiola, & Wunder, 2008). To satisfy conditionality and additionality requires

understanding causal pathways, (processes), recognizing spatial extent and distribution, (patterns), developing proxies or indicators for easy recognition and monitoring, and simple, yet accurate and validated measures of environmental services provided (Tomich, Thomas, & van Noordwijk, 2004). Monitoring must be present in performance-based PES programs because without adequate and reliable monitoring, how can successful PES programs be defined?

Possessing necessary scientific and environmental tools and information permits PES programs to operate truthfully and efficiently. Concerns with access to information and knowledge include availability of scientific knowledge of targeted ecosystems, understanding ecosystem services provided, access to baseline data and access to PES related information. Understanding ecosystem services provided, the working components, and interconnectivity of a given ecosystem constitutes a potential barrier to PES programs. If particular ecosystem services are preferred, understanding how ecosystems produce these services and what management manipulation will increase production is critical. Availability of scientific knowledge refers to sheer quantities and availability of resources and knowledge needed to establish working management plans. Access to PES related information questions if enough PES related information exist to guide creation of new or operating PES programs and if is information readily available. Issues with access to baseline data question current and historical production levels of chosen ecosystem services is available and accessible because without previous baseline data to compare are successes of PES programs and their associated management practices justified? Accurate means of measurement and monitoring for ecosystem services, the end value product, must be in place to ensure validity, assess if PES

programs are achieving their goals, and deciphering other effects programs have on ecosystem workings, and varying metrics and quantification of services make identifying successful PES programs difficult (Chaffin, Mahler, Wulfhorst, & Shafi, 2012).

Methodology and research setup

Clearly potential barriers to successful implementation and operation of PES programs exist and are well discussed throughout the literature. These documented potential barriers provide individual aspects for PES programs to compare and assess success, which this research attempts to achieve. Below details methodologies used to allow for comparison between documented potential barriers and real life PES applications.

Methodologies implemented during research include case study analysis, literature review, survey, and interviews. A three tiered system, where results collected from one tier inform the next, allow for a robust data set. Tier I encompasses a thorough literature review of journal articles, trade and government publications, and gray literature providing necessary information to establish potential structural, theoretical, and practical barriers to defining success in PES programs, a major component of this research. Four distinct categories for potential barriers became clear; economic, political, social, and scientific, and all potential barriers were identified, categorized and prioritized by record of mention. In addition to literature review, interviews with one PES program manager and with developers of a pilot payment for watershed services program helped identify practical barriers.

With information obtained from literature review and initial interviews, a survey was constructed to represent Tier II. A questionnaire was administered to determine if respondents' programs fit broadly within the parameters of PES, assess their programs

goals and missions, and to assess their perceived success of their program in achieving its goals and missions. Seventeen survey questions address program manager's concern level in regards to each prospective structural and theoretical barrier identified. Twenty-three components were selected as potential practical barriers to successful PES programs, and managers were asked to assess their satisfaction level with each component. Four optional open ended questions about individual program operations conclude the survey.

Tier III includes selecting five programs for additional interviews, each with distinct program goals of increasing biodiversity, water quality, water quantity, fire risk mitigation, and nutrient reduction. Interviewee's took advantage of opportunities to elaborate and considerable insight emerged due to the open ended nature of interviewing.

Participants were selected based on geography, within the continental United States, ability of their program to fall under PES's definition, and must be considered a program manager or director. Prospective participants were emailed invitations to contribute and after obtaining permission, either agreed to an online survey, interview, or both. All respondents were speaking within their professional capacity with agreement of anonymity. Forty-three groups were targeted with thirty returning surveys. Five surveys were found inapplicable to this research, culminating in twenty-five qualifying surveys. Two additional participants were selected for a trial run with their data excluded from analysis, and considering their feedback the survey was reworked to allow for intuitiveness. Surveyed programs represented five subsets of PES, with overarching goals associated with water quantity, water quality, nutrient reduction, fire risk

mitigation, and biodiversity. Survey responses were coded and entered into Excel for anonymity and analysis.

Survey setup

Survey and interview processes asked participants to rate their concern level with each identified potential barrier within context of their program. Below lists these potential barriers by category of discipline and offers a brief explanation for context, providing an excellent quick reference guide for the reader, program manager, or PES stakeholders.

Category	**Potential barrier to successful PES programs**	**Explanation**
Economic	Leakage	Land owners may be compensated to conserve certain areas, only to displace destructive practices to other holdings.
Economic	Trade-offs	Payments for ecosystem services may not cover opportunity costs of other land use options.
Economic	Stock and flow	Many ecosystem services cannot be stored, skewing traditional operations of markets.
Economic	Non-excludability or lack of property rights	Troubles in assigning property rights and inabilities to exclude individuals from consuming services for free.
Political	Multiple goals	Multiple environmental, economic, social and political goals dilute original intentions of PES programs.
Political	Establishing conditionality	Conditionality requires a system ensuring payments are truly producing the desired ecosystem services.
Political	Collaboration framework	Working with multiple stakeholders and their goals.
Political	Adaptive management	Ability to reactively change program structure given new information or changing conditions.
Scientific	Connecting land practices to environmental outcomes	Does causality exist between land management practice and environmental performance?
Scientific	Additionality	Ensuring more desired service is produced as a result of payment for specific land management practices.

Scientific	Performance measures and monitoring	The ability to accurately measure and monitor the desired ecosystem service.
Scientific	Targeting and trade-offs	Targeting one ecosystem service may negatively affect the production of other ecosystem services.
Social	Equitable distribution	Are incentives and ecosystem services excluded to some users?
Social	"Crowding Out" voluntary socially responsible behavior	Will payments become expected for actions previously done because of social norms and responsibilities?
Social	Commodification of nature's services	Should natures services be priced or a human right?
Social	Perverse incentives	An incentive that has an undesirable result, which is contrary to the interests of the incentive makers.

Table 1 Survey questions of potential barriers associated with PES

Twenty-three practical program components were identified as potential barriers to successful PES programs through literature review, consulting with the Washington state department of natural resources, as they are designing and implementing two PES programs, and an interview with an active PES program. Participants were asked to rate their satisfaction level with each of these components. The following presents PES program components assessed during surveying, categorized by discipline and offering a brief explanation, and provide a reference point for PES stakeholders, identifying potential practical barriers to successful operations.

Category	**Practical components of PES representing potential barrier to successful PES programs**	**Explanation**
Economic	Sellers compliance	Are producers of ecosystem services complying with contractual agreements?
Economic	Motivation of sellers	Are producers eager and willing to participate?
Economic	Transaction mechanisms	Means and methods of establishing a transaction between seller and buyer.
Economic	Availability of willing sellers	Do enough willing sellers exist to fulfill PES program goals?

Economic	Funding for transaction	Does funding exist to pay transactions at appropriate amounts?
Economic	Availability of willing buyers	Do enough willing buyers exist to fulfill PES program goals?
Economic	Motivation of buyers	Are buyers eager and willing to participate?
Economic	Transaction costs	Do transaction costs erode compensation to the producers/sellers?
Political	Agency partnerships	Do partnerships with government agencies enhance program operations?
Political	Relationship with applicable regulatory agencies	Is working relationships with corresponding government agencies acceptable?
Political	Stakeholder collaboration	Does stakeholder collaboration enhance or detract from overall PES goals?
Political	Implementing adaptive management	Flexibility to react and adapt program structure given new information.
Political	Elected officials involved	Do elected officials enhance PES programs operation?
Scientific	Understanding of ecosystem services	Understanding of how ecosystem services are produced or enhanced?
Scientific	Metrics and quantification of service	Can ecosystem services provided be measured and do they include a unit of measurement?
Scientific	Scientific knowledge of targeted ecosystem	Is scientific knowledge available for the ecosystem under PES program management?
Scientific	Access to PES related information	Ease of access to PES information for guiding program development.
Scientific	Access to baseline data	Ease of access to baseline data regarding ecosystem functioning, social demographics, land use, and environmental measurements.
Scientific	Monitoring of environmental performance	Ability to monitor environmental changes perpetuated by PES protocol.
Social	Anticipated duration of the program	Does PES program's duration solve long term environmental goals?
Social	Education and outreach	Does education and outreach allow for perceptive decision making?
Social	Leadership	Is leadership adequate to achieve PES goals and missions?

Table 2 Identified practical components of PES programs used as survey questions for PES programs operating in the USA

Qualifying questions were administered determining whether participant's PES programs fit under PES's definition. Programs must be voluntary, provide cash or in kind incentives, and monitor for contractual compliance to be included in the survey. The following questions were used for assessment.

Qualifying PES Survey Questions
Is your program voluntary?
How would you define your incentives?
Do you monitor for contractual compliance?
Do you currently monitor environmental performance of the specified ecosystem service in your program?

Table 3 Table of qualifying PES survey questions

Additional questions ensure each program possess recognizable goals to compare their perceived success against, ranks importance of economic, political, scientific/environmental and social to program goals, and additional information for analysis. Below outlines the remaining survey questions.

Further PES Survey Questions
Do you currently serve in a leadership position?
Does your program have a recognized goal or mission?
If your program has a recognized goal or mission, please describe. (Open ended)
Please rate how successful your feel your PES program is, or has been, at accomplishing the intended goal or mission.
Please rank the following themes in relation to your programs goals and missions. (Open ended)
Please identify any goals specific to the above themes. (Economic, Environmental, Political/Policy, and Social. (Open ended)
Do the goals of your program overlap with other environmental regulations or governance?
Do you have access to quantitative baseline or monitoring data of your desired ecosystem services?
Do you monitor or observe non-targeted ecosystem services?
Do you use qualitative data in your analysis of success?
Please describe how you measure your programs success? (Open ended)
Would you be willing to share quantitative data associated with your program?
Would you be willing to participate in an on phone interview or remain in contact?

Table 4 Table of qualifying PES survey questions

Concluding the survey, four optional open ended questions were present with desires of enticing new information or insight from participants, although most opted out.

Open ended PES Survey Questions
Please describe components within your program you feel need improvement and how you would anticipate improving them.
Please describe individual program components strengths and why you feel they work.
Please describe your position towards using Payment for Ecosystem Services as a policy tool. As a conservation tool?
Please provide any additional comments or feedback regarding your PES program, PES in general, or this survey. Thank you.

Table 5 Table of open ended survey questions

Chapter Three: Results and analysis

Goals for analysis of participant responses consist of isolating barriers to defining successful PES programs, and estimating institutional similarities between structural, theoretical, and practical components, and comparing PES managers' concern level and satisfaction with program components to their perceived success of their PES application as whole. To be included in analysis, PES programs must be voluntary, provide incentives, monetary or in-kind, for a change in behavior resulting in delivery of desired ecosystem services, and possess stated goals or mission. Twenty-five out of thirty respondents fit this definition and were included in analysis. All programs possessed clearly describe goals or missions to compare their perceived success against, and results indicate all PES managers view their programs as successful.

With a firm grasp of PES's concept and origin, investigations into potential barriers to implementation and operation of successful PES programs are possible by asking the question "Do issues exist within the PES framework that can impede the definition and operation of successful programs?" Each participant is asked to identify their concern level for seventeen potential structural and theoretical barriers in comparison with their program. Potential barriers are categorized by discipline perspectives of economic, political, scientific, social, and practical. The following sections outlines survey results regarding concern levels of potential structural and theoretical barriers, and are discussed from highest to lowest concern.

1. Economic trade-offs represents high concern for programs surveyed, with only one program reporting no concern. PES managers understand their programs cannot offer competitive prices in comparison to other options available. Practical issues with funding

for transactions, securing indefinite funding, and availability of willing buyers confound problems associated with economic trade-offs.

2. Commodification of nature constitutes a barrier to defining successful PES programs and also questions the intent of PES, including nature's valuation. Two-thirds of respondents expressed concern over commodification of nature with majority of programs dealing with water quality issues. One water quality based program commented, stating "One of the biggest barriers to advancing PES". Given PES's economic premise, finding commodification of nature as a primary concern is surprising. Commodification of nature emerges represents the primary social concern throughout the literature, corresponding well with survey results.

3. Ranked highest concerning politically related potential barrier, working within collaboration frameworks clearly represents an issue. Can't we all just get along? Wording of this question does not allow for indication whether respondents are concerned with working within collaborative frameworks and its inherent problems, or concern over not implementing a collaboration protocol. Working within collaboration frameworks represents a universal problem in most environmental regulation or governance programs, and PES programs are no different. With over fifty percent of respondents claiming concern, working within the confines of collaboration frameworks signifies a barrier to defining successful PES programs, specifically with reference to program development and implementation.

4. Issues revolving around targeting and tradeoffs specific ecosystem services represent the highest scientific concern, with forty-three and a half percent of programs showing concern. Consequently, eighty percent of PES program managers surveyed indicate they

monitor for environmental performance of their targeted ecosystem service or services, however, only twenty-nine percent indicate monitoring for non-targeted ecosystem services. Without full monitoring of all ecosystem services associated with a selected PES program, understanding if targeting specific ecosystem services promotes a decline in others cannot be fully evaluated, nor can environmental effects of PES programs, meriting high concern levels of participants. Targeting for specific ecosystem services is a potential barrier to successful PES programs.

5. Forty-three percent of respondents indicate concern with adaptive management, making it a probable barrier to defining successful PES programs. Comments from interviewed PES programs identified their main concerns, consisting of constantly moving environmental targets and difficulties relaying changes to stakeholders.

6. Thirty-nine percent of respondents were concerned with proving additionality with most programs associated with water rights. Additionality is difficult to prove with water rights, as they may be purchased, but proving purchased water is returning to the system is arduous if not impossible. An assortment of natural variables makes it difficult to isolate sources of additions and losses of water.

7. Crowding out socially responsible behavior signifies a mid-level concern to survey participants, with over forty percent concerned response. Eight out of nine concerned responses were registered by PES programs aiming to improve water quality through nutrient reduction programs, dealing mostly with farming communities.

8. Possessing multiple goals is concerning to PES managers focusing on water quality. Looking at the five types of programs surveyed, this may be understandable, as

programs associated with fire risk mitigation, water quantity, biodiversity, and nutrient reduction have singular goals.

9. The concept of leakage ranked is the second highest concerning economic potential barriers. PES programs showing concern with leakage are associated with water quality, quantity, and biodiversity and consequently controlled the largest land holdings.

10. All programs dealing with water rights showed concern with policy coherence and overlap, as well programs associated with biodiversity, water quality, and nutrient reduction, with over thirty-six percent responding concerned. One program associated with returning irrigation water for in-stream uses elaborated on their concern, stating "The myriad of archaic water laws and codes make leasing and transactions difficult." Insight through an interview with a PES program dealing with water quantity and flow suggested federal policy does not recognize returning water for in-stream use as a viable making it difficult to convince land owners to give up their water rights.

11. Even though ranking as a low policy related priority, establishing conditionality is still a reputable concern to program managers, as over one third of respondents show concern, with programs associated with biodiversity, water quality and quantity showing the most. Nutrient reduction programs contain fairly standard protocols for assessing total daily maximum loads of nutrients and tracking to sources of pollution, making establishing conditionality an easier proposition.

12. Connecting land practices with environmental outcomes continually surfaced as an issue to successfully operating PES programs throughout the literature and represent a mid-level concern to PES program managers surveyed with twenty-seven percent. Specific problems were detailed in water rights programs, suggesting although water may

be returned for in stream uses, un-irrigated fields left behind become infested with invasive weed species, mainly scotch broom, leading to less water in the system and heightened water quality issues. Inclusion of a restoration program coinciding with water rights programs would help alleviate this problem. Lack of scientific knowledge and ecological processes and inabilities to quantify individual ecosystem services purports a major concern to practitioners and academia, and is considered a barrier to defining successful PES programs dealing with water issues.

13. Just over fifteen percent of surveyed PES program managers are concerned with perverse incentives. A broad spectrum of programs were concerned, including biodiversity, water flow and rights, and water quality programs were all represented equally. One comment by a manager dealing with water rights and returning irrigation water to instream uses provided a salient insight to the problem, stating "Incentives are in place to use as much of the water as possible, pay for pipe, bigger project, use as much water as before." Issues with water rights and returning water for in stream uses can be challenging with the myriad of archaic water rules which helped define westward expansion, essentially making it difficult for land owners to return their water, with its "use it or lose it" format.

14. Non-excludability and lack of property rights concerns are low. As mentioned previously in discussions of Coase and Hardin, troubles associated with lack of property rights create a situation where non-excludability exists. Non-excludability in an economic sense, points to difficulties charging all users for ecosystem services provided. PES programs based on carbon sequestration supply a perfect example, as though only few may pay for ecosystem services of carbon sequestration, the entire world will reaps

benefits. Five program managers consider non-excludability concerning, with nutrient reduction, water quality and water flow as their program goals. All programs surveyed work at watershed levels, producing what economists refer to as a "club good". A club good may be excludable to participants outside of the watershed, but free riding can still be a problem.

15. Performance measure and represents the lowest structural scientific and environmental concern, with only five programs concerned, just over twenty percent. Lack of monitoring can be associated with lack of funding and high transaction costs. Given difficulties regarding lack of knowledge and connecting land practices with environmental outcomes, one may assume monitoring to be a top priority, however, data from this survey indicates program managers have a grasp on performance measures and monitoring, and cannot be considered a potential barrier to most surveyed programs.

16. The lowest social potential barrier to PES program managers is distribution of resources and ecosystem services, with four respondents expressing concern. Looking at this question closer, identifying if respondents are concerned with distribution of payments or services would add clarity. All programs surveyed operate at a limited scale, mostly watershed levels, with well-defined stakeholders. Three of the four programs goals consisted of nutrient reduction programs based on changing farming habits to reduce runoff. Many have conceded nutrient reduction programs targeting larger farming operations already battling with environmental concerns, making a situation where polluters are compensated for changing their actions. Also, some argue land stewardship is eroded by offering payments for what should be done in the first place (Ariely, Bracha, & Meier, 2009). Distribution issues as discussed above, are typically based on programs

at a national or international level, and often exist in developing countries. Given the smaller scope of the surveyed programs, distribution should not be a mitigating factor in defining successful PES programs in the United States, and data supports this assessment.

17. Issues with stock and flow properties of ecosystem services ranks as the lowest overall concern to operating PES programs in the United States. Concerned respondent's programs associate with water rights issues, or buying water rights for returning water for in-stream uses. Unless a dam is present, bringing on its own environmental concerns, water flows cannot be controlled.

Many documented potential barriers to successful PES operations are concerning to the survey PES program managers. The following graph illustrates concern levels with structural and theoretical components of surveyed PES programs detailing in rank order numbers of concerned responses compared to overall responses with each component categorized by disciplinary concern. Please refer to Table 1 for a quick reference and explanation of concepts and terms.

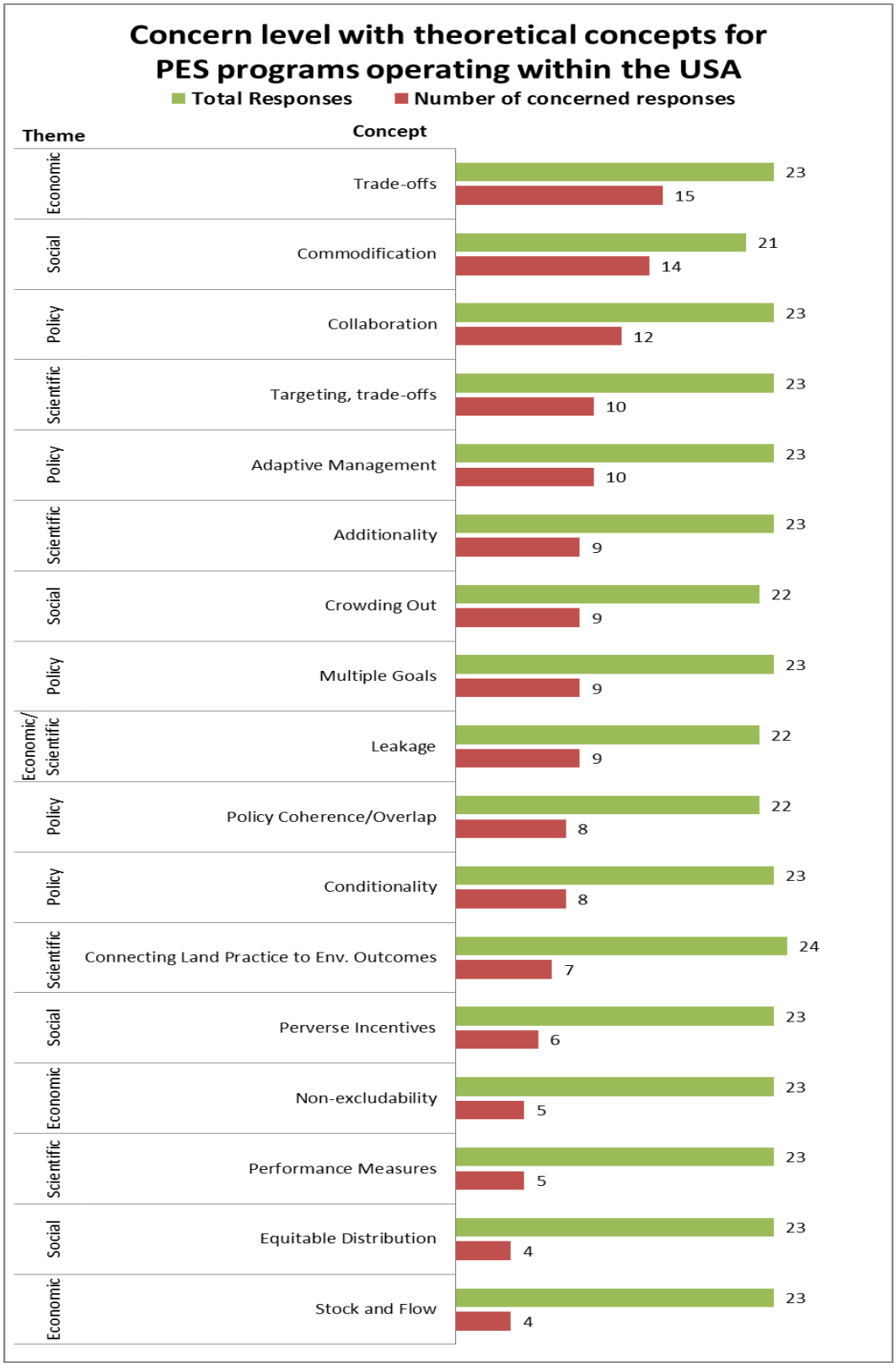

Figure 2 Concern level with potential barriers to PES programs in the USA

Practical barriers to successful PES programs are identified by literature review, specifically non-journal publications assessing current PES programs, and interviews of two PES program managers. Twenty-three survey questions contemplate practical components associated with operating and defining successful PES programs. Considering satisfaction levels of individual practical components of PES programs can aid in adapting programs to achieve success. Economic components of PES program deal with funding and actors working within proposed markets, showing distinct trends of dissatisfaction with several components. Political and policy related components consider collaboration between programs and government entities, and satisfaction levels were mixed. PES practitioners showed general satisfaction with scientific, environmental, and social components. The following section briefly outlines satisfaction level with individual practical components of PES programs in rank order, with highest levels of dissatisfaction listed first.

1. Transaction costs are the number one source of dissatisfaction for PES managers surveyed, with over fifty-two percent unsatisfied. High transaction costs erode funds available for payments to land owners, leading to problems with economic trade-offs, duration of program operations, and leakage. Programs commented on difficulties reaching economies of scale since many are small operations, however, some newly formed programs felt transaction costs will go down with program development completed. Initially high internal startup costs, such as equipment, research and development, and program layout will reduce over time. A theme of lack of funding is emerging, as the need for other sources of money other than grants is representing a real problem. Unsatisfied programs commented on having difficulty transferring funding

responsibility to the local utilities. Often utilities need to authorize rate increases to procure funding for PES programs, which can be difficult to justify to the public.

2. Dissatisfaction with availability of willing buyers was high, mostly with programs holding multiple goals of water quality, such as flood mitigation, nutrient reduction, biological contamination reduction, sedimentation reduction, and water filtration. Many of these programs operate off of government grants, and without a pool of willing buyers, programs cannot operate beyond the grants duration. Willing buyers could include local water utilities, electric utilities associated with dam power production, the public with tax money, and non-governmental organizations. Inabilities to align willing buyers with PES programs constitute a barrier to success for many programs, and willing buyers should be solidified during planning.

3. Six programs were somewhat unsatisfied with implementing adaptive management, comprising of biodiversity and large water quality programs. Results indicate biodiversity related PES programs are having difficulties with multiple practical components as well as water quality programs affecting large land holdings, possibly due to a larger pool of stakeholders involved in decisionmaking. Stakeholder trust must be established for adaptive management to succeed. One program manager associated with nutrient reduction and water quality quoted " Farmer's distrust new methods initially.", showing application complications with an adaptive management protocol.

4. Coinciding with transaction costs, funding for transactions represents the fourth highest source of dissatisfaction for survey PES program managers, with four programs somewhat unsatisfied, and two programs unsatisfied. Funding related issues pose real problems and represent a barrier to successful PES programs.

5. Only four programs were satisfied with elected officials involved, with five programs unsatisfied, although none elaborated. Given the sensitive nature of politics, most participants declined to answer, which may be justified. Elected officials may present a barrier to successful PES programs, especially when considering they represent constituents.

6. Buyer's motivation comprises an issue for over twenty percent of the programs, with the same programs showing dissatisfaction with funding for transactions. Two of these programs were created to reduce sedimentation and nutrient content as means to reduce water filtration costs for local utilities, and both are extremely unsatisfied with utilities motivation to engage in monetary transactions, given they only have grant funding for a 3 year trial. Program managers expect utilities to begin negotiations once grant money has expired. On a positive note, one program expressed being very satisfied with local utilities, stating "The city is motivated to address nitrogen sources for its wells, rather than investing in treatment." showing collaboration and local funding can and does happen.

7. Transaction mechanisms represent processes and parties involved for transactions to occur. Mechanisms can include establishing a contractual agreement, implementing compliance, and working through a verification process. Four respondents were somewhat unsatisfied, with one unsatisfied manager concerned with all components associated with funding and buyers.

8. Four programs were somewhat unsatisfied with availability of willing sellers, with these programs covering large areas with multiple goals of water quality. A minimum level of willing sellers is necessary to ensure enough land is under PES program

management to increase production of desired ecosystem services. Given only four programs were somewhat unsatisfied, the availability of willing sellers cannot be considered a barrier to PES programs surveyed.

9. Of the four programs were somewhat unsatisfied with stakeholder collaboration, all were dissatisified with other components relating to stakeholder collaboration such as; implementing adapative management, relationship with regulatory agencies, and availability of willing buyers.

10. Four programs were somewhat unsatisfied with their relationship with applicable regulatory agencies and all commented why. Two programs are concerned with differences in work culture, specifically when dealing with time frames associated with federal and local agencies. One program had a history of adverserial relationships between potential sellers and the presiding regulatory agency, and finally one program seemed more than somewhat unsatisfied, stating " It's hard to work on complex programs when staff turnover is high, the topic complex, and the resources to support staff are so very limited, and well almost always say that decision is "Above my pay grade", but no apparent leader is there to support decisions."

11. Funding for research and development had few unsatisfied respondents. Three programs were somewhat unsatisfied, consisting of biodiversity and water quality programs. Most research and development occurs at inception of PES programs when grant moneys are readily available. Given high satisfaction for this component, it cannot be considered a practical barrier to defining successful PES programs.

12. Agency partnerships were generally seen as positive. One of the three somewhat unsatisfied respondents suggested another name for agency partnerships. "Not really a partnership, more like a forced family relationship."

13. Only two water quality programs have concern with sellers motivation. Overall responses show a general satisfaction with the motivation of the sellers, with one manager of a water quality program stating "Producers want to be good neighbors and understand that helping the City also benefits their own private wells."

14. Access to baseline data seems readily available except for two somewhat unsatisfied programs, a privately funded program and a program dealing with biodiversity. Obtaining baseline data for biodiversity is difficult, given the labor intensive data collection method of observation. Access to baseline data is not a mitigating factor in determining the success of PES programs surveyed.

15. Quantifying biodiversity's ecosystem service into a metric conducive to PES programs proves to be a barrier as both somewhat unsatisfied programs primary goal is conserving biodiversity. All other programs displayed satisfaction with metrics, and looking closer at program types, metrics were easy to identify. Examples include total daily maximum load (TDML) for nutrient reduction programs, cubic feet of water returned for water quantity programs, turbidity for sediment issues, and temperature and oxygen levels in water, etc.

16. Two programs were somewhat unsatisfied with education and outreach and both programs express dissatisfaction with most practical components.

17. Leadership is strong in all but one program surveyed.

18. One program displayed dissatisfaction with seller's compliance, comprising of a program to reduce nitrates from farm run-off.

19. Access to PES related information seems readily available, as only one program was somewhat unsatisfied. This particular program is privately funded, possibly indicating a lack of governmental support.

20. Only one program dealing with biodiversity had issues with availability of scientific knowledge. A trend is developing with programs associated with biodiversity goals, and will be elaborated upon in case reviews.

21. One program dealing with water quality had issues with monitoring for environmental performance, stating "Inspections by state personnel is VERY slow and hit and miss."

22. Satisfaction was high for understanding ecosystem services provided.

23. No objections to the anticipated duration of the program were shown.

A clear trend of dissatisfaciton with economic and politically related components of surveyed PES programs is shown. Funding and collaboration with stakeholders as a whole encompass the top thirteen sources of dissatisfaction. The following graph illustrates dissatisfaction levels with practical PES component ranked from highest to lowest dissatisfaction.

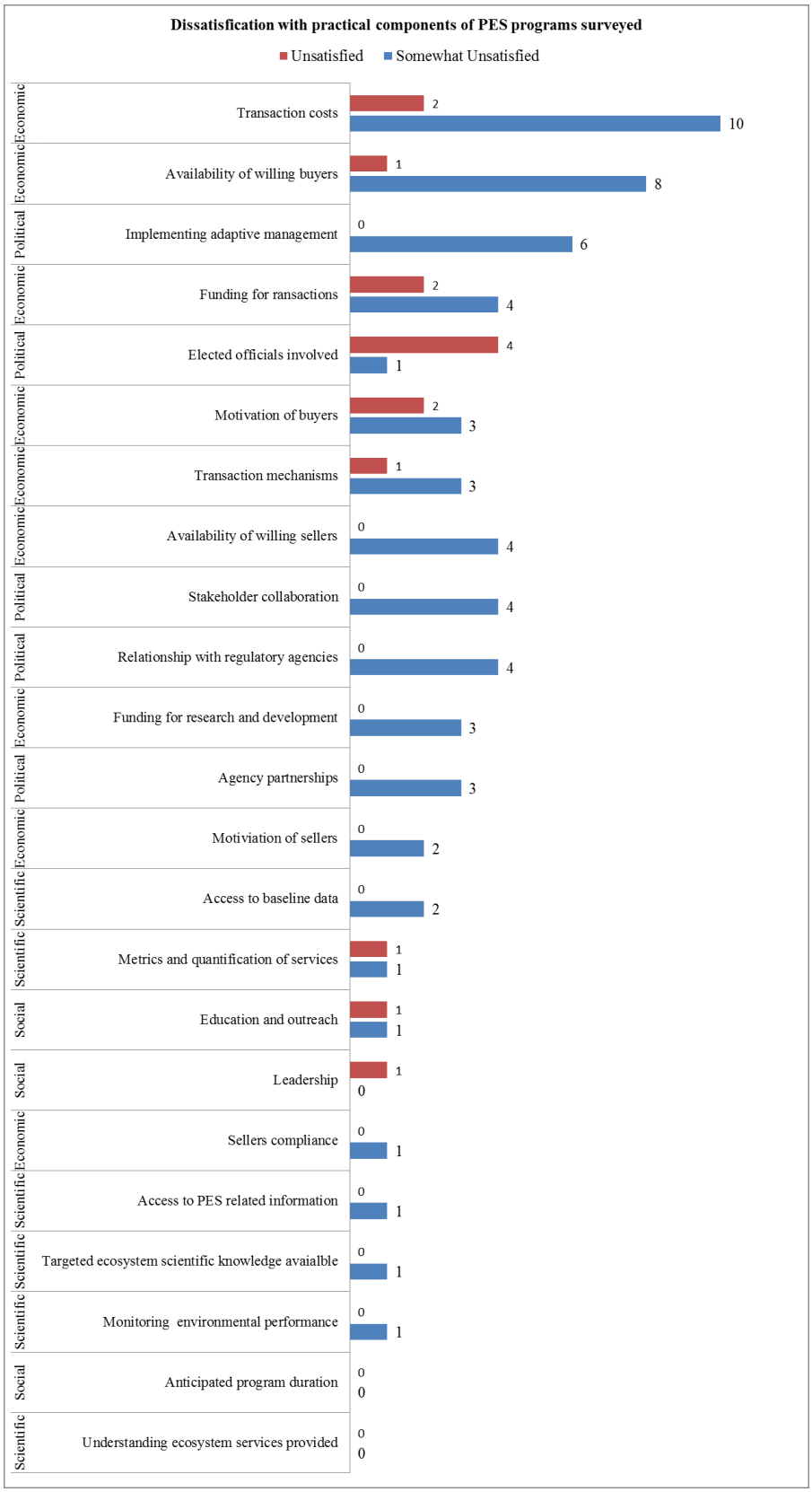

Figure 3 Dissatisfaction level with practical program components for surveyed PES program managers

Analysis by PES program type

Analysis by PES program type illuminates concerns and dissatisfaction with programs associated with specific environmental goals, and provides useful insight for program managers operating or implementing these specific types of PES programs. Surveyed programs encompassed five general goals for their programs as follows; water quality, water quantity, fire risk mitigation, nutrient reduction and biodiversity. Below outlines each program by type, describing their individual goals and program structure, followed by program specific trends and analysis.

Water quality

PES programs categorized under water quality include a combination of environmental goals such as sedimentation reduction, nutrient reduction, fire risk mitigation, flood mitigation, biological contaminant reduction, increased water flow, habitat conservation and restoration, carbon sequestration, and recreation. Fourteen programs are categorized as water quality related PES programs, all possessing at least two or more afore mentioned goals.

A clear trend is expressed when looking at satisfaction levels of practical components for PES programs associated with water quality. All concerns fall under the economic and policy categories, with issues regarding funding holding six out seven highest rankings. Potential barriers to defining successful water quality related PES programs in the United States listed by level of dissatisfaction, highest to lowest, include transaction costs, availability of willing buyers, implementing adaptive management, motivation of buyers, availability of willing sellers, funding for transactions, and stakeholder collaboration.

Intuitively, funding and working with stakeholders represents true barriers to defining and operating successful water quality related PES programs surveyed. Problems with funding may arise because most PES programs are started with grant money, with ideas that buyers and sellers will enroll once program structures are established. Grant money characteristically has a limited timeframe, putting pressure on programs to secure buyers to continue beyond grant funding. Without a pool of buyers, payouts to producers diminish and programs often fail.

Transaction costs and availability of willing buyers represent the only two categories with over fifty percent of respondents unsatisfied. Transactions costs constitute a well-documented concern for program managers and survey data supports this. Transaction costs erode payments rendered to producers of desired ecosystem services, making it difficult to cover opportunity costs. If payments are not adequate, producers will not enroll in the program, providing a sure barrier to the implementation and success of PES programs. Interestingly, all programs having problems with the availability of willing buyers also are dissatisfied with transaction costs. Given the documentation, data supplied, and confirmation through survey and interview, these two practical components are linked, with transaction costs being the causal variable. Without comparable payments to opportunity costs, buyers will not enroll in PES programs. Left unaddressed, transaction costs and availability of willing buyers represent a barrier to successful water quality related PES programs.

Interconnection between availability of buyers, motivation of buyers, and funding for transactions is evident, considering that program managers who showed

dissatisfaction with one were unsatisfied with all, and can be considered probable barriers to success for PES programs associated with water quality.

Many water quality programs were dissatisfied with collaboration and adaptive management, and given multiple goals and large stakeholder pools, this is understandable. Collaboration must happen in order for adaptive management to work since protocols are constantly changing. Concern levels with structural and theoretical components for PES program managers of water quality based programs mirrored overall survey results, expressing high concern with commodification of nature, economic tradeoffs (opportunity costs), and targeting and tradeoffs. Economic trade-offs could also point to the problem of transaction costs and the availability of willing buyers as discussed above.

Water quantity

Four programs surveyed contain goals of increasing water quantity with missions of returning water for irrigation or damming to in-stream uses. All programs were satisfied with practical components except one, showing dissatisfaction with economic and policy related component, conceding difficulties in procuring water rights for uses other than irrigation, working with regulatory agencies, and the lack of willing buyers as primary concerns. Interviewing this program manager uncovered complaints about turnaround time of applications, typically 6 months, and difficulties in transaction mechanisms and policy coherence and overlap. Returning irrigation water for in-stream uses is not considered a beneficial use of state and federal water rights, and ensuring farmers that transferring their rights will not negate irrigation rights is critical for program's success, and will alleviate these barriers.

Structural and theoretical concerns ran high with PES programs associated with water quantity and represent probable barriers to success for these programs. Connecting management practices to environmental outcomes ranked first. Managers noted the lack of restoration happening when water is diverted from irrigating fields and back to in-stream uses. Un-irrigated fields are often left fallow, resulting in weed infested fields. Incorporating restoration into these programs will help goals of conserving and restoring riparian habitat.

Concerns with economic trade-offs is warranted, given payments associated with returning water for in-stream use does not compete with selling water rights outright or continuing irrigated farming. Regarding leakage, two respondents were concerned and spoke to difficulties assessing where water is coming from since water rights may be procured, but deciphering how much water is actually being returned to the system is difficult. Managers can assess overall increases in water volume, but pinpointing contributing locations requires in depth monitoring and is unlikely given financial constraints. Concerns with conditionality can also be explained by this.

Three out of four programs were concerned with the commodification of nature, showing the paradoxical nature of working within PES frameworks for environmental gain.

Fire risk mitigation

Fire risk mitigation is questionable if it fits PES's parameters of being voluntary as these programs are funded by utility charges to customers. In both cases reviewed programs were approved by voter referendum, making them technically voluntary, although some may have voted no. Regardless, these type of programs merit

investigation. Goals of fire risk mitigation programs are to reduce chances of catastrophic fire, resulting in a mass sedimentation. If a fire eliminates forest cover, barren land is exposed, and with precipitation will erode quickly, leading to copious amounts of turbidity and sedimentation in water sources. Water utilities are extremely concerned with this scenario, given difficulties and costs associated with filtering sedimentation. A catastrophic fire, and resulting sedimentation, renders local water source useless until problem are rectified with new filtration plants.

Neither respondent were unsatisfied with practical components of their programs. Fire risk mitigation programs are straight forward, with funding secured through payments by customers, and land management practices easily definable and understood. Some issues did come to light during interviewing, specifically dealing with applicable regulatory agencies. Concerns around work cultures associated with agencies and their "lack of timeliness" turning around reports and essential collaboration represents an issue worth noting. Other concerns were limited, with one program showing concern with performance measures, economic trade-offs, multiple goals and collaboration.

Nutrient reduction

Nutrient reduction PES programs involve working with farmers to change fertilizing and drainage practices to reduce amounts of nutrient flow into watersheds and subsequent water supplies. Nitrogen, phosphorous, and fecal coliform are targeted, with well understood management practices producing predictable results.

Four programs surveyed fell under nutrient reduction, and typical funding related dissatisfactions emerging, with half of the programs unsatisfied at some level with transaction costs, transaction mechanisms, funding for transaction, availability of willing

buyers and motivation of the buyers. Adaptive management related issues were also prominent. In talking with one program manager, difficulties in implementing adaptive management lies with fear that farmer's will not comply with federal regulations, and the succeeding cost and time associated with changing management practices. Farmers are more comfortable with static, predictable land management protocols allowing for changes to be made without concern of future moving targets.

Biodiversity

Two programs with biodiversity goals were included in the data set with missions of maintaining biodiversity integrity on selected sites. Maintaining and increasing biodiversity protects habitat, makes ecosystems more resilient, maintains working ecosystems, and protects species which may be of use to humankind in the future. Both programs were unsatisfied with multiple practical components of their program. Issues with funding emerged, as program managers were unsatisfied with transaction costs and mechanisms, availability of willing sellers, and funding for research and development. Working with regulatory agencies and elected officials also represented concern to both programs and interviews revealed lack of interest or concern for biodiversity by these agencies and officials. Relating the importance of biodiversity, and justifying conservation costs is a barrier to success for these programs.

Concerns with connecting land practices to environmental outcomes and performance measures were apparent. Scaling up program scope represented the top concern. Given such a large metric for success as biodiversity, collecting data and observations is extremely difficult, time consuming, and prone to inaccuracies. Secondly, other than leaving a site as is, land practices inevitably have effects on biodiversity.

Overall PES programs associated with biodiversity possessed larger percentages of dissatisfaction with practical and structural components and concern theoretical concepts, and given the format of these programs, this is understandable.

Results from individual and program specific components of PES programs show distinguishable trends of concern and dissatisfaction with structural, theoretical and practical components of PES programs. Lack of adequate funding and collaboration mark the most understood barriers to successful PES programs, which represent universal problems for government or private programs of any type. Concerns specific to PES are also prolific, and are discussed in the following section.

Chapter Four: Discussion

When asked about successfulness in achieving PES program goals, all managers felt their programs were succeeding, four claiming very successful programs and twenty-one affirming somewhat successful programs. Given this percieved high succuss level, one may expect an equally high satisfaction level with program components and low concern with potential structural barriers, however, this is untrue for many PES program managers, confirming structural, practical and theoretical barriers to defining successful PES programs do exist. All structural and practical components surveyed could represent a barrier to success for individual programs, but the aim of this research was to identify components broadly accepted as barriers and look for general themes of concern and dissatisfaction.

Survey participants were asked to prioritize economic, political/policy, scientific/environmental, and social components of their program in relation goals and missions. Scientific and environmental goals ranked as the highest priority for surveyed program managers, with economic and policy related issues showing mid-level precedence. Understanding environmental and scientific issues is key given most programs seek to improve selected ecosystem services. High satisfaction level with scientific components, primary ranking for environmental concerns and satisfaction with their programs success makes sense. Social goals ranked lowest, with only two programs prioritizing it higher than last. Even though managers typically defined social concerns as low priority, when asked about their concern level of individual social issues in comparison to their program, some concerns ran high. The following graph indicates surveyed PES program managers' priorities in relation to their program goals.

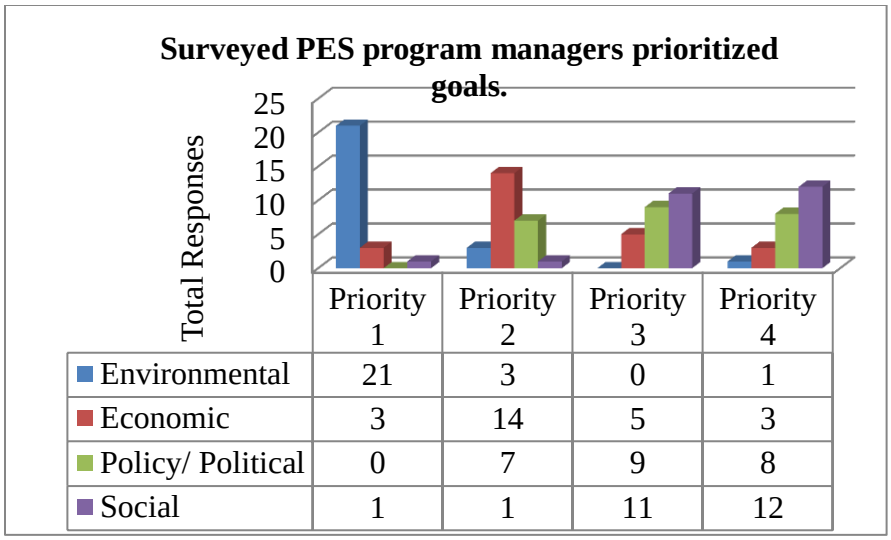

Figure 4 Prioritized goals of surveyed PES programs operating in the USA

Comparing differences between previously discussed prioritized goals and survey results show concern with structural components of PES programs mirror that of prioritized goals, with highest prioritized goals showing the least amount of overall concern. Below indicates higher concern with political and social issues than economic and scientific.

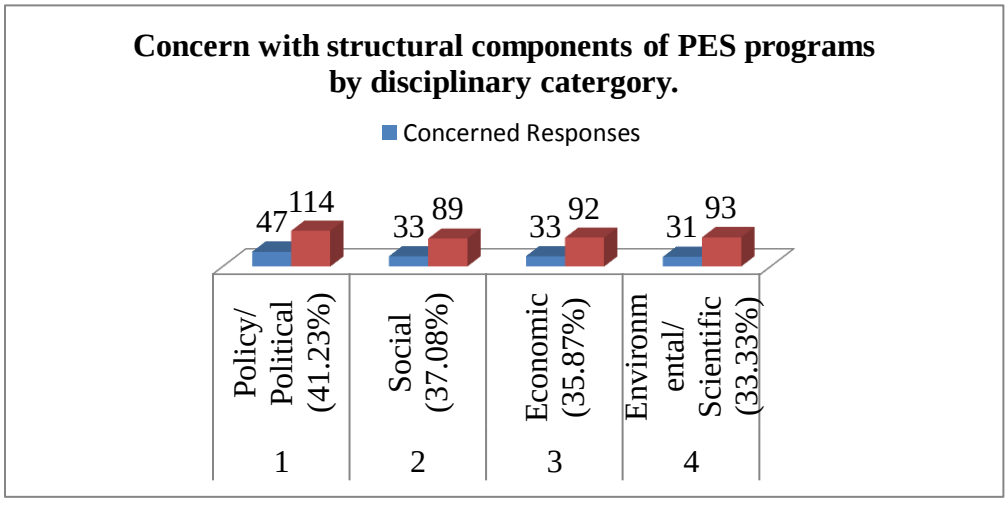

Figure 5 Concern level with structural components by discipline.

Overall dissatisfaction with practical components of surveyed PES programs is considerably lower than concern levels with structural and theoretical components, but potential barriers to success do exist. High levels of satisfaction were shown for questions relating to scientific practical concerns of PES program components, with only seven respondents showing any dissatisfaction. Problems with isolating and quantifying ecosystem services such as monitoring, ecological understanding, proving additionality, trade-offs, and difficulties in tying land practices to specific environmental outcomes received much attention in the literature, however, surveyed PES managers have little dissatisfaction with these components, indicating they are not potential barriers to successful PES operations surveyed. Social issues comprised of three questions, with only three total dissatisfied responses, making social practical components of duration of program, leadership, and education and outreach a non-issue for surveyed programs.

The highest dissatisfaction was show with economic and political practical components related to funding and collaboration as a whole, indicating these issues do present barriers to defining and operating successful PES programs. Below details in rank order unsatisfied responses by disciplinary category, clearly showing the marked difference between categories.

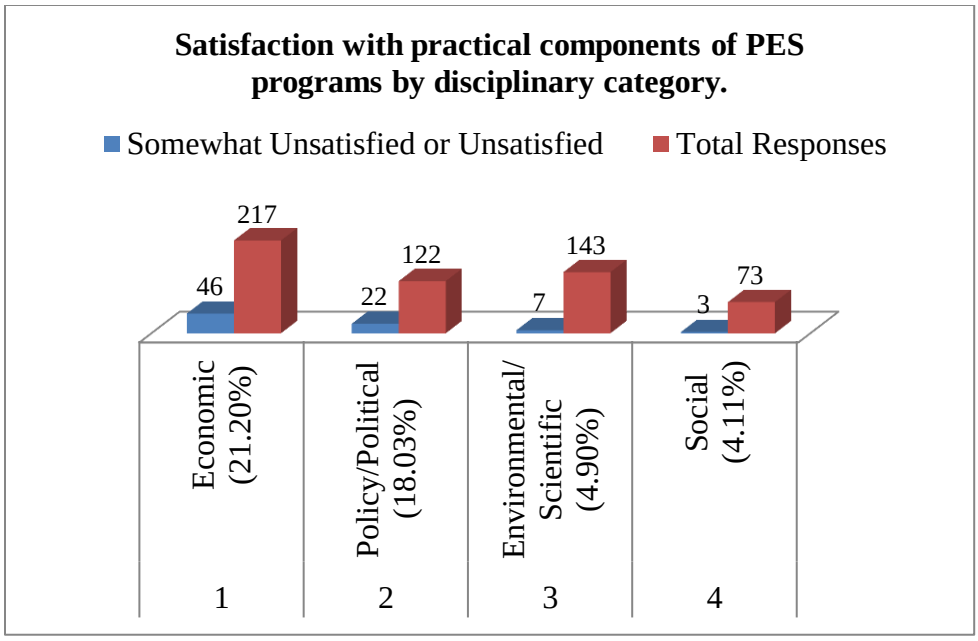

Figure 6 Satisfaction with practical PES components by disciplinary category

General satisfaction levels were high for surveyed PES program components, and may be attributed to respondents percieved success of their program, all ranked either very successful or somewhat successful, however potential economic barriers to success still exist. Inherent to all PES programs are goals of achieving economic markets for desirable ecosystem services. With markets established, a host of concerns emerge which can lead to an inefficient market results for PES programs. Program managers indicate securing dependable funding as first priority to ensure successful PES programs, and high transaction costs erode funding available for payments and operations. Given the relatively new nature of this market and the programs in general, high transaction costs may be expected. Many managers felt their transaction costs will go down as programs mature and more actors are involved. Economies of scale will help alleviate some of these issues, however, high transaction costs take away from payments to service providers and increase the price for potential ecosystem service buyers, making PES

programs unable to attract willing participants. High transaction costs continually produce a barrier to successful PES programs.

Lack of willing and motivated buyers confounds problems with funding. Managers explained their programs were initially funded by government grants or outside sources as pilot projects to display the potential of PES as a mechanism to increase land manager's opportunities and income, while easing the strain on the environment. The transition to finding real buyers willing to pay for these services has been difficult, with the only tangible relationships typically coming between municipalities and upstream land owners. PES programs must attract an adequate pool of willing and motivated buyers to ensure success.

Most PES programs do not operate in isolation, and often coincide with government regulations and agencies. Since PES essentially represents a policy decision towards environmental governance, typical policy development problems arise, with many programs frustrated with collaborating with all actors involved in PES programs, specifically when trying to implement an adaptive management protocol. Collaboration frameworks can work, but often result in policies or programs that miss their original intention. Implementing adaptive management requires constant collaboration with all stakeholders, informing them of new findings, new procedures and changing program goals. Producers of the ecosystem services generally insist on some consistency of practices and payment, and understandably so. Here lies the difficulty of introducing an economic incentive for land stewardship. Landowners need to have concrete guidelines and expectations for payment. Adaptive management, as the name indicates, allows for adapting the original program in light of new technical information, ecosystem

performance, management performance, and available funding, often changing initial contractual agreements. Positive and productive collaboration are necessary for successful PES programs, specifically when adaptive management is implemented. Many programs do not implement adaptive management to alleviate many of the problems associated with collaboration, but all desired to do so, conceding program results and efficiencies would be improved. Although general satisfaction with practical components of PES programs is high, components associated with funding and collaboration can provide barriers to success, and must be addressed during programs inception.

Structural and theoretical concerns with PES programs do not show clear trends of concern by disciplinary category, however components associated with funding, collaboration, environmental targeting and trade-offs, and commodification of nature clearly present potential barriers to the success of PES as a whole. Concerns with funding and collaboration are similar to that of practical components, however, high concern with commodification of nature and targeting for specific ecosystem services are unique.

Commodification of nature questions one's view of use of markets for conservation purposes and provides a potential barrier to the PES concept as a whole. Nonetheless, natural scientists are increasingly embracing pragmatic valuation and market-based approach (Child, 2009) (Spash, 2008) explain "the reason for this is probably the search for short-term policy action to halt ecosystem services loss where traditional narratives for conservation have failed to influence economic decision-making. Because it fits in with the ideological and institutional economic structures in

place, market-based policy design has been in an advantage position to reach decision-making and to get policy proposals implemented (Gomez-Baggethun & Ruiz-Perez, 2011). Although PES constitutes an attractive alternative to command and control environmental governance, concerns over the longevity and efficiency of programs are warranted. Furthermore, and most concerning to academia, PES establishes markets for ecosystem services, most of which have been available for free through history, allowing for an easy visualization where these services will only be available to those willing to pay, excluding marginal communities. Concern over the commodification of nature raises the sensitivity of social and value judgments associated with PES, as many feel by establishing these type of programs, inevitably ecosystem services will be priced and only available to those with means to pay.

Targeting specific ecosystem services represents high concern to academia and surveyed PES programs, given unknown effects of land management practices on other ecosystem services. Only twenty-nine percent of programs surveyed indicate monitoring for non-targeted ecosystem services, making a situation where most programs will not know the overall effect of their management practices. A wealth of information could be supplied to the scientific world if proper monitoring occurs; however, additional monitoring requires additional funding, reducing payments for producers and raising costs for buyers, making PES programs uncompetitive with other land management activities.

The overarching goal of this paper is to identify and verify barriers to success for PES programs as means to raise awareness of these issues for current and future programs, allowing for programs to develop protocols to alleviate these barriers. Clearly

potential barriers exist, specifically with collaboration and funding. PES is becoming exceedingly popular to policy makers because of its intuitive nature, breaking ecosystem services down to simple monetary values. Many programs are brought forward in haste without proper stakeholder analysis and vetting of programs structure, making programs destined to fail. Success for PES programs can be increased with a complete evaluation of all practical, structural and theoretical components associated prior to and during program operations, and this paper supplies a great resource for identifying and verifying these components.

Chapter Five: Conclusions

The crux with PES programs lies within inner conductivity of nature and socioeconomic, socio-ecological, and sociopolitical interplay. Defining successful PES programs implies managers delineate programs goals and missions, assess satisfaction with individual program components, and understand their programs position in context to PES definitions, practice and theory.

Practical barriers to successful definition and operation of PES programs in the United States do exist, mainly categorized under economic and political disciplines. An overall lack of funding perpetuated by high transaction costs and lack of willing and motivated buyers and sellers represent major practical barriers, inducing many programs to fail under economic pressure. Issues with collaboration at multiple levels, including elected officials, regulatory agencies and PES stakeholders as a whole exhibits political barriers to success. Working with multiple goals and issues with policy overlap and confusion confound collaboration concerns.

Concerns with structural and theoretical components also provide potential barriers to successful PES programs operating in the US. Economic and environmental trade-offs, commodification of nature, implementing adaptive management and working within a collaboration framework do not allow PES managers to fully assess their programs success. Economic trade-offs illicit difficulties associated with funding, with concerns revolving around problems with covering opportunity costs of ecosystem service producers, whereas environmental trade-offs refers to concern targeting one ecosystem service may hinder production of other ecosystem services. Implementing adaptive management and working in collaboration frameworks again points to

overarching difficulties reaching consensus given numbers of stakeholders and their goals, interpretations, and nuances. Heightened concern with commodification of nature portrays the paradoxical nature of PES as PES frameworks establish potential markets to be exploited. Yes barriers to successful PES program operations exist, but by taking a close look at each component producing potential barriers and looking at interconnections, ways to improve individual and overall efficiency with PES is possible. This report supplies information to do so.

Future recommendations

Future recommendations include establishing a network of PES programs, where program managers can consult other programs for advice, outline program structure, identify working models in practice, and identify and rank concerns and dissatisfactions. Allowing broader communication between programs will raise the overall effectiveness of PES individually and as a whole.

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