

Upper Green River Basin Ecosystem Services

Feasibility Analysis Project Report



Russell Schnitzer

By Esther A. Duke, Amy Pocewicz, and Steve Jester

December 2011

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Acknowledgements

This feasibility analysis was possible due to financial support from the Dixon Water Foundation, the World Bank Community Connections Fund, and The Nature Conservancy.

We thank our partners at the University of Wyoming and Sublette County Conservation District, who include Kristiana Hansen, Melanie Purcell, Anne Mackinnon, Roger Coupal, Ginger Paige, and Tina Willson. We are also grateful to Jonathan Mathieu and The Nature Conservancy's Colorado River Program and to the many individuals who participated in interviews and focus group discussions. The report also benefitted from discussion with and review by Ted Toombs of the Environmental Defense Fund.

Suggested citation:

Duke, EA, A Pocewicz, S Jester (2011) Upper Green River Basin Ecosystem Services Feasibility Analysis. Project Report. The Nature Conservancy, Lander, WY.

Available online:

www.nature.org/wyoscience

December, 2011

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Pronghorn antelope

Scott Copeland

I. Introduction

Intensified land use change and resource extraction, coupled with climate change, will challenge communities across the western United States to manage for and conserve wildlife and to provide clean, reliable, and affordable water and other services to urban and rural populations. In other words, these communities must find ways to better manage for ecosystem services or “the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life” (Daily, 1997, p. 3). Ecosystem services include many benefits that businesses and people derive from nature such as food, freshwater, pollination, and climate regulation (DeSantis & Ranganathan, 2011). These services form the link between nature and economic development. Recent growing interest in ecosystem services reflects a broader trend that includes not just traditional conservationists, but also agricultural producers, businesses, and communities. As “governments and corporate leaders move beyond a narrow mindset of protecting nature from economic development to focus on how to invest in nature for development” (DeSantis & Ranganathan, 2011, p.1), the dialogue and the actors are changing.

Incentive-based tools to protect and restore ecosystem-service flows, broadly referred to as payments for ecosystem services (PES), are a promising approach to address these challenges. Through PES programs beneficiaries of ecosystem services pay suppliers, typically landowners, who ensure through their land management that nature continues to supply these services. In the Upper Green

River Basin of southwest Wyoming a public-private partnership is actively exploring new paradigms and approaches such as PES programs, including various voluntary and regulatory conservation banking and credit trading systems, and ecosystem service markets. A widely-accepted PES program could provide enhanced wildlife habitat for priority species and secure water quality, quantity, and flows while protecting the customs and culture of the ranching community and providing for sustainable livelihoods. Obstacles include complex property right structures, surface and subsurface development rights, the number of government agencies, energy companies and citizen groups involved, competing interests, the time scale for ecosystem recovery, history of minimal public engagement in management, lack of political will, and widespread unfamiliarity with the PES approach (Lemphers, 2008). However, an increasingly diverse team of local and regional actors are interested in funding conservation efforts on private and public land and are exploring new roads forward.

This report explores the feasibility of using PES in the Upper Green River Basin, along with suggestions for the appropriate design of such a program. In the following sections we provide an overview of ecosystem service threats and opportunities in the basin, introduce possible PES approaches, and provide results from a feasibility analysis. After discussing the opportunities and obstacles facing PES program development, we provide information on and suggestions for project next steps.

II. Payments for Ecosystem Services

The root of the problem with our current system of valuation in regards to ecosystem services is that many of the benefits that we derive from ecosystems are external to the economic system (externalities), or public goods for which no one pays. In other words “the existence of many forms of market failure means that natural capital depletion is often much greater than would be socially optimal” (Engel et al., 2008). Since a substantial portion of ecosystem benefits are

externalities, voluntary approaches such as PES are likely to change people’s behaviors or practices if they are rewarded for the provision of the ecosystem services or for land-use practices that are directly related to the protection or improvement of ecosystem services. The foundation of the PES concept is to compensate landowners for the management of ecosystem services (wildlife habitat, late season stream flows, etc.), which are valuable to people and

communities, but that typically provide no income to the landowner. PES incentivizes the stewardship of important ecosystem services and allows the communities and industries which value and depend on these services a means for investing in the availability of those services now and into the future. PES allows for the pricing of environmental degradation so that the costs of these impacts are incorporated in the cost of development (e.g. oil and gas development), whereas traditionally these costs were accounted for inadequately or inaccurately. Ultimately, PES is about integrating the value of ecosystem services more fully into our economy and thus encouraging more holistic and sustainable development. PES is increasingly used to create incentives for agricultural producers to manage their land for biodiversity and ecosystem service outcomes, alongside continued food production (Harvey et al., 2008; Pagiola et al., 2008).

The idea of PES is now being explored in a diversity of communities and ecosystems throughout the United States from New York City to Fort Hood, Texas and around the world, from Costa Rica to China (Figure 1). Notable examples in the Americas include a national-scale, 15-year PES program in Costa Rica focused on greenhouse gas mitigation, hydrological

services, scenic value, biodiversity, and more recently water services (Pagiola et al., 2005; Zbinden & Lee, 2005; Sierra & Russman, 2006; Pfaff et al., 2007; Pagiola, 2008), a similar national program in Mexico (Alix-Garcia et al. 2004; Pagiola et al., 2005; Corbera et al., 2009), and the municipal drinking water purification services that residents of New York City, USA and Quito, Ecuador purchase from upland farmers (Daily & Ellison, 2003; Foley et al., 2005; Grieg-Gran et al., 2005; Pagiola et al., 2005).

Payments for ecosystem services are not just about environmental protection or restoration, but also about the role that ecosystems play in underpinning economies, industry, and individual businesses (DeSantis & Ranganathan, 2011). A conservative estimate of the current global size of the major PES programs related to carbon, water, and biodiversity places the total value at a minimum of \$130 billion (Hamilton et al., 2010; Madsen et al., 2010; Stanton et al., 2010). Already nearly a decade ago, a global analysis found 287 PES and PES-like initiatives in operation or under development (Landell-Mills & Porras, 2002). Few of these are, however, true markets with multiple buyers and multiple sellers competing to arrive at a price and transactions.

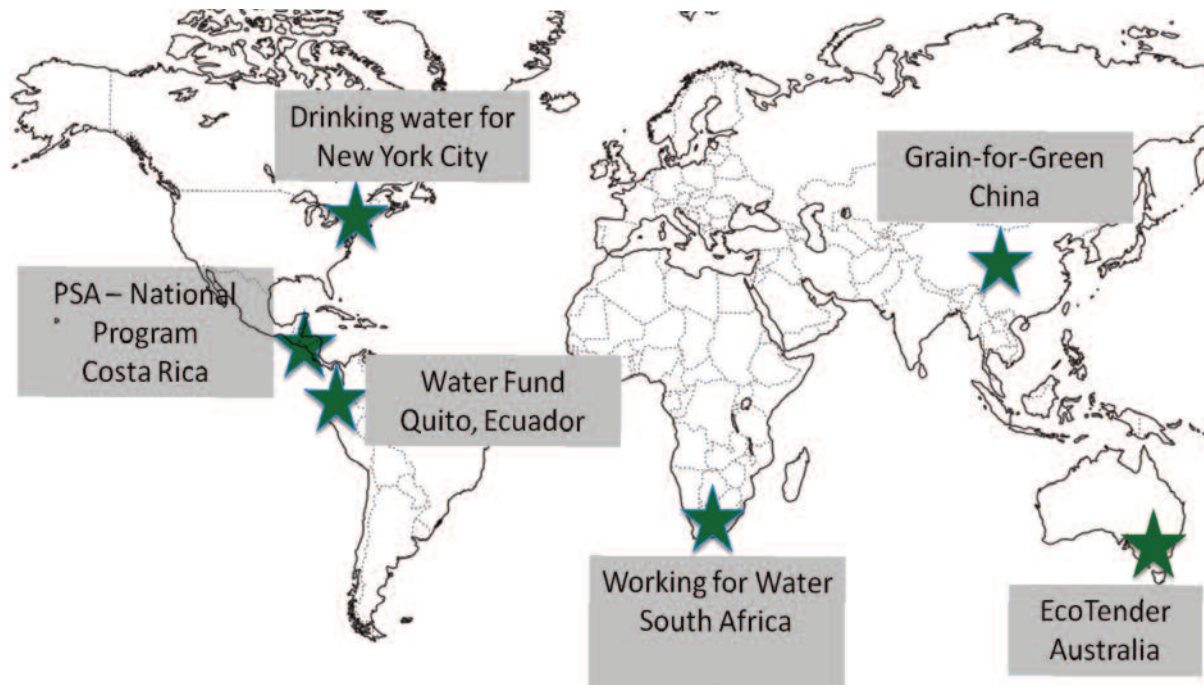


Figure 1. A few of the largest and most well known PES programs around the world

Ensuring that PES funds are spent wisely is a key area of inquiry for researchers, policymakers, funders, and other stakeholders. This situation is heightened by the fact that at local, national, and global scales, existing funding for conservation still provides only a fraction of the recognized need. As a subsidy approach, PES is particularly vulnerable to several potential pitfalls:

- 1) Lack of Additionality - making payments for land-uses that would have been adopted anyway and thus reducing funds available to induce more sustainable land-use change elsewhere (Pagiola, 2008);
- 2) Leakage – shifting environmental damage to a different location, but not actually reducing overall impacts (Engel et al., 2008); and
- 3) Perverse Incentives – increasing environmentally damaging activities in order to be eligible for subsidies at a later date (Engel et al., 2008).

In order to avoid these pitfalls, PES should only be used in appropriate situations, with adequate planning and when supported with strong institutional capacity. Although PES could, in principle, merely provide rewards that do not function as incentives for real change, most service buyers are only willing to make additional payments for actual additional services. This “conditionality” is a key redeeming factor of PES, and it requires transaction monitoring and oversight to be credible (Engel et al., 2008). This oversight requires institutional capacity. Purposeful and site specific program design is essential because program oversight, structure, and eligibility requirements mediate participation. For a PES program to be successful in achieving its environmental objectives, it must be designed to enable participation by landowners to manage ecologically-important parcels of land (Kosoy et al., 2008).

There are numerous different types of PES, and we will begin by providing a broad overview of these opportunities. With PES programs, ranchers, farmers, and forest stewards manage for new commodities such as wildlife, carbon, and water services, while the beneficiaries of these services invest in them to ensure their continued production. PES agreements can be

permanent or prorated into term-limited contracts. Some people discussing term-limited PES agreements call them "conservation contracts" (in contrast to conservation easements). Under many such contracts, a landowner or manager commits to perform on his/her land practices which steward the production of “services” over a set term of years, while in some programs actual increases in ecosystem services are measured (i.e. increased stream flow or decreased water temperature). Facilitating these exchanges is easier with the development of formal businesslike approaches or markets to connect buyers and sellers. The major emerging market types can be categorized by buyer type and motivation as follows:

Compliance: driven by regulations and enforcement

Pre-Compliance: acting in anticipation of future regulation

Voluntary: driven by business and ethical concerns

Government-mediated: public payments to private landowners for ecosystem service provision

Risk Management: Investments to manage the risks that people take (e.g. ensuring water or other services that a company or utility may find essential to their bottom line).

Actual payments can be direct (e.g., payment for rangeland soil carbon), embedded (e.g., grass-fed beef, agrotourism), or risk management contracts (e.g., municipal water utility investments in upland watersheds). Of course, in applied situations the lines between these categories end up blurred and programs often combine approaches. The Fort Hood Recovery Credit Trading System (see Box 1, p. 22) is one good example of a recently developed habitat credit market which is motivated by compliance and is a government-mediated market using direct payments (Robertson & Rinker, 2010; Scarlett, 2010).

III. The Upper Green River Basin

The Upper Green River Basin of southwest Wyoming is a rural working landscape, dominated primarily by ranching, along with resource extraction including oil and gas and the mineral trona (source of sodium carbonate). The headwaters of the Colorado River system begin in the Upper Green, providing water for millions of agricultural, industrial and residential consumers throughout the southwest. The Upper Green is also an area of world class wildlife. The sagebrush steppe wildlife assemblage is essentially intact here and includes species such as the greater sage-grouse, pronghorn antelope, mule deer, moose, elk, pygmy rabbit, white-tailed prairie dog, and several sagebrush songbirds. The Upper Green features the longest and one of the largest remaining ungulate migrations – of pronghorn antelope – in the lower 48 states, which spans over lands stewarded by multiple federal agencies, three Wyoming counties, and over the property of 40 private landowners (Cherney & Clark, 2008). This is one example of the current ecosystem benefits being provided in the basin.

Since 2000, the Upper Green River Basin has experienced greatly expanded surface disturbance as a result of increased oil and gas development and related residential development. Much of this development has occurred in Sublette County, Wyoming (Figure 2). Sublette County was the number one producer of natural gas and the number two producer of crude oil in the state in 2010 (Petroleum Association of Wyoming, 2011). Much of this production has come from the Jonah and Pinedale Anticline natural gas fields (Figure 2). This oil and gas boom brought jobs and economic growth into the region. The population of Sublette County nearly doubled between 2000 and 2010 from 5,920 to 10,247 (US Census, 2011); and traffic increased by 86% between 2000 and 2007 (Ecosystem Research Group, 2009). Along with this growth have come impacts to wildlife populations, ecosystem services, and local communities. Many wildlife species, including greater sage-grouse and mule deer, are sensitive to the infrastructure and activities associated with oil and

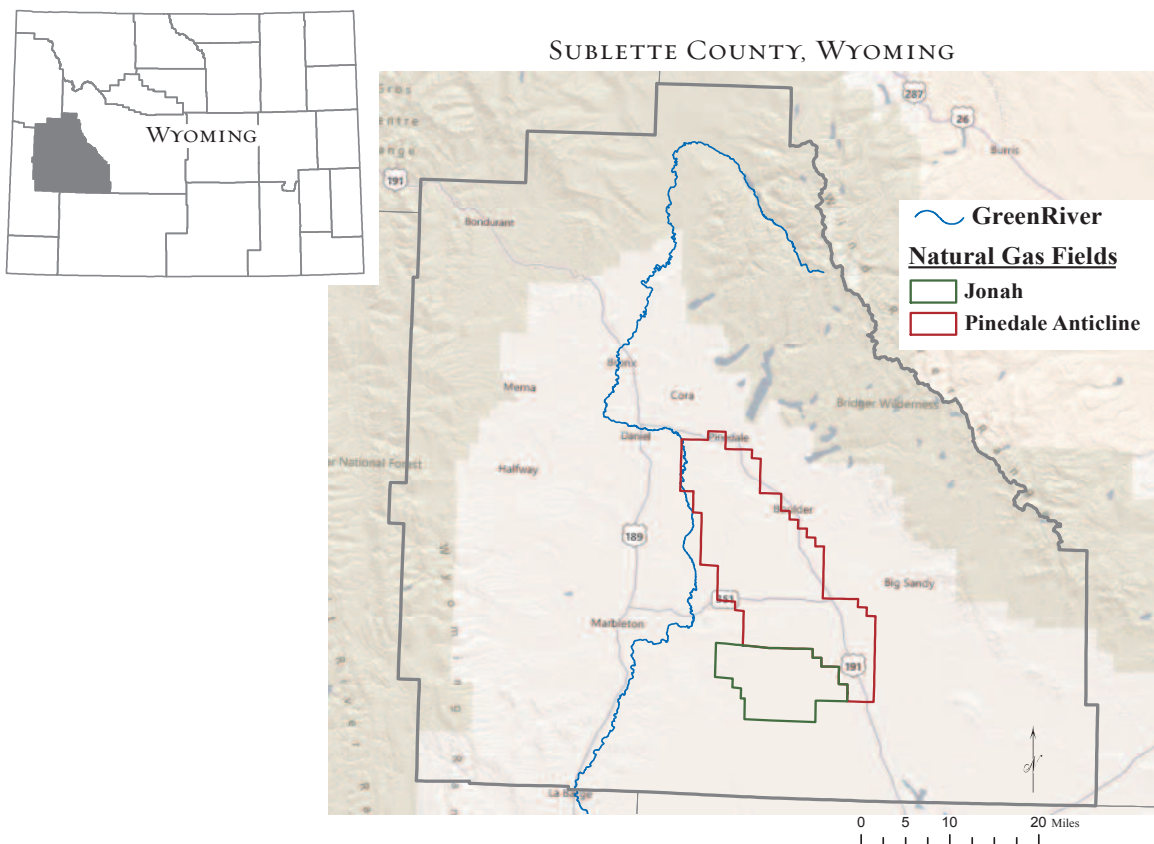


Figure 2. Sublette County is located in the Upper Green River Basin of southwest Wyoming.

gas development (e.g., Berger, 2004, Sawyer et al., 2009; Naugle et al., 2011). Other associated impacts of energy development booms here and elsewhere in the western U.S. include decreases in air quality (Schnell et al., 2009) and social well-being (Smith et al., 2001) and increases in the cost of living (Albrecht et al., 1985; Ecosystem Research Group, 2009).

Many mechanisms for conservation are currently in place in Sublette County, including some directly related to recent energy development impacts. To reduce or offset impacts from natural gas development, developers of the Jonah and Pinedale Anticline fields contributed funding towards mitigation, an example of permittee-responsible compensatory mitigation. For each field an interagency government office was established to manage and distribute these funds, the Jonah Interagency Office (JIO) and the Pinedale Anticline Project Office (PAPO; <http://www.wy.blm.gov/jio-papo/index.htm>). Mitigation planning also occurred to identify the biological impacts and the best locations to mitigate multiple impacts (Kiesecker et al., 2009; Copeland & Kiesecker, 2010). Mitigation funds have been directed to a range of wildlife and habitat protection or improvement projects, including conservation easements, water developments, fencing, and habitat restoration. Other conservation incentives offered to

date for private landowners in the area include some technical assistance, cost-share funding for habitat improvements and funding for the purchase of perpetual conservation easements, and some Natural Resource Conservation Service (NRCS) programs. However, not all lands are eligible or are a good fit for NRCS programs, and some private landowners are not interested in or are unable to sell permanent conservation easements. Others prefer not to enroll in government-run programs, including those of the NRCS or the current industry mitigation programs managed by the interagency government JIO and PAPO teams.

In recent years, landowners and funders in Sublette County have expressed interest in incentives to manage lands for ecosystem service production though potentially renewable term contracts. Some of this interest is motivated by the landscape changes that have been occurring rapidly, leading to greater pressure and negative impacts on ecosystem services and agricultural producers. Landowners are interested in a program that offers something that is not a perpetual conservation easement and not a cost-share habitat enhancement program, but instead a payment for habitat and/or water services in a specific place for a specific time period.

IV. Upper Green River PES Collaborative Initiative

The Nature Conservancy (TNC) in partnership with the University of Wyoming (UW), and the Sublette County Conservation District (SCCD) is exploring the feasibility of local landowner-requested term habitat leasing agreements and term water services contracts to compensate landowners for specific land management practices which result in maintenance or improvement of habitat and/or water services. This project seeks to engage both buyers and sellers to assess feasibility and describe a potential program for a PES-based approach to enhance wildlife habitat and watershed health.

Ecosystem service markets for conservation on private lands require agricultural, ecological, legal, and financial expertise, as well as buy-in from landowners, conservationists, investors, regulators,

and government agencies. Landowner networks, cooperatives, conservation districts, and third-party aggregators can play crucial roles in building partnerships and integrating the necessary expertise. The aim of this exploratory study was to build partnerships, identify gaps or weaknesses in the current conservation and mitigation systems, and determine how best to use PES programs to enhance wildlife habitat and watershed health in the Upper Green River Basin. The TNC-SCCD-UW team is working to determine if conservation contracts, designed for the Upper Green, are a practical way to encourage and sustain continued conservation practices. The team hopes that such a tool could also be useful to industry working in the Upper Green as an additional way to provide meaningful mitigation and invest in resources for the future.

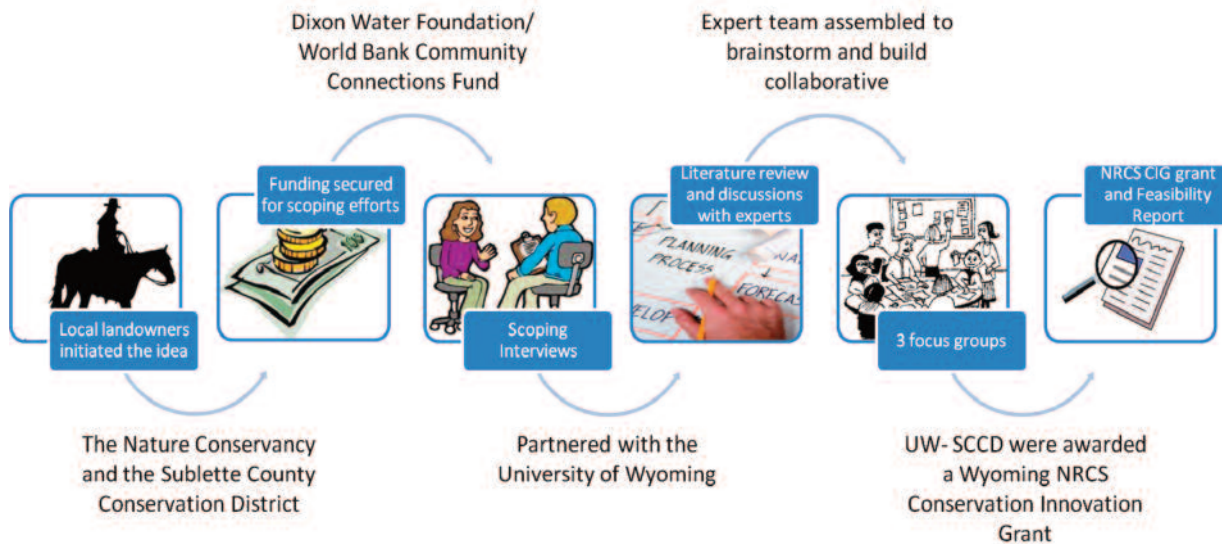


Figure 3. The history of the Upper Green River PES collaborative to date

TNC launched this project in early 2010, working closely with the SCCD and local landowners (Figure 3). TNC conducted initial interviews that summer with local conservation experts and potential program funders. Soon after beginning the exploratory analysis on PES feasibility, TNC staff learned of a related effort that was in the beginning stages of development by a team at the UW. Both groups were interested in exploring the feasibility of wildlife habitat contracts to ensure biodiversity services and in providing incentives for water services including the ecological health of riparian areas. Since each partner brought different skills and expertise to the project, the two related efforts joined forces to apply their combined expertise to explore PES opportunities for both biodiversity and water services. At this juncture TNC scientists synthesized the scoping interview responses and reviewed key literature and related projects and programs in order to prepare for the creation of a broader collaborative. Beginning in early 2011, the partners were working closely together and were in communication with other stakeholders working in the basin. TNC took the lead on organizing and facilitating two focus groups in Pinedale, WY, and assisted the UW team with a third focus group in Denver, CO (Figure 3). This series of interviews and focus groups were designed to solicit and compile expert advice and opinions from a diverse cross-section of professionals from government, non-profits, academia, and industry working to understand and manage sagebrush steppe/rangeland ecosystem products and services.

This concluded the initial feasibility analysis funded through the Dixon Water Foundation and the World Bank Community Connections Fund. UW and SCCD jointly received two follow-up grants for this project, one from the Natural Resource Conservation Service (NRCS) in Wyoming, and one from the University of Wyoming Agricultural Research Experiment Station (AES) to undertake part of the additional social and ecological analysis needed to guide the design and implementation of a PES project in the Upper Green. The two-year UW-SCCD project will build off of the critical initial findings included in this report and contribute to the base of knowledge needed to implement a PES program in the project area. Our team is still seeking additional funding to see the project through to the creation of a self-sustaining PES program. These details are discussed in the Next Steps section of this report, beginning on page 26.



The Green River in southwest Wyoming

Ed Orth

V. Feasibility Analysis Methodology

The methodology employed for this PES feasibility analysis consisted of two components: 1) information collection, and 2) information synthesis. The methods are based on the participatory rural appraisal (PRA) approach. PRA is “a family of approaches and methods to enable rural people to share, enhance, and analyze their knowledge of life and conditions, to plan and to act” (Absalom et al., 1995, p. 1). PRA enables the rapid collection and analysis of ecological, economic, and social information for use in project design, execution, and evaluation. This approach has its roots in rapid rural appraisal, applied anthropology, agro-ecosystem analysis, activist participatory research, field research on farming systems, and other related practices (Chambers, 1994). The approach was developed as an alternative to traditional social science methods (e.g. surveys, formal focus groups, etc.) when time and financial resources are limited and local knowledge is valued (Chambers, 1994). For this project, we used a PRA approach to quickly assess whether the PES program seemed like a good enough fit to merit more in-depth research to guide the development of the project. Information collection for this project included typical PRA sources such as websites and published materials, interviews with key contacts, site visits, and meetings or correspondence with key stakeholders in Wyoming and with contacts from other PES projects (review of existing related

efforts). The results section of this report includes outcomes from informal semi-structured interviews and facilitated focus group discussions conducted between the summer of 2010 and the fall of 2011.

Early discussions within the TNC-SCCD-UW team and with potential partner organizations inevitably ended up focusing on the oil and gas industry as a potential buyer of ecosystem service contracts in the Upper Green River Basin. The energy industry drives the majority of impacts to ecosystem services in the region and has the most to gain from purchasing effective and efficient verified conservation contracts. Oil and gas mitigation funds are currently the principal intermediary agent managing conservation programs in Sublette County and as such their input is integral to these PES discussions. Thus, information includes input from oil and gas mitigation team members, oil and gas company representatives, as well as ranchers, and conservation practitioners. The aim of this information gathering process was to identify and engage potential buyers and program administrators in a collaborative exchange to address the project objectives presented below. The methodological approach applied during each stage of this information gathering process is summarized in the sections that follow.

PROJECT OBJECTIVES

1. Determine the likely feasibility of a “payment for ecosystem services” program focused on wildlife habitat and watershed health values in southwest Wyoming.
2. Identify potential ecosystem services that funders are willing to pay for and landowners are willing to manage.
3. Determine a program structure and contract terms that could result in a viable market-like program and begin to explore options for determining pricing of services.
4. Identify a process of clearing transactions acceptable to both buyers and sellers which also minimizes transaction costs.
5. Identify potential roadblocks to implementation and develop strategies to address them.

Semi-Structured Scoping Interviews

Our team used a convenience sampling approach for interviews during this exploratory study, meaning that participants were selected based on easy availability. We interviewed Sublette County landowners (potential sellers), government agency and NGO scientists (expert informants), and NGO/ government conservation funders active in the area (potential funders) to get their suggestions regarding site-specific ecological priorities, program design preferences, and desired outcomes for conservation funders. The initial number of interviews was small (three each for potential sellers, expert informants, and potential funders) since the intent was to solicit expert opinion to help guide slightly larger focus group discussions. The expert informant and potential funder groups came from the same types of institutions and were differentiated based on their role within these institutions. The expert informants included scientists (biologists/ecologists) with knowledge of the species and systems of interest in the area, and outreach specialists from non-profit organizations and government agencies. The potential funders group consisted of individuals who are responsible for funding decisions through government and non-profit organizations. Only one of the interviewees was a representative from a private sector industry. Interviewees were mostly representatives of groups that might help to fund a pilot project or work with the buyers. The objective of our initial interviews with experts and key informants was to determine opportunities and obstacles to PES program development, determine existing knowledge gaps, and identify key sets of actors to include in the development of the schemes.

Next we organized and facilitated a series of focus groups to follow-up on key issues identified through the scoping interviews and the literature review.



Focus group 1: Experts and Potential Collaborators

The first focus group on September 21, 2011 convened team members from the three organizations spearheading this project (TNC, UW, and SCCD) along with representatives from Wyoming Land Trust, Trout Unlimited, Wyoming Landscape Conservation Initiative (WLCI), USDA-NRCS, and water resource experts. This first focus group was designed to solicit input from experts and potential program collaborators. Our specific goals were to:

- Increase communication between groups and exchange information about conservation on private lands and in the Upper Green River Basin.
- Develop a partnership to initiate a joint and/or linked conservation incentive program.
- Explore how best to use PES programs to improve land and water management in the Upper Green River Basin.

The 14 attendees contributed to the discussion through a facilitated situation mapping activity, sometimes also referred to as systems mapping. Situation mapping is a process of graphically representing a situation in order to create a shared and systematic understanding of it. This mapping uses a visual representation to explore complex interrelationships and systems that are hard to explore in words alone. This activity is designed to facilitate dialogue and exploratory thinking and to integrate the knowledge of all participants. The goal of the activity is not the actual map but the discussion, which often helps to identify central issues and may also identify strengths, questions, partnerships, organizational roles, and new ideas. This activity and the resulting maps provide an opportunity for idea sharing regarding the assigned topic. Participants were divided into three teams and each team created a map of the “situation” of ecosystem service management in the Upper Green River Basin. The facilitator suggested that the end maps might include organizations, tools, ecosystem services, suppliers, and beneficiaries/users.

Focus Group 2: Mitigation Teams

On September 22, 2011, we hosted a second focus group for Jonah Interagency Office (JIO) and Pinedale Anticline Project Office (PAPO) team members to discuss the PES tool with our team. JIO and PAPO are the two oil and gas mitigation funds operating in the basin. These interagency teams include state and federal employees from the Wyoming Department of Agriculture, Wyoming Game and Fish Department, the Bureau of Land Management (BLM), and Wyoming Department of Environmental Quality. We invited them to provide expert advice, express concerns, and explore how best we might work together to come up with innovative solutions to the adverse effects of development in the region. During a creative thinking exercise, using a nominal group process, the 12 focus group participants identified and ranked opportunities and challenges for the JIO and PAPO team to work with the Upper Green River Basin PES Collaborative. Each participant was allowed 5 votes for opportunities and 5 votes for challenges/obstacles.

Focus Group 3: Potential Buyers

On October 24, 2011 the Upper Green River Basin PES collaborative engaged oil and gas industry representatives in a focus group to discuss industry's potential interest and concerns regarding implementation of a PES option as part of mitigation. Twelve people participated in the focus group, including representatives from Encana, QEP Resources, BP, and Anadarko. The focus group was organized as an open forum.

Focus Group 4: Potential Sellers

Two landowner focus groups were held in Sublette County on December 7 and 8, 2011 to gather further information on local interests and concerns of the ranching community in regards to PES markets. Two separate focus groups were facilitated to engage landowners from the different part of the county and to represent the full range of communities. Twelve people attended one meeting and eleven people attended the other. These focus groups were also organized as an open forum. Results were not yet available to include in this report.

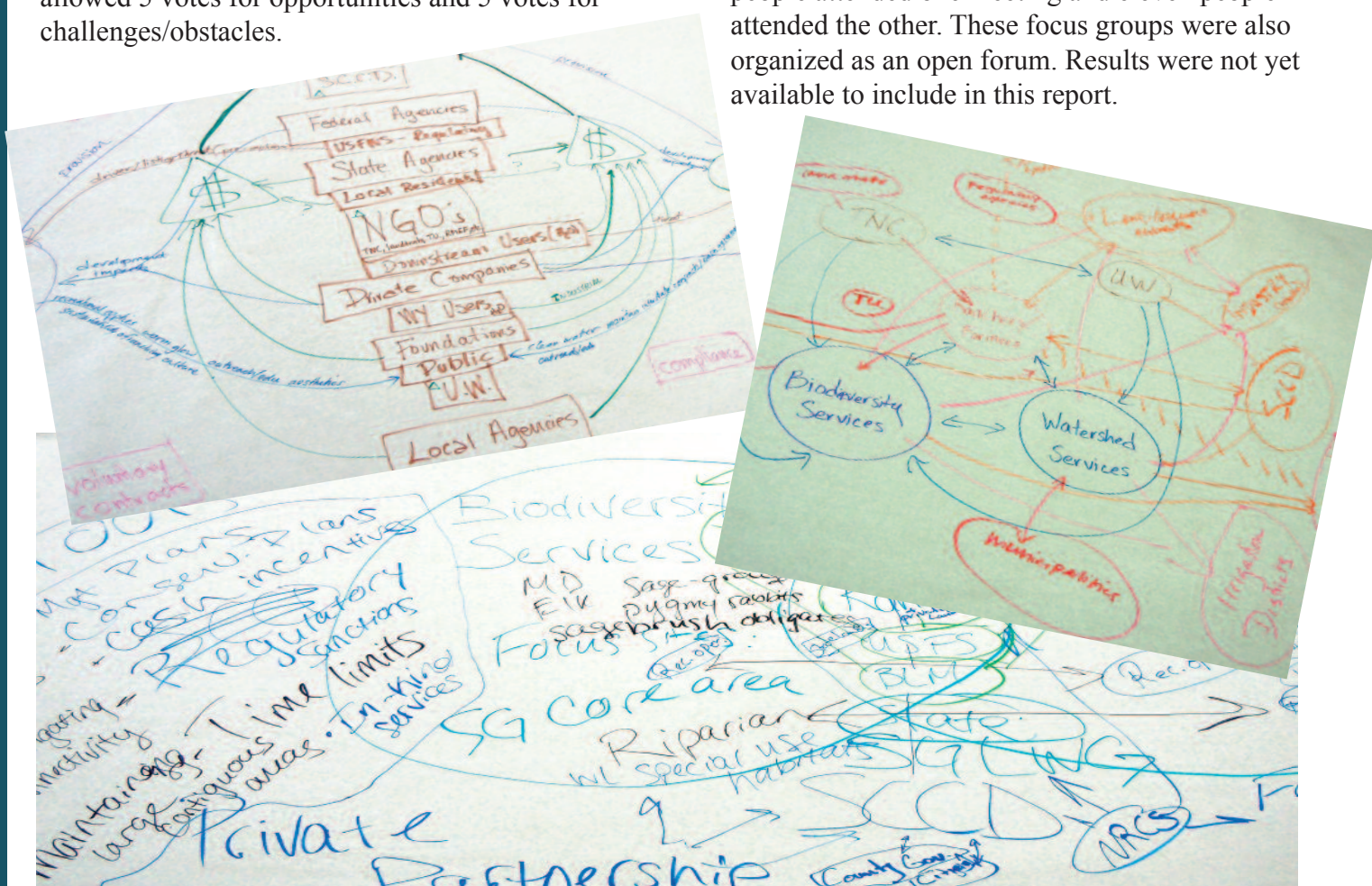


Figure 4. Situation maps created in Focus Group 1

VI. Results and Discussion

A. Semi-Structured Scoping Interviews

The scoping interviews revealed a diversity of preferences for program focus and design, yet three key insights arose. First, many stakeholders prefer not to work with a government agency as the program administrator (Table 1). Those who recommended a government agency preferred to work with a state-level agency. Second, many of the interviewees expressed interest in the availability of short contracts,

of 5 years or less. Third, habitat for watch list species or those likely to be listed in the future is a noted concern for many of those interviewed. It is also notable that freshwater species, riparian areas, and other water-focused concerns emerged during these interviews. A qualitative summary of results of the scoping interviews is provided in Table 1.

Table 1. Summary of scoping interview results

Scoping Interview Findings

Ecological Priorities (*input from expert informants*)

Species to focus on:

- Sage-grouse
- Mountain plover
- Mule deer
- Pronghorn
- Native trout
- Wild trout (naturally sustaining, but not native)

Important systems:

- Sagebrush-grasslands
- Desert shrub
- Riparian habitats
- Coldwater aquatic systems

Arrangement on landscape/scale/scope:

- Sage-grouse core areas¹
- Watersheds
- Sub watershed scale

Program Design Preferences (*input from potential sellers and potential buyers*)

Contract Management Entity:

- Conservation District
- Nongovernmental Organization/501c3 (TNC, private land trusts, etc.)
- No state or federal agency, the more local the better
- NRCS perhaps jointly with UW extension biologist
- Wyoming Game and Fish Department
- Wyoming Wildlife and Natural Resource Trust

Compliance and Monitoring:

- Some annually, more intensive every 3-5 years
- Generic baseline for program instead of a landowner baseline
- Systematic but flexible approach to monitoring
- Monitoring programs can also be designed to include education/outreach

Contract:

- 5 years with renewals and reassessment
- If done in conjunction with or as mitigation for development project, then duration could be linked to project duration/reclamation time frames
- 20 year maximum
- 1, 2, or 3-year drought type situation
- First 5 year payment up front with annual payments afterwards, money held in escrow

Program Focus (*input from potential buyers*)

Outcomes - Three main goals:

- Reduce fragmentation
- Reduce invasive species
- Maintain and improve water quality, quantity, and flows

Important Factors:

- Protect existing investments
- Ecosystem function/ benefits more than a single species
- Benefits “watch list” or endangered species
- Public land/private land dual focus

Requirements/prioritization criteria:

- Closely aligned with industry impacts and processes
- Maintains existing habitat
- Cost efficient
- Has longevity

¹The state of Wyoming has adopted a sage-grouse core area policy (State of Wyoming Executive Order 2011-5) that limits infrastructure development within areas of the highest breeding population densities for sage-grouse (population core areas, Doherty et al., 2011) as a strategy to avoid population losses of the bird that could warrant it for listing under the Endangered Species Act.

B. Focus Group 1: Experts and Potential Collaborators

The discussions and emphasis differed by group, as demonstrated by the situation maps (Figure 4). At the end of the mapping exercise, the participants shared their maps with the other groups and discussed the similarities, differences, and discoveries. Two groups focused in on brainstorming ideas for potential buyers, funding sources, and potential users both inside and outside of the Upper Green. In addition to the extractive industries (oil, gas, mining), participants identified other ecosystem service beneficiaries including tourists, the hospitality industry, second home owners, municipalities, sportsmen (especially hunters and anglers), downstream water users, and irrigation districts. Participants made some specific recommendations for broadening the market, for example, going to all major hotel chains associated with the Colorado River (of which the Upper Green is the headwaters) and developing a “\$1 for the river” program. In one of the groups the focus was primarily on potential buyers, particularly industry, which they categorized as extractive vs. non-extractive. This group emphasized that we need to start with the energy industry. Since federal lands are leased for energy development, participants noted that the federal agencies are also driving some of the development. The third group focused more on the diversity of stakeholders and potential partners and how they are linked. They also discussed the idea of compensating local land stewards in community-level investments instead of targeted individual monetary compensation to a landowner.

Following the map presentations, the group discussed some of the issues associated with large tracts of public land in the county, and the assumptions that the public land already meets protection needs. Participants in this discussion concluded that although public land does provide some important ecosystem services, the private lands generally provide disproportionately higher quality wildlife habitats as they are generally clustered around streams and riparian areas. Furthermore, many ranchers in the basin rely on their public land permits to manage their operation holistically and thus also act as stewards of public lands in the region. Another topic of concern

for participants was whether landowners should be compensated only for improvements or also for existing practices when they already manage their land for high ecological function. Central to this discussion was the concern that perverse incentives could be a problem if the program were to only compensate landowners for improvements. In other words, those who already employ land management practices which support the provision of ecosystem services may be encouraged to degrade their land so that they can then get paid to improve it. One suggestion for addressing this concern was to consider a step system where, for example a landowner whose property meets certain baseline requirements could receive \$5 /acre to maintain it as is, while this same landowner could qualify to receive \$20/acre to make specific improvements (these numbers are arbitrary and used for discussion purposes only).

All of the organizations represented at this focus group expressed interest in staying involved in future discussions and potentially playing a role in future PES program development and implementation.

C. Focus Group 2: Oil and Gas Mitigation Teams

Participants in the mitigation team focus group provided an overview of the existing mitigation funds associated with the Jonah and Pinedale Anticline natural gas fields, as well as information about a nearby proposed natural gas field (Normally Pressurized Lance) which may also include mitigation options once developed (Table 2). Mitigation for the two existing fields has incorporated different stages of the mitigation hierarchy, which includes first the avoidance of impacts, then minimization or restoration of impacts, and finally offsets or offsite mitigation (Kiesecker et al., 2009). For the Jonah Field, infill development was very dense and thus only offsite mitigation was required using related mitigation funds. The goal of offsite mitigation is to seek an overall net neutral or positive outcome, over time, by identifying suitable locations off the field to protect or improve resources similar to those impacted by the development and by implementing best management practices for restoration with the

area impacted (Kiesecker et al., 2009). Mitigation for the Pinedale Anticline included avoidance of impacts for critical areas within the field, as well as offsite mitigation.

The creative thinking exercise in which members of this focus group participated yielded a great deal of discussion. Focus group participants emphasized that a project different from what the mitigation funds have implemented to date could work, as long as the results address the current mitigation priorities. Many species or habitats were identified for mitigation based on their occurrence within the development area, but due to limited funding, those targets for mitigation are further prioritized each year through an adaptive management approach. This year’s wildlife priority is mule deer, whereas it was previously sage-grouse, and priorities may shift to something else next year based on results from the monitoring of development impacts. Although these ever-changing priorities result in their own issues, opportunities are also created as new projects develop and change each

year based on industry impact monitoring results. The mitigation funds already have a lot of data on the location of important places to target in order to meet long-term mitigation goals for individual priorities or for multiple biological targets concurrently (see Kiesecker et al., 2009; Copeland & Kiesecker, 2010). A PES program designed to prioritize these spatial target areas could help to build off of existing knowledge to leverage conservation investments. A PES program may also help provide long-term monitoring and fill in funding gaps. The detailed results of the creative thinking exercise are summarized in Table 3.

One issue that was raised numerous times throughout the discussion pertained to whether or not good stewards of the land should be compensated for what they are already doing or if landowners should only be compensated for ecological improvements. This is an important issue, common with all conservation incentives and there are many options for making payments more outcomes based.

Table 2. Mitigation structures and funding for existing and proposed natural gas fields in Sublette County

Project Name	Mitigation Scope and Structure	Stage
The Jonah Field	<p>All mitigation is offsite; there are also onsite reclamation requirements</p> <p>All mitigation project review, approval, and monitoring is handled through an interagency team including state and federal natural resource management representatives</p>	All or almost all mitigation funds are have already been allocated to projects
The Pinedale Anticline	<p>There is some onsite mitigation in addition to offsite mitigation and reclamation</p> <p>All mitigation project review, approval, and monitoring is handled through an interagency team including state and federal natural resource management representatives</p>	All or almost all mitigation funds are have already been allocated to projects
Normally Pressurized Lance	Discussions regarding the scope and structure of Normally Pressurized Lance (NPL) mitigation are currently underway. Some decision makers have suggested that mitigation may be structured differently for this field.	Proposed development, not yet approved at the time of this report

Table 3. Mitigation team focus group outcomes

Focus Group Outcomes
JIO/PAPO Oil and Gas Mitigation Fund Staff

Opportunities	Votes	Challenges	Votes
Collaborate/share ideas, learn from what has worked for JIO/PAPO and partner to monitor (PES may provide long-term monitoring after PAPO/JIO expire)	11	JIO/PAPO may have limited flexibility and ability to adapt to current issues as a result of Record of Decision (ROD) restrictions	11
Leverage PAPO/JIO funds with other funding, collaborate to meet goals, objectives, and/or current priorities, and also fill in funding gaps that the JIO/PAPO funds can't or won't handle. This applies both ways, as both groups expressed that the other may help them to leverage funding	8	NEPA may make collaboration more difficult - Including actual process (time consuming/labor intensive)	10
The two teams could coordinate efforts to achieve greater conservation outcomes with existing or remaining resources and build on what has already been done in order to develop something that will go beyond the development time frame and life of the JIO/PAPO, including: <ul style="list-style-type: none"> • Projects on conservation easement (CE) or non-CE lands that involve 5-20 years of desired practices; • Projects with coordinated practices among different landowners (CE/non-CE, etc.) to achieve watershed and habitat results; • Types of projects may include those linking upland and lowland areas, maintaining high value existing habitat, or upgrading or providing new habitat. 	7	Reluctance of landowners to work with federal/state agencies could mean that the PES Collaborative would lose participants because of partnering with JIO/PAPO.	6
Identify future mitigation areas, e.g. for NPL or other development fields. Think together about what NPL mitigation may look like.	5	JIO/PAPO projects need to benefit the same species/resources that are impacted by oil and gas development, and mitigation goals require specific activities/outcomes driven by current species issues	4
There is resistance to agency involvement by some landowners - bringing in non-agency coordination may encourage otherwise unwilling private landowners to participate in an inclusive process that incorporates/reflects the interests of all stake-holder groups	5	JIO/PAPO funding is limited and short term (life of field development)	4
The PES Collaborative could help support benefits of certain grazing management program schemes, such as rest-rotation, deferred-rotation approach to landowners/permittees mostly on federal (BLM) lands.	2	JIO/PAPO projects have spatial limitations for the location of funded projects based on gas field impacts	1
The PES Collaborative might identify and/or support priority areas and types of projects for wildlife habitat mitigation efforts at the landscape level (proactive with mitigation team rather than reactive)	2	The establishment of agreed upon practices and measurements may be difficult	1
		Existing mitigation framework may be driven by a “business as usual” attitude/resistance to change	1

Options discussed included the following:

- Payment could only be for improvements in ecological condition /ecosystem service provision (i.e. landowners would have to make improvements in order to participate even if their land already has high ecological value and provides good wildlife habitat or other services).
- Payments could be made for maintaining existing ecological conditions or services if they meet certain baseline requirements (i.e. landowners would not have to make changes if their land already provides good wildlife habitat or other ecosystem services).
- Payments could be made for maintaining existing ecological conditions or services PLUS additional incentives would be available for those who already meet the baseline to provide additional ecosystem services.

Some of the mitigation fund team members expressed that there has to be some change in management practices, increase in benefit, or change in ecological condition; they suggested that this is an important component of the mitigation project ranking system. Without this piece there is no additionality, as described earlier in this report. They also commented that some past mitigation projects have received criticism, including conservation easements for which short-term benefits are difficult to measure. This is a complicated issue since mitigation has a different meaning or definition for different people or interest groups. The proposal that a PES program focused on land management practices as a proxy for ecosystem services could add additional ecological values to some places already under conservation easements or enrolled in an NRCS program also resulted in marked differences in opinion among focus group participants. Some approved of this approach as long as the relationship between the “practices” and the ecological outcome was well documented. Others expressed that only a “payment for performance” type model based on ecological metrics (e.g. stream flow, breeding pairs, or landcover) can clearly guarantee results.

Several participants mentioned the importance of tying public lands into landscape-scale conservation efforts. Many agreed that a key next step should be to integrate or at least better link the management of

public and private lands. However, they cautioned that it is challenging to implement projects on public lands. Public land projects require National Environmental Policy Act (NEPA) review. Participants acknowledged that conservation districts including SCCD often incorporate federal leases into conservation plans and noted this as a step in the right direction. Participants asked that the PES collaborative consider if and how public lands might be incorporated into the program to properly recognize the interwoven landscape of uses and impacts.

D. Focus Group 3: Potential Buyers

Oil and gas industry members attending this focus group discussion were familiar with the PES concept and expressed interest in the approach. This discussion focused on what the oil and gas industry would need in order to seriously consider investing in PES in Sublette County. Several central themes emerged, aligned around assurances, accountability, and streamlining and efficiency.

1. Assurances: All participants agreed that assurances from regulatory agencies constitute an essential component of any PES contract that they might consider signing to purchase credits. Industry representatives expressed the need for assurances that with the purchase of adequate ecosystem service credits, development would be authorized to proceed regardless of whether expected ecological results are achieved, as long as the investment was in good faith and expected to achieve adequate conservation results. They also expressed interest in a mitigation banking approach that might provide assurances against future risk, such as an ESA listing of a wildlife species that had been part of their mitigation efforts.

In Sublette County, oil and gas development is regulated by the Bureau of Land Management (BLM), because most of the land leased for development here occurs on BLM-managed lands or on private surface lands where the sub-surface mineral rights are federally-owned and managed by the BLM. Any energy development impacting federal land, either through the extraction of federally-owned sub-surface minerals or through federally-owned surface access points is subject to the National Environmental

Protection Act (NEPA) and requires federal agencies to prepare environmental impact statements (EIS) and receive US Fish and Wildlife Service (USFWS) response. Therefore, without BLM endorsement of PES as a means to meet mitigation requirements through the EIS process and resulting record of decision (ROD), industry will likely not be interested in buying credits.

The state of Wyoming also regulates oil and gas development. The Wyoming Oil and Gas Conservation Commission issues permits to drill, and the Wyoming Department of Environmental Quality issues permits related to WDEQ's enforcement of the air and water quality standards set forth in the Clean Air Act and Clean Water Act, as mandated by the Environmental Protection Agency. Generally, state review of potential wildlife habitat impacts has been less stringent, with only federal ESA and USFWS restrictions enforced. However, the state of Wyoming recently adopted a sage-grouse core area policy that limits infrastructure development within areas of the highest breeding population densities for sage-grouse (population core areas, Doherty et al., 2011) as a strategy to avoid population losses of the bird that could warrant it for listing under the ESA. This policy, initiated by Governor Freudenthal and reaffirmed by the current Governor Mead (State of Wyoming Executive Order 2011-5), has been adopted by the BLM (BLM Instruction Memorandum No. WY-2010-012; Doherty et al., 2010) and is a model that other western states are also now considering. The state of Wyoming may provide further opportunities for regulatory certainty in the near future. Governor Mead is in the process of developing a first statewide Energy Policy, and discussions are beginning within state government regarding a statewide mitigation framework. Mitigation is not currently required by the state for impacts to wildlife and their habitats; however, mitigation is already used by the state through a permitting offset program for air quality issues associated with oil and gas development in Sublette County.

2. Accountability: The oil and gas companies working in southwest Wyoming would very much like the opportunity to invest in projects with more measurable results and more rigorous monitoring than they currently find available. Representatives

expressed interest in projects initiated with good baseline data. Careful project design, implementation, and monitoring to allow them to verify that their mitigation funds are well spent. Some industry representatives expressed frustration with mitigation projects to which significant portions of their funds are allocated (such as large conservation easements) and for which measurable results towards mitigation are weak or lacking.

Participants in this focus group acknowledged that efforts such as the Cooperative Sagebrush Initiative (a project of the Sand County Foundation) have contributed a great deal to opening up the possibility of applying conservation banking and credit trading PES tools to oil and gas development negotiations generally. Thus far, however, efforts have not resulted in an agreement with adequate assurances, streamlining, and accountability to convince all stakeholders. A pilot PES program that included rigorous measuring and monitoring to provide a model to mitigation fund administrators might allow for wider acceptance of the approach in future development decisions. If PES included accounting whereby impacts and offsets could be directly quantified and linked, then the PES approach could provide a framework for standardizing offsets. The BLM has pioneered some innovative approaches to combined on-site/off-site mitigation in tangent with onsite reclamation in Sublette County Wyoming, specifically in the Jonah and Pinedale Anticline projects. This integrated landscape-level planning and experience with managing mitigation could make Sublette County an ideal location to pilot PES.

3. Streamlining and efficiency: Federal and state permitting and review processes can be long, cumbersome, and uncoordinated among regulatory agencies. Industry may be more interested in a PES program if it could streamline the multiple approval processes or decrease the amount of time it takes to complete an EIS. Seasonal restrictions on drilling can also limit the operating efficiency of industry. Meeting participants expressed interest in an option to buy credits that might allow them more flexibility with timing stipulations. If provided with these time and money savings through increased operating efficiency, industry may be willing and able to invest more in natural capital and conservation.

VII. Overall Discussion and Conclusions

Our team successfully engaged a variety of stakeholder groups through focus group discussions. Since local landowners initiated this feasibility analysis and are interested in a future PES program, we focused on scoping out the level of interest and the type of program that might be feasible from the perspective of regulators, potential sellers, and other stakeholder groups. This way our next discussions with buyers can be more targeted and focus in on real possible program modalities. We also collected useful input from the focus groups to guide decisions about program focus and design. The following summary compiles insights gathered from the scoping interviews and the three focus groups, as related to the specific objectives stated earlier.

1. Determine the likely feasibility of a “payment for ecosystem services” program focused on wildlife habitat and watershed health values in southwest Wyoming.

Those contacted as part of this analysis to participate in interviews or focus group discussions were eager to participate and several even asked if they could invite additional stakeholders to contribute to discussions. Although all informants mentioned potential obstacles when asked, most seemed to be optimistic about the promise for applying PES tools in the Upper Green River Basin. Interest in term contracts is high, and the primary hurdles to developing a successful program pertain to aligning such a program with regulations, providing adequate assurances to all stakeholders, and developing rigorous land management practices, ecological targeting, and monitoring. Further exploration regarding how to design term contracts to be attractive to ecosystem services buyers is also needed.

2. Identify potential ecosystem services that funders are willing to pay for and landowners are willing to produce.

Respondents across all stakeholder groups expressed interest in habitat for impacted species, along with a focus on healthy waterways and riparian areas (Table 1). Ecosystem service credits to be traded

might best be linked as directly as possible to specific development impacts as determined through environmental impact statements, conservation plans, and other site-specific information. These credits might also be weighted at the landscape scale so that ecologically important parcels of land could be prioritized.

3. Determine a program structure and contract terms that could result in a viable market-like program and begin to explore options for determining pricing of services.

Our team connected with and exchanged ideas with several other collaborative groups working on similar efforts throughout the Intermountain West. The most closely related effort that we came across is a partnership between the Environmental Defense Fund and the Colorado Cattleman’s Association focused on developing an ecosystem services credit trading system which would provide mitigation credits to oil and gas. This Colorado collaborative has already formalized their alliance through the creation of an organization called Partners for Western Conservation. The PES model which they are in the process of implementing could provide a structurally useful approach for our team to build off of in the Upper Green. Our focus group discussions were loosely based around the feasibility of implementing the type of credit trading approach detailed in their schematic (see Figure 5). This provides a possible framework that could be applied based on a review of existing efforts.

As mentioned previously in this report, actual payments can be **direct** (e.g., payment for rangeland soil carbon), **embedded** (e.g., grass-fed beef, agrotourism), or **risk management contracts** (e.g., municipal water utility investments in upland watersheds). In this type of credit banking and trading system, the payments would be direct and, depending on the buyer and what assurances are included, could be considered risk management contracts. The actual pricing of credits can be arrived at through reverse auction, where sellers compete to offer credits at the lowest piece on the market and thus attract buyers.

How Credits Trading Works

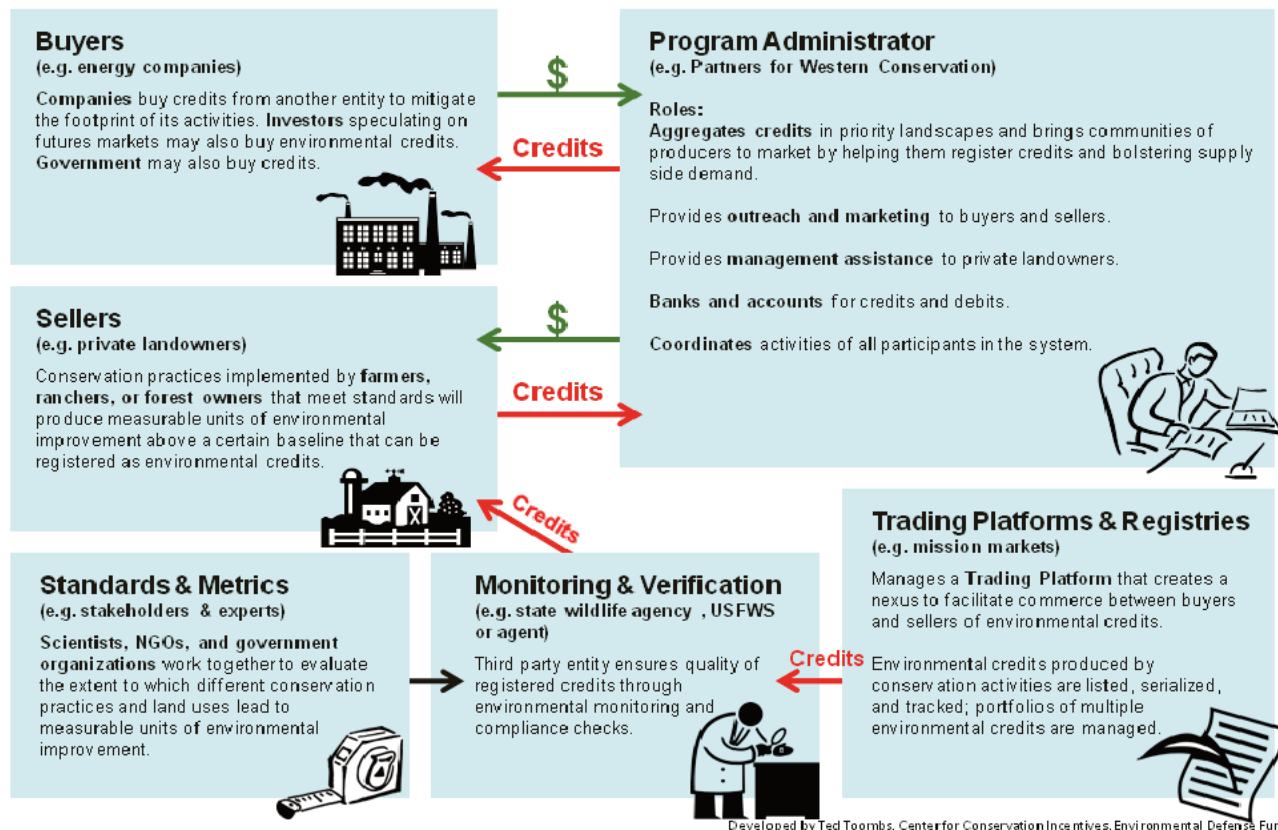


Figure 5. This is one possible ecosystem service credit trading framework that was developed by Ted Toombs (Regional Director, Center for Conservation Incentives, Environmental Defense Fund) and his team in partnership with the Colorado Cattleman’s Association and Partners for Western Conservation. It was derived from a similar but broader framework developed by Ryan Atwell, USDA Office of Environmental Markets.

Markets can be bounded so that buyers can only buy within certain spatial areas if they want to apply their credits to meet specific regulated mitigation requirements. Spatial ecological targeting can also allow for certain ecologically-important lands to be worth more credits than other land parcels. Combining these approaches provides lower cost ecological targeting then doing a full scale valuation study whereby scientists attempt to actually measure the monetary value of ecosystem services produced on each specific parcel of land.

Team members at both the UW and at TNC have also begun to explore and plan to further investigate water services market opportunities for the Upper Green. Water Funds provide one model for attracting investment. In a Water Fund, downstream water users pay upstream landowners to engage in land use and

management practices that ensure the continued delivery of high quality and reliable water supplies. Water Funds provide financing for riparian restoration and conservation activities that protect the environment and ensure the delivery of high-quality services to downstream beneficiaries. Water Funds can be driven by regulatory requirements, for example in cases like New York City where investing in upland watershed management provided a more cost effective and socially acceptable way to meet municipal water quality requirements, or Water Funds can be voluntary such is the case with many projects in Central and South America (Stanton et al., 2010). Successful implementation of the Water Fund model requires an identifiable group of downstream beneficiaries, who value and rely on water services, and who are willing to pay for upstream conservation through land use and management practices that

ensure the continued delivery of high-quality and predictable surface water flows. A perception that water quality or the reliability of flows is threatened also helps to create incentives to pay for watershed conservation (Goldman et al., 2010).

Water credit trading programs are another option and could fit within an ecosystem service credit trading framework such as that detailed in Figure 5. Many water quality credit trading programs in the United States are driven by the Clean Water Act total maximum daily loads (TMDLs) regulations, implemented by the states as delegated with oversight from the U.S. Environmental Protection Agency (EPA). Two such examples are the Willamette Partnership's water temperature credits and the Bay Bank's water temperature, nutrients, and sediment credits. TMDLs define permissible levels of emissions that are consistent with achieving water quality standards, and provide a basis for allocation of the burden of emission reductions. Another program driven by regulatory compliance which may help inform water quality program development for the Upper Green is the Upper Colorado River Basin Salinity Control Program (Wyoming Water Development Commission, 2010). Under the Salinity Program, downstream water users in the Lower Colorado River Basin pay upstream landowners to implement irrigation efficiency improvements and other land management practices that reduce salinity loading in the Colorado River, thus generating water quality improvement benefits. The Salinity Program is funded through appropriations and hydropower revenues, 85 percent of which originate in the Lower Basin.

4. Identify potential roadblocks to implementation and develop strategies to address them.

Concerns about assurances came up in discussions with potential buyers, and the Sublette County Conservation District also voiced concerns about this on behalf of landowners. Under the Endangered Species Act (ESA), the presence of an endangered or threatened species on private property reduces the value of the property because it restricts the land use activities in which the owner can engage. Thus, landowners view endangered species as a liability

and are discouraged from attracting endangered or candidate species to their property. Over the past couple of decades the ESA has been modified to include several rules and agreements to encourage landowner engagement. These ESA programs include Safe Harbor Agreements, Candidate Conservation Agreements with assurances, and most recently Recovery Credits. A key consideration when developing conservation banking and crediting programs is to include adequate assurances for all parties involved.

Safe Harbor Agreements provide guarantees to landowners who work with the U.S. Fish and Wildlife Service (USFWS) that the landowner's management activities will not result in further regulations. The agreements are designed to address the recognized perverse incentives for landowners to conserve species under the ESA. Safe Harbors Agreements are voluntary agreements between non-Federal property owners and the USFWS. Safe Harbors Agreements serve to reduce the liability of making conservation improvements which may lead to the colonization of their property by endangered and threatened species (USFWS, 2011).

Candidate Conservation Agreements (CCA) and Candidate Conservation Agreements with Assurances (CCAAs) are formal agreements between the USFWS and one or more parties to address the conservation needs of candidate species, or species likely to become candidates, before they are listed as threatened or endangered. Candidate species are plants and animals for which the USFWS has sufficient reason to propose them as endangered or threatened under the ESA, but for which development of a proposed listing regulation is precluded by other higher priority listing activities (USFWS, 2011). The goal of CCAs and CCAAs is to conserve species so as to preclude listing by voluntarily committing to implement specific actions that will remove or reduce the threats to a given species. The USFWS has entered into many CCAs over the years, primarily with other Federal agencies, State and local agencies, and conservation organizations, such as TNC. For example, the lesser prairie-chicken is a candidate species that will benefit from several CCAs and CCAAs currently under development in Colorado, Kansas, New Mexico, Oklahoma and Texas. Some of these have led to

successful restoration of viable populations and averted the need to list a species (Scarlett, 2010). In 1999 the USFWS added an “assurances” opportunity creating CCAAs to provide future regulatory certainty to non-federal property owners who voluntarily agree to manage their lands or waters to remove threats to candidate or proposed species (Scarlett, 2010; USFWS, 2011). Specifically, assurances guarantee that in the event a species covered in the agreement is subsequently listed as endangered or threatened, the USFWS will not assert additional restrictions or require additional actions in excess of those that the property owner voluntarily committed to in the agreement. In order to protect these types of conservation investments from dramatic landscape changes due to natural disasters such as floods or wildfires, insurance mechanisms including reserve accounts of conservation and recovery credits should be built into the system (Scarlett, 2010). Also, it is important to note that without compensatory incentives for landowners to participate, it is difficult to engage them as they are often already working hard just to keep their ranch in production in the midst of changing circumstances. This is discussed further in the next section.

5. Identify a process of clearing transactions acceptable to both buyers and sellers which also minimizes transaction costs.

The framework from Partners for Western Conservation described in Figure 5 is based off of conservation banking and recovery credits trading models. Both are conservation incentive tools which can be implemented to turn endangered and threatened species into assets for landowners, instead of merely limiting the liability landowners face if those species are found on their land. Landowners should not only be spared punishment, they should be encouraged to provide habitat for endangered or potentially soon to be endangered species on their property.

Conservation banking is one of the oldest and most established ecosystem service market tools. The state of California emerged as a pioneer in conservation

banking in the mid 1990s when it began using its state ESA and Environmental Protection Act to facilitate conservation banking with enforcement by the California Department of Fish and Game. In 2011, a study found that California had 82 active and sold-out banks (Madsen et al., 2011). Conservation banking and credit trading are PES tools which may be useful to consider applying in southwest Wyoming.

The development of a conservation bank and credit trading system begins by creating a “bank” of “conservation credits” through conservation, preservation, enhancement or restoration projects from which developers can withdraw to offset their impacts. These credits can be bought, sold, or traded on a market (Fox & Nino-Murcia, 2005). Conservation banks (sometimes referred to as mitigation banks) include biodiversity banks, habitat banks, and species banks. Wetland and stream banks are another related set of banking systems. In 2010 there were a reported 798 active wetland and stream mitigation banks in the U.S. alone, with an additional 125 in some stage of development and 137 already sold out of credits (Madsen et al., 2011). Credits are the unit used to measure the ecosystem services or ecological function being traded and these credits are usually measured in acres of habitat. In some cases the unit of credit is a breeding pair, a combination of habitat and species, or other appropriate measurements. Conservation banks are usually created to provide endangered species mitigation credits, but can be developed around pre-compliance or voluntary markets. Bank credit buyers can include municipalities, federal agencies, or private firms and industry. Credit sellers include private landowners and companies specializing in mitigation bank creation. In addition to buyers and sellers, intermediary organizations assist in the creation and operation of conservation banks. Intermediary roles are often performed by non-profit environmental or land conservation groups, private consulting firms, capital investors, and government agencies. The Ecosystem Marketplace’s [speciesbanking.com](http://www.speciesbanking.com) (<http://www.speciesbanking.com>) tracks all conservation banks in the United States.

In general, conservation banking has a number of advantages over traditional permittee-responsible compensatory mitigation:

- Responsibility for compensatory mitigation implementation and success is assumed by a party other than the permittee. Thus, liability for design, construction, monitoring, and long-term protection is transferred to the bank and uncertainty over whether the compensatory mitigation will be successful in off-setting project impacts is reduced.
- Ability to assemble and apply extensive financial resources, planning, and scientific expertise is not always available to individual mitigation projects.
- Designed to consolidate credits from many smaller development schemes and can prioritize spatially connected land parcels across projects to provide substantial added value to large landscape-scale initiatives.
- Can reduce permit processing times and provide more cost-effective consolidated mitigation opportunities through efficient use of limited resources in the review and monitoring of projects.

Conservation banking provides a useful tool for both incentivizing conservation and balancing conservation and development at the landscape scale. However, conservation banking traditionally results in permanently protected public or private lands managed through easement provisions to benefit specific species. The traditional banking model does not provide term options. Some critics believe requiring a commitment in perpetuity may provide disincentives for participation and are ill-suited to dynamic environmental conditions. Under these conditions, adaptive management is more difficult, although still somewhat possible through monitoring and adjusting management practices within a conservation bank to improve species benefits. Term-limited options could add more flexibility as conservation priorities and needs change. Also, some types of habitat buyers may prefer shorter term and/or

lower value credits while others may prefer the highest quality habitat protected for the longest time period possible. Of course, the value of habitat and the length of the contract should always be equal to or greater than the ecological impact which is being mitigated. New models of conservation banking and credit trading are emerging to meet these needs. One of these is Recovery Credit Trading. Similar to conservation banks, the Recovery Credits Framework (RCF) allows federal agencies to offset adverse impacts on threatened and endangered species and/or their habitat by implementing actions on private lands to protect the species as long as these actions result in net conservation benefits for the affected species. The RCF offers multiple term-limited contracts, with contracts lasting from 7 to more than 20 years (Scarlett, 2010). Under this framework, permanent loss of habitat must be offset by permanent credits while temporary habitat loss may be offset through term credits. The Department of Defense undertook a three year proof of concept for the RCF in December 2005 and applied it to offset impacts to the golden-cheeked warbler on Fort Hood Military Reservation in Texas (Robertson & Rinker, 2010). The framework was developed by a working group convened by the Texas Department of Agriculture. The proof of concept used a reverse auction with private landowners to price benefits provided from wildlife management plans and tested term credits in increments up to 25 years (Robertson & Rinker, 2010). For details on the Fort Hood proof of concept see Box 1. Based on the feedback we received through the interviews and the focus groups, it seems that a framework for recovery credit trading or conservation banking could be a good fit in the Upper Green River Basin. The recent success of RCF in Texas provides a particularly relevant example for this collaborative to draw from moving forward (Robertson and Rinker, 2010; Scarlett, 2010).

Conservation banking and credit trading tools enable both conservation and development by providing a mechanism for appropriate and necessary development to occur in a more responsible and environmentally sensitive manner. Conservation banking and recovery credit trading could both be made compatible with the current mitigation hierarchy if applied to sites that have been identified as

Box 1: Fort Hood Recovery Credit System

The Fort Hood U.S. Army base is located within a rangeland ecosystem with habitat occupied by a variety of wildlife species, including the black-capped vireo and the largest known population of golden-cheeked warbler. These two bird species were listed as endangered in 1986 and 1990 respectively. The Endangered Species Act (ESA) listings had a substantial impact on operations at Fort Hood, effectively closing down nearly a quarter of the base. Local cattle ranchers who had leased back parts of the land for grazing since losing their land to the Army in the 1950s also had to look for alternatives. Specifically, the ESA makes it illegal for federal agencies to authorize, fund, or take actions that may "jeopardize the continued existence of listed endangered or threatened species (ESA Section 7(a) (2)). Under the ESA it is also illegal for federal agencies, corporations, or citizens to take endangered animals without written permission from the U.S. Fish and Wildlife Service (USFWS). Also, once a species has been listed, the ESA requires that critical habitat for the species must be identified and protected, including areas necessary to recover the species (ESA Section 3(5) (A) and Section 7(a) (2)).

An increase in demand for desert training grounds in recent years encouraged the United States Army to explore innovative approaches to meeting the ESA requirements while simultaneously opening up more of Fort Hood for training missions. The result was a habitat credit trading system and restoration program supported by a diverse coalition of groups including the Environmental Defense Fund and other environmental non-profit organizations; United States government agencies (The US Army, NRCS, US Fish and Wildlife Services, etc.); Texas A&M University; and the Central Texas Cattlemen's Association. Together they created the Leon River Restoration Program and Fort Hood Recovery Credit System (RCS). The RCS pays private landowners surrounding Fort Hood to control invasive juniper trees and manage grazing in a way that protects habitat for the bird species while at the same time promoting the restoration of grazing land and increasing surface water flow. Part of the funding for the program has come from a biodiversity offset project established with Fort Hood in which the United States Army pays landowners to increase the area under restoration. In return, Fort Hood receives credits that are used as needed to offset actions on the base that may adversely affect the listed birds and their habitat. The system is designed to ensure steadily increasing net benefits to the birds by annually setting aside 10 percent of the available credits and through habitat measurement criteria designed to ensure that more acreage of habitat is conserved and appropriately managed on private lands than is adversely affected on Fort Hood. In the pilot project, private landowners enrolled their properties through a reverse auction. Competitive elements included contract term, cost per recovery credit year (credits determined multiplied by contract term), and landowner cost share. In this way the Army regains access to set amounts of formerly restricted land on the base.

This market-based approach to endangered species conservation is an example demonstrating how payment for environmental services can work. The program is now expanding in scope from six to 34 counties and to include other buyers, including energy companies running transmission lines for wind power projects.

This summary is based on Robertson & Rinker (2010), Scarlett (2010), and Sorice et al. (2011).

appropriate. The tools are best used in tandem with broad landscape-level planning frameworks such as Development by Design (Kiesecker et al., 2009; Kiesecker et al., 2010).

In this way irreplaceable areas where impacts are unacceptable (such as sage-grouse leks) are identified and protected. Once appropriate development sites are identified, site-specific reclamation and mitigation plans can be developed. It is at this point that conservation banking and credit trading might play a useful role. They provide examples of the types of institutional and financial frameworks that might be applied under the PES umbrella.

Conservation banking and credit trading systems can be driven by compliance or pre-compliance markets or they can be voluntary ventures driven by business and ethical concerns. They can also be government-mediated and/or driven by risk management concerns. Here we explore these various drivers in more detail.

Compliance

Compliance markets are driven by the need to comply with government regulation. They are often designed in a cap and trade format for polluting emissions or include required offsets or mitigation for specific development to be approved. The carbon market and wetland banking are both examples of compliance driven markets in some cases. The Fort Hood Recovery Credit System is another example (Box 1). Conservation banking and credit trading programs that are driven by the legal requirements that industry meet specific mitigation terms often include assurances such as Safe Harbor Agreements, CCAAs, or the Recovery Credits Framework described previously. Verification of credits is an important component of compliance markets. Verification criteria depend on the type of agreement. For example, under a “Conservation Banking Agreement” (the USFWS official federal guidance for the establishment, use, and operation of conservation banks), sale of conservation units or credits is based on species conservation outcome rather than management action. This means that a bank must verify that actual species are being conserved, not just that participants are performing land management practices which are thought to foster habitat.

Requirements are different for conservation banks and credit trading platforms established under the other types of agreements.

Pre-compliance

Federal and state endangered species laws are designed to protect species and their habitat from extinction. However, incentives for the conservation of rare species before they are listed are largely missing from these laws. Many argue that proactive conservation actions, in anticipation of formal government regulation, are more efficient, less contentious, and more cost-effective. As a result, there is growing interest in pre-compliance conservation banking and credit trading programs. In a pre-compliance market, agencies or companies that anticipate having impacts on a species can preemptively buy habitat credits to offset future impacts, and individuals or institutions who own appropriate land can engage in management practices that qualify them to sell habitat credits for a profit. Pre-compliance conservation programs, if executed properly, could provide preemptive biodiversity conservation gains prior to costly regulatory triggers.

Voluntary

The voluntary payments market is a diverse group of transactions that occur under a variety of circumstances. Most voluntary conservation credit purchases are direct or indirect payments for the protection, restoration, or management of land with high ecological value. Buyers in voluntary deals can be corporations looking to mitigate the biodiversity impact of their operations, conservation organizations looking to set up positive incentives for conservation management on private land, or individuals willing to pay for recreation values. Sellers have included national, state, or private landowners that are willing to accept payment to maintain or restore the biodiversity on their land. Pre-compliance conservation banking and credit trading programs can also attract buyers who are interested in buying conservation outcomes as strategic philanthropy and corporate social responsibility efforts. If the buyer does not foresee regulatory decisions directly affecting them in the future then they are considered voluntary buyers, not pre-compliance. Credit verification is usually set on a per deal basis and most

often made in good faith. As most deals are structured without an enforcing regulatory framework, the dealmaker's incentive to perform on environmental goals is driven by the need to maintain the ability and credibility to make future deals.

For example, Bay Bank (www.baybank.org) voluntary habitat credits requirements include the following:

- Each habitat conservation project requires a habitat management plan and a contract to maintain the habitat for a specified period of time (ranging from 20 to 100 years).
- All credits are registered with Bay Bank. This allows landowners to document their conservation actions.
- All purchased credits are monitored for the life of the project, based on a monitoring plan that is included in the project contract.

Government-mediated

Some federal programs, such as habitat conservation plans, Safe Harbor Agreements, and CCAs offer nonmonetary incentives to landowners through assurances against future regulation. Other federal programs, including the NRCS' Grassland Reserve Program (GRP), offer landowners monetary compensation for term-limited conservation practices. GRP is a voluntary 2008 Farm-Bill authorized program that helps landowners restore and protect grassland. Participants have the option of committing to a 10, 15, or 20-year rental contract. In return for abiding by the contract terms, the USDA provides annual payments of no more than 75 percent of the grazing value of the land. The annual payment per acre in Sublette County is \$6.50. Participants commit to limiting future use of the land "while retaining the right to conduct common grazing practices; produce hay, mow, or harvest for seed production (subject to certain restrictions during the nesting season of bird species that are in significant decline or those that are protected under Federal or State law); and conduct fire rehabilitation and construct firebreaks and fences" (Natural Resource Conservation Service [NRCS], 2011). NRCS also administers the Conservation Reserve Program (CRP), a land retirement incentive

program and the Environmental Quality Incentives Program (EQIP), a working lands program through which landowners receive incentives for improved management practices. Other well known NRCS Farm Bill conservation incentive programs include the Conservation Stewardship Program (CSP), the Wetlands Reserve Program (WRP), and the Wildlife Habitat Incentives Program (WHIP).

It may be important to differentiate between government-managed federally funded programs such as NRCS programs and those programs which work in tandem with federal regulations to bring private fund to conservation. In many cases PES can offer the "carrot that makes the stick of regulations more palatable" and effective (Pagiola, 2008, p. 669). In other words, government regulations or the threat of future regulations can provide the motivation for buyers to purchase conservation credits or enter into other agreements to compensate landowners for ecosystem services. Many existing federally managed/funded programs do not fit well in Sublette County because ranchers use public lands for a large portion of their operations and because not everyone wants to work directly with the government, or receive what some see as "government hand-outs". Programs such as the GRP also often do not pay enough per acre annually to be a viable option for landowners who may be struggling to break even each year. In fact, in the fiscal year 2011 only two WHIP contracts and two GRP contracts were awarded. Farm Bill funds contributed to Sublette County in the fiscal year 2011 totaled over \$22 million, and this was the most the county has ever received due to the Farm and Ranchland Protection Program (FRPP), which created 14 perpetual easements. Nearly all (93%) of this FRPP funding came through the Sage-Grouse Initiative. Another subtle, but important difference in the PES approach is that landowners are compensated through PES for managing the supply of specific ecosystem services. Thus, there is a measureable end product instead of paying land owners to not do certain things on their land, such as subdivide or develop housing or roads (as in the case of an easement).

Risk Management

This type of PES serves as a kind of insurance payment, and there are several examples of how risk management contracts have been used for water quality and quantity services provided through maintaining a healthy watershed. The City of Santa Fe, New Mexico has established an innovative payment for ecosystem services program to help protect its watershed (and drinking water system) from catastrophic wildfire and ensure the continued delivery of high quality drinking water. The value of the ecosystem services provided in this case were estimated based on the actual costs of maintaining a healthy forested watershed. Research indicates that it is far less costly to implement measures to reduce wildfire risk than to dredge reservoirs of sediment and repair damage to water filtration and delivery systems after a catastrophic fire. Costs to remediate water supply systems after a catastrophic wildfire have ranged from \$10 million (Los Alamos, NM in 2000) to \$31 million (Denver, CO in 2002). Estimates of the cost to reduce the risk of catastrophic wildfire in the Santa Fe watershed are approximately \$200,000 per year, whereas estimates of the costs associated with a catastrophic wildfire are nearly \$22 million. The cost of the annual investment is distributed across all water users and is a small percentage payment on their water usage. The cost of the Santa Fe ecosystem services payment program for an average household is estimated to be about \$6.50 per year (Margolis et al., 2009). Similar programs such as the Forests to Faucets program under development in Denver Colorado bring public payments to federal land management through investments in Forest Service management of the watershed.



Russell Schnitzer

Conclusions

Overall, interest in PES is high in the Upper Green River Basin and payments may include those related to habitat for sensitive wildlife species or healthy waterways and riparian areas. We identified existing credit trading approaches which may be well-suited for a program in the Upper Green and elsewhere. The focus moving forward will be to address challenges identified through this feasibility analysis, which include regulations, assurances, ecological targeting, and monitoring. The five PES drivers overviewed in this report are all relevant to the situation in the Upper Green. Depending on which ecosystem services are included in the program and which beneficiaries participate in the exchange, these different drivers will influence program development to varying degrees. One opportunity that may be viable is to combine NRCS or other government-mediated incentive funds with other buyer funds in order to combine multiple market or mitigation payments and thus offer a competitive price for ecosystem service provision. However, in situations where credits are being generated to meet regulatory requirements to offset damages, there is a risk of credit stacking. In these cases landowners must ensure that all environmental damages are sufficiently mitigated or performance metrics met in order for their credits to be verified (Cooley & Olander, 2011). When offsets are not double counted, stacking or multiple credit schemes can provide funding for better conservation projects and more holistic approaches for managing multiple ecosystem services while in other situations it may negatively affect the overall ecosystem service outcomes. The appropriateness of stacking credits or multiple credit schemes depends on a variety of program design and situation specific characteristics. This is one of many issues which should be carefully considered as our team moves forward with designing a PES program.

The process we used in this feasibility analysis and our findings for the Upper Green should be informative for others embarking upon site-specific PES programs, and perhaps will be most useful to programs in areas also experiencing oil and gas development and designing mitigation strategies for these impacts.

VIII. Next Steps

At this point, the Upper Green PES Collaborative may benefit from identifying scientifically-based technical guidelines and interfaces from other initiatives that could provide the template for an appropriate ecosystem service accounting and trading system. We must also collect more site-specific data to inform the design of the PES program. The next step for the Collaborative is to envision an approach that incorporates the greatest strengths exemplified by some of the tools and pilot initiatives described in this report, while also remaining attentive to the site-specific realities of Sublette County and the Upper Green River Basin.

In order to coordinate these efforts and facilitate the continued success of the newly formed collaborative and related research efforts, it is essential to have support for a staff person to dedicate significant time to guide these negotiations, synthesize research findings into the program design process, and assemble the components of the system. This lead organizer might best be based out of TNC, but working with key partners regionally and nationally, including the SCCD, the USDA Office of Environmental Markets (OEM), UW, a variety of state and federal agencies, oil, gas and mining companies, and landowner groups such as Partners for Western Conservation (Figure 6).

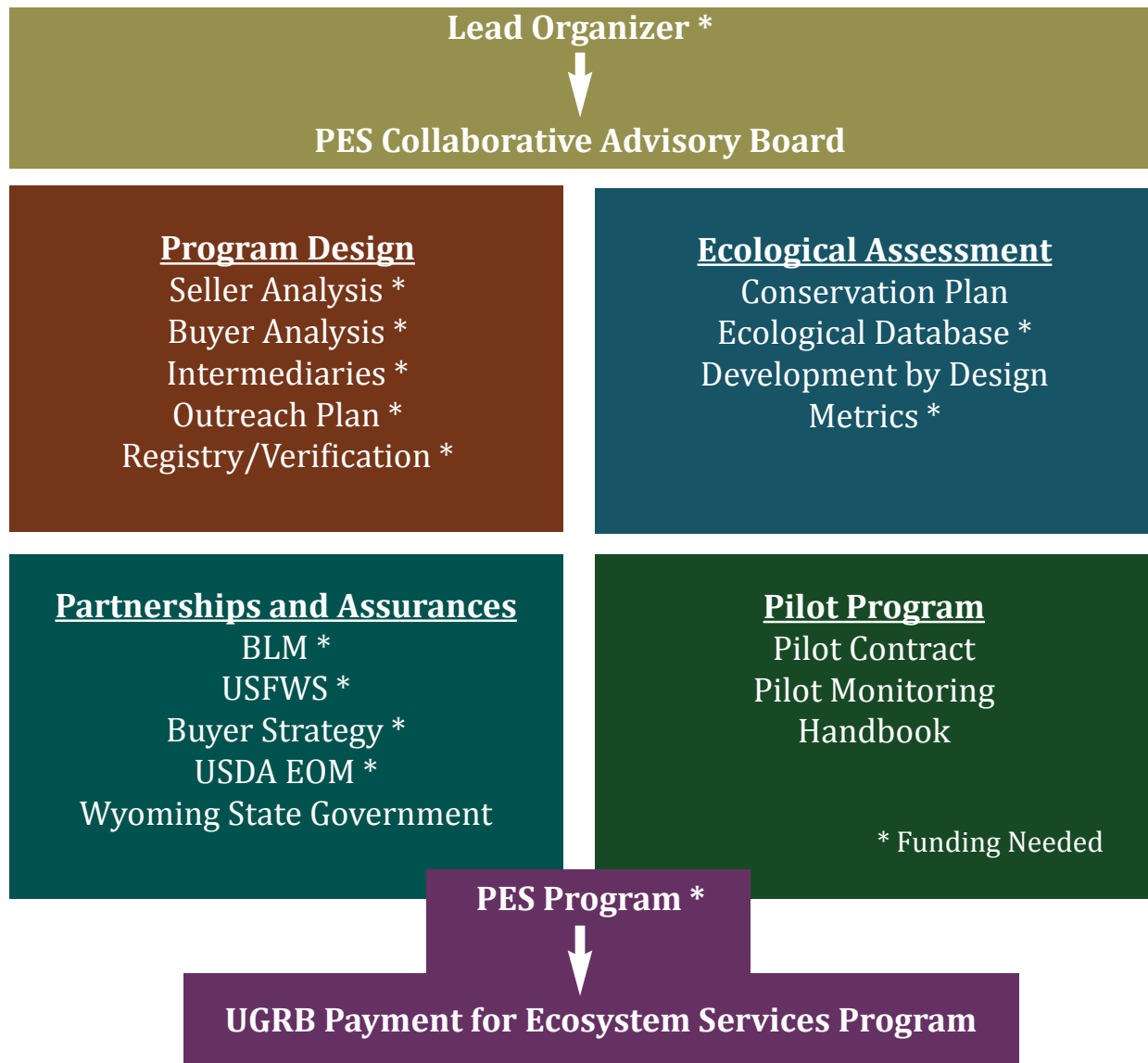


Figure 6. A two-year plan for PES program development in the Upper Green River Basin

The lead organizer would facilitate a coalition of stakeholders that consisted of buyers (local businesses, government, consumers, and NGOs), sellers (ranchers, farmers, and foresters), and brokers to create the PES program or marketplace. This would include collecting more targeted information from each stakeholder group through surveying potential buyers and sellers. It would also entail working with the USDA OEM which develops national policy incentives, standards, registries and verification protocols to strengthen the local PES initiative as well as engaging other critical partners such as the BLM and the USFWS. Visiting other groups experimenting with ecosystem service markets across the U.S. (e.g., Bay Bank, Willamette Partnership) to gather first-hand ideas to improve the design of this new southwest Wyoming initiative could also save this project time and resources. This lead organizer would participate in fundraising efforts and long-term PES program planning and would work together with researchers at the UW to determine the best way to: move forward with scientific metrics design; analyze the local market supply and demand for ecosystem services; and explore how public policy incentives might be used to catalyze local marketplaces. This individual would also work with the partners to design and monitor public and private sector payments to ranchers during the pilot project phase - including selecting, modifying, and applying appropriate program frameworks and metrics. In the near future the collaborative will need to determine how to best balance management prescriptions and performance measured as ecological outcomes. They will also need to work together to build public support for the program through the development and implementation of a marketing and outreach plan and contract with a registry to register and track credits (if a credit trading type of PES framework is deemed appropriate and valuable to the area). Having a central point of contact to direct the collaborative effort is essential to developing a successful coordinated and streamlined approach. The project has not yet secured funding to cover the salary and benefits to hire a lead organizer for the PES collaborative. For now the group is making do by piecing together a few hours of staff time here and there from the core organizations and by hiring expert contractors to take on specific pieces of the project. This piecemeal approach has thus far

held the project together but is ultimately limiting the ability of the collaborative to rise to its full potential.

In the meantime, team members have secured funding to continue data collection to inform specific aspects of the overall program design process. While working on the feasibility analysis presented in this report, the team also applied for and received a Wyoming Conservation Innovation Grant from the state NRCS to develop a small, two-year pilot program to test the viability of the concept in the basin in preparation for a subsequent full-scale PES program(s). NRCS funding will be used to: provide a clear framework and methodology for establishing an ecosystem service program that will provide invaluable information to us as we scale up the pilot program to the basin level; document information for landowners and potential funders about the market value of the basin's rangeland resources; develop metrics using ecological site characteristics to evaluate the effectiveness of implemented practices; and identify a firm foundation for the development of a self-sustaining ecosystem market in the basin. The NRCS-funded project will include the execution and monitoring of a pilot PES contract transaction. These efforts build directly off of the information gathered through this feasibility analysis and included in this report. The team also received a grant from the University of Wyoming Agricultural Experiment Station (AES). These funds are designated to conduct a survey of ranchers in the Upper Green River Basin, to solicit landowner preferences for ecosystem service contract features and overall program design. The survey will be sent to all, approximately 400 ranchers, in Sublette County with a follow-up non-response check via telephone. This will allow for the collection of more in-depth information from a broader constituency of respondents than the snowball sampling method of open-ended interviews undertaken thus far.

The metric development, pilot program, and landowner survey each constitute a key next step in the exploration of appropriate PES program design for this area. However, there are significant knowledge gaps which still need to be filled. Neither of these grant-funded pieces of the project specifically addresses the regulatory assurance, streamlining, and accountability issues which emerged as critical

concerns for potential buyers through this feasibility analysis. The team is still seeking additional support to further investigate and strategize to address these concerns. We are also seeking funding to undertake a survey of potential buyers. Although a draft of the survey has already been developed and revised according to feedback from potential buyers during the November, 2011 focus group in Denver, CO, our team does not currently have projects funds to disseminate the survey, analyze the data, and make program design recommendations based on potential buyer preferences. During this feasibility analysis our team focused on learning more about opportunities to attract investment from the oil and gas industry, but there are other ecosystem service beneficiaries, especially related to water, who we did not have the opportunity to talk with yet such as the trona mining industry, electrical power industry, and other downstream water users. The largest industrial water users in the Green River Basin are the Jim Bridger Power Plant and the Naughton Power Plant, which are responsible for a combined 70 percent of industrial depletions. Trona mines, which include FMC Wyoming, Tata Chemical, OCI Wyoming and Solvay, are responsible for an additional 29 percent of industrial depletions (PacifiCorp, 2011ab; WWDC, 2010). The proposed survey would strengthen our

understanding of broad-scale buyer preferences for different contract attributes and improve likelihood of implementing a successful PES program in the Upper Green.

This initial feasibility analysis has revealed which issues need to be explored more rigorously. The quantitative data collected through the surveys will allow for more rigorous analysis of the various program design preferences, potential eligibility bottlenecks, etc. Quantitative and representative data from both buyers and sellers, together with ecological data from the NRCS-funded project, will provide some of the information needed to guide the development of a successful PES program in the basin. At this juncture the pieces of the puzzle are beginning to pile up. With the addition of an architect to fit the pieces together and guide the process forward, this project has the promise to offer tangible results within a reasonably short timeline. This project has the potential to leverage lessons learned in recent years through other related efforts, while also providing valuable insight into the next generation of PES to be applied to some of the most complex and contentious issues facing the conservation of sustainable rural working lands and associated communities in the western United States.



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Ed Orth

IX. Literature Cited

- Absalom, E., Chambers, R., Francis, S., Gueye, B., Guijt, I., Joseph, S., & Welbourn, A. (1995) Sharing our concerns and looking to the future. *PLA Notes*, 22:5-10.
- Albrecht, D.E., Murdock, S.H., Leistritz, F.L., Halstead, J.M., & Albrecht, S.L. (1985) The impacts of energy resource projects on rural communities in the western United States. *Research in Rural Sociology and Development*, 2:109-123.
- Alix-Garcia, J., De Janvry, A., & Sadoulet, E. (2004) Payments for Environmental Services: To whom, where, and how much? *Environment and Developmental Economics*, 13:375-394.
- Berger, J. (2004) The last mile: how to sustain long-distance migration in mammals. *Conservation Biology* 18:320-331.
- Chambers, R. (1994) Participatory Rural Appraisal (PRA): Challenges, potentials and paradigm. *World Development*, 22:1437-1454.
- Cherney, D.N., & Clark, S.G. (2008) The American West's longest large mammal migration: Clarifying and securing the common interest. *Policy Sciences*, 41(3).
- Cooley, D., & Olander, L. (2011) Stacking Ecosystem Services Payments Risks and Solutions. Nicholas Institute for Environmental Policy Solutions Working Paper NI WP 11-04. Duke University. Available online at <http://nicholasinstitute.duke.edu/ecosystem/land/stacking-ecosystem-services-payments>.
- Copeland, H. & Kiesecker, J. (2010) Mitigation planning for the Pinedale Anticline. The Nature Conservancy. Lander, WY. Available online: <http://www.wy.blm.gov/jio-papo/papo/wildlife.htm#dbd>.
- Corbera, E., Soberanis, C.G., & Brown, K. (2009) Institutional dimensions of Payments for Ecosystem Services: An analysis of Mexico's carbon forestry programme. *Ecological Economics*, 68:743-761.
- Daily, G.E. (1997) *Nature's Services - Societal Dependence on Natural Ecosystems*. Washington, D.C.: Island Press.
- Daily, G.C., & Ellison, K. (2003) *The New Economy of Nature: The Quest To Make Conservation Profitable*. Island Press.
- DeSantis, A. & Ranganathan, J. (2011, July 26). Investing in Nature for Economic Growth (Part I of II). *Environmental Leader: Environmental and Energy Management News*. Available online: <http://www.environmentalleader.com/2011/07/26/investing-in-nature-for-economic-growth-part-i-of-ii/>
- Doherty, K.E., Tack, J.D., Evans, J.S. & Naugle, D.E. (2010) Mapping breeding densities of greater sage-grouse: A tool for range-wide conservation planning. Sept 16, 2010. Completion report prepared for Bureau of Land Management, Washington Office.
- Doherty K.E., Naugle, D.E., Copeland, H., Pocewicz, A. & Kiesecker, J. (2011) Energy development and conservation tradeoffs: systematic planning for sage-grouse in their eastern range. In: Knick, S.T., J.W. Connelly (Eds). *Greater sage-grouse ecology and conservation of a landscape species and its habitats*. Studies in Avian Biology. University of California Press.
- Ecosystem Research Group. (2009) Sublette County Socioeconomic Impact Study. Phase II – Final Report. Prepared for Sublette County Commissioners. Missoula, MT: Ecosystem Research Group. Available online: <http://wy-sublettecounty.civicplus.com/DocumentView.aspx?DID=392>
- Engel, S., Pagiola, S., & Wunder, S. (2008) Designing payments for environmental services in theory and practice: An overview of the issues. *Ecological Economics*, 65:663-674.
- Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., et al. (2005) Global Consequences of Land Use. *Science*, 309:570-574.
- Fox, J., & Nino-Murcia, A. (2005) Status of Species Conservation Banking in the United States. *Conservation Biology*, 19:997.
- Goldman, R.L., Benitez, S., Calvache, A., and Ramos, A. (2010) Water funds: Protecting watersheds for nature and people. The Nature Conservancy, Arlington, Virginia. Available online at: http://www.naturalcapitalproject.org/pubs/TNC_Water_Funds_Report.pdf.
- Grieg-Gran, M., Porras, I., & Wunder, S. (2005) How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. *World Development*, 33:1511-1527.
- Hamilton, K., Chokkalingam, U., & Bendana, M. (2010) State of the forest carbon markets 2009: Taking root and branching out. Washington, D.C.: Ecosystem Marketplace 72 p.
- Harvey, C.A., Komar, O., Chazdon, R., Ferguson, B.G., Finegan, B., Griffith, D.M., Martinz-Ramos, M., et al. (2008) Integrating Agricultural Landscapes with Biodiversity Conservation in the Mesoamerican Hotspot. *Conservation Biology*, 22:8-15.
- Kiesecker, J.M., Copeland, H., Pocewicz, A., Nibbelink, N., McKenney, B., Dahlke, J., Holloran, M., & Stroud, D. (2009) A framework for implementing biodiversity offsets: selecting sites and determining scale. *BioScience*, 59:77-84.
- Kiesecker, J.M., Copeland, H., Pocewicz, A., & McKenney, B. (2010) Development by Design: Blending landscape-level planning with the mitigation hierarchy. *Frontiers in Ecology and the Environment*, 8:261-266.
- Kosoy, N., Corbera, E., & Brown, K. (2008). Participation in payments for ecosystem services: Case studies from the Lacandon rainforest, Mexico. *Geoforum*, 39:2073-2083.
- Landell-Mills, N., & Porras, I.T. (2002) Silver bullet or fools' gold? A global review of markets for forest environmental services and their impact on the poor. London: International Institute for Environment and Development.
- Lemphers, N. (2008) Sustainable energies? A feasibility study of conservation credit trading schemes as a tool to conserve the Sagebrush steppe biome in three western states. Cambridge, MA: MUSIC report, MIT. 30 p. Available at: <http://scienceimpact.mit.edu>.
- Madsen, B., Carroll, N., Moore Brands, K. (2010) State of Biodiversity Markets Report: Offset and Compensation Programs Worldwide. Available at: <http://www.ecosystemmarketplace.com/documents/acrobat/sbdmr.pdf>

- Madsen, B., Carroll, N., Kandy, D., & Bennett, G. (2011) 2011 Update: State of biodiversity markets report: Offset and compensation programs worldwide. Washington, D.C.: Ecosystem Marketplace. Available at: <http://www.ecosystemmarketplace.com/documents/acrobat/sbdrm.pdf>.
- Margolis, E., Lyons, D., Dupzyk, P., Mearns, L., & Derr, T. (2009) "Santa Fe Municipal Watershed Plan: 2010-2029. Santa Fe, NM: City of Santa Fe, Water Division. Available on-line at <http://www.santafenm.gov/DocumentView.aspx?DID=4354>.
- Natural Resource Conservation Service (NRCS). (2011) Wyoming NRCS Programs. Retrieved online at <http://www.wy.nrcs.usda.gov/programs/>, accessed Dec 2011.
- Naugle, D.E., Doherty, K.E., Walker, B., Holloran, M., & Copeland, H. (2011) Greater sage-grouse and energy development in western North America. In: Knick, S.T., J.W. Connelly (Eds). Greater sage-grouse ecology and conservation of a landscape species and its habitats. Studies in Avian Biology. University of California Press.
- PacificCorp. (2011a) Jim Bridger Plant, Available online at http://www.pacificcorp.com/content/dam/pacificcorp/doc/Energy_Sources/EnergyGeneration_FactSheets/RMP_GFS_Bridger.pdf.
- PacificCorp. (2011b) Naughton Plan. Available online at http://www.pacificcorp.com/content/dam/pacificcorp/doc/Energy_Sources/EnergyGeneration_FactSheets/RMP_GFS_Naughton.pdf.
- Pagiola, S. (2008) Payments for environmental services in Costa Rica. *Ecological Economics*, 65:712-724.
- Pagiola, S., Arcenas, A., & Platais, G. (2005) Can Payments for Environmental Services Help Reduce Poverty? An Exploration of the Issues and the Evidence to Date from Latin America. *World Development*, 33:237-253.
- Pagiola, S., Rios, A., & Arcenas, A. (2008) Can the poor participate in payments for environmental services? Lessons from the Silvopastoral Project in Nicaragua. *Environment and Development Economics*, 13: 299-325.
- Petroleum Association of Wyoming. (2011) <http://www.pawyo.org/facts.html>, accessed Nov 2011
- Pfaff, A., Robalino, J. A., Boomhower, J., & Sanchez-Azofeifa, A. (2007) Costa Rica's Payment for Environmental Services Program: Intention, Implementation, and Impact. *Conservation Biology*, 21:1165-1173.
- Robertson, S., & Rinker, H. B. (2010) Third Party Evaluation of the Recovery Credit System: Proof of Concept. Sarasota, FL: Robertson Consulting Group, Inc.
- Sawyer, H., Kauffman, M.J., & Nielsen, R.M. (2009) Influence of well pad activity on winter habitat selection patterns of mule deer. *Journal of Wildlife Management* 73:1052-1061.
- Scarlett, L. Reshaping the Endangered Species Act: A Holistic Approach Needed? *Resources for the Future* 10-15(2010): 1-15. <http://www.rff.org/rff/documents/rff-ib-10-15.pdf>
- Schnell, R.C., Oltmans, S.J., Neely, R.R., Endres, M.S., Molenaar, J.V., & White, A.B. (2009) Rapid photochemical production of ozone at high concentrations in a rural site during winter. *Nature Geoscience* 2:120-122.
- Sierra, R., & Russman, E. (2006) On the efficiency of environmental service payments: A forest conservation assessment in the Osa Peninsula, Costa Rica. *Ecological Economics*, 59:131-141.
- Smith, M.D., Krannich, R.S., & Hunter, L. (2001) Growth, decline, stability, and disruption: a longitudinal analysis of social well-being in four western rural communities. *Rural Sociology* 66:425-450.
- Sorice, M.G., Haider, W., Conner, J.R., & Ditton, R.B. (2011) Incentive structure of and private landowner participation in an endangered species conservation program. *Conservation Biology* 25:587-596.
- Stanton, T., Echavarria, M., Hamilton, K., & Ott, C. (2010) State of watershed payments: An emerging marketplace. *Ecosystem Marketplace*: Washington, D.C. 102 p. Available online: http://www.foresttrends.org/documents/files/doc_2438.pdf
- U.S. Fish and Wildlife Service (2011) www.fws.gov, accessed Nov 2011.
- U. S. Bureau of the Census. (2011) Census of population and housing. Washington, DC: Bureau of the Census.
- Wyoming Water Development Commission (WWDC). (2010) Green River Basin Plan. Available online at <http://waterplan.state.wy.us/plan/green/green-plan.html>.
- Zbinden, S., & Lee, D. (2005) Paying for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program. *World Development*, 33:255-272.