Irrigation districts, complimentary or counteracting forces on environmental water transactions in Oregon?

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AUTHORIZATION TO SUBMIT DISSERTATION

This dissertation of Spencer Thomas Plumb, submitted for the degree of Doctor of Philosophy with a Major in Natural Resources and titled "Irrigation districts, complimentary or counteracting forces on environmental water transactions in Oregon?" has been reviewed in final form. Permission, as indicated by the signatures and dates below, is now granted to submit final copies to the College of Graduate Studies for approval.

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ABSTRACT

Across much of the western U.S. demands for water far exceeds annual supplies. Many western states are turning to incentive-based transactions to encourage economically efficient re-allocations of water from agricultural uses to environmental, domestic and industrial uses. This research, presented across three chapters in this dissertation, explores the influence of irrigation districts on water transactions for environmental flows. Irrigation districts manage water at local and regional scales and are important in guiding individual behaviors. We propose that irrigation districts are both affected by and actively affecting new incentive-based programs that seek to influence individuals through economic incentives. Looking across institutional scales we seek to understand how these institutional interactions influence individual participation. We draw upon common-pool resource management, individual expectancy-value, and economic theory to structure our analysis and generalize our findings to other instances of institutional change.

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DEDICATION

To my parents, Tom Plumb and Gail Foresman-Plumb; thank you for unconditional love and compassion, nurturing persistence and exploration, and forgiving the mess.

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INTRODUCTION

Native plants and animals of xeric ecosystems have developed elegant and diverse adaptations to cope with water scarcity. By comparison, humans continue to refine strategies for survival in water scarce regions. Our water management institutions, and the infrastructure they support, represent the strategies we have developed for making difficult decisions about water allocations under conditions of scarcity. The ability for these institutions to be both dependable and yet adaptable to new inputs and demands will define our continued success inhabiting arid regions.

Current water allocation institutions for the western United States are based on the Prior Appropriation Doctrine. Prior Appropriation established a system known as 'first in time, first in right,' allocating water rights according to a system of priority based on the chronological order the rights were developed (Getches, 2009). Today's western water institutions have been largely designed to support and enforce Prior Appropriation (Rosen & Sexton, 1993). Prior Appropriation allowed for the collective action that formed irrigation districts, because members knew that their water right priority would be honored.

However, as the development of the West continues demands for water have exacerbated issues of scarcity and required changing water institutions. Some states have implemented market-based institutions to expand the types of water uses in an attempt increases the efficiency of water by letting individuals trade towards highest, best use. By allowing the exchange of water rights for payments, incentive-based water transactions allow water to be reallocated from lower to higher value uses, often from agriculture to domestic, industrial and environmental uses (Carey & Sundling, 2001;

Rosegrant & Binswanger, 1994).

Following these institutional changes, Payment for Ecosystem Service (PES) type programs emerged, sometimes using incentive-based mechanism to reallocate out-of-stream agricultural uses, to environmentally essential instream flows (Garrick, Siebentritt, Aylward, Bauer, & Purkey, 2009; Neuman, 2004) . Also, PES programs target water-use efficiency improvements with incentives that pay for technological upgrades (Aylward, 2013). While many economists theorize that incentive-based transactions, and PES-type programs, could equitably increase the efficiency of water use, nearly twenty years of water management reveals a distinct lack of participation in these programs and other unforeseen outcomes despite the use of economic incentives (Garrick, McCann, & Pannell, 2013; Neuman, 2004).

This research, presented across three chapters in this dissertation, explores the effect of these institutional interactions on environmental water transactions. Looking across institutional scales we seek to understand the effectiveness of, and barriers to, market-based incentives for encouraging structural and institutional changes. We draw upon common-pool resource management, individual expectancy-value, and economic theory to structure our analysis and generalize our findings to other instances of collective action and institutional change.

Evidence of institutional and individual responses was gathered and analyzed through qualitative, quantitative and mixed-methods research approaches. The first chapter uses qualitative interviews with irrigation district managers to describe the institutional contexts of existing local management institutions and to create a typology of districts based on these descriptions. The second chapter draws from expectancy-value

models of individual decision-making and employs quantitative data from irrigation district member surveys to explore the role that local irrigation districts play in shaping individual decisions. The third chapter draws from interviews, surveys, and state level transactions data to provide empirical support for institutional economic theory that informs PES designs aimed at encouraging institutional alignment.

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CHAPTER 1

EXPLORING INSTITUTIONAL INTERACTIONS: THE ROLE OF COMMON- POOL RESOURCE MANAGEMENT INSTITUTIONS IN INCENTIVE-BASED CONSERVATION

Abstract

Payment for Ecosystem Service programs are increasingly used to encourage private actors to preserve and restore environmental flows in freshwater ecosystems. The success of these incentive-based transaction programs has varied across geographic locations and it remains unclear how local resource governance institutions influences transactions. This research explores the role that irrigation districts play in the integration with new, state institutions that support water transactions. We performed 20 interviews with district managers and water practitioners in Oregon, U.S. We created a typology of three groups of districts based on common- pool resource management characteristics, including: rule making, water conservation activity, diversity of water uses and external collaborations. Using those groupings we uncovered diverse institutional arrangements and manager views that may influence differential responses to water transaction programs. Our findings suggest that strategic investments in local institutions may facilitate integration with incentive-based programs.

Introduction

Payment for Environmental Services (PES) programs have spread rapidly across a wide range of countries, resources, and management regimes (Ferraro and Kiss 2002; Wunder et al. 2008). As incentive-based tools, PES allow the beneficiaries of ecosystem

services to pay property rights holders to ensure or improve the ecosystem services and functions provisioned by their property (Farley & Costanza, 2010). For instance, cities may pay upstream land owners to adopt best management practices that reduce sedimentation and pollution runoff into municipal water supplies (Wunder, 2005a). Transactions for instream flows, from here forward 'water transactions,' are another type of PES program being used to balance agricultural and environmental water demands in areas where surface water is scarce, including much of the western U.S. (Garrick et al. 2009).

Water transactions are designed to be voluntary programs where agricultural users are paid to forego using water on crops in order to keep water "in stream" to improve habitat conditions for native fish species (Garrick et al. 2009; Poff et al. 1997). However, low levels of participation and variable support for the program continue to hinder successful implementation (Garrick and Aylward 2012; Wheeler et al. 2009). These findings from practice contradict the theoretical premise of PES programs, which suggests that individuals are economically rational actors who will use water to whatever ends maximize profits. PES programs are also designed to work where individuals hold private property rights that allow them to make economic decisions without needing to consider the effects of those decisions on other users (Vatn, 2010).

In practice, water transactions programs are interacting with longstanding social and organizational institutions that have helped manage surface water (Bretsen and Hill 2009). Surface water is a common-pool resource because any user along a canal or river has access to water, the withdrawal of which would reduce the availability of water for other users. Additionally, there is a limited supply in a given year, making it both rival

and finite (Ostrom 1990). Irrigation districts, from here forward referred to as 'districts,' emerged in most western U.S. states. Districts used collective action to build and finance the infrastructure projects necessary for transporting water from natural water bodies to farms for irrigation (Hansen et al. 2010). Once irrigation canals were in place, districts formed as organizational bodies that created and enforced institutions – or formal and informal rules – necessary to manage the allocation and delivery of water rights (North, 1990).

From these origins, districts have operated as hybrid forms of Common Pool Resource Management (CPRM) institutions, deliver watering to individuals according to state systems of privatized usufruct rights for more than a century. Districts often use their own rules and norms to help facilitate cooperation among individuals and help prevent conflicts over water (German and Keeler 2010; Rosegrant and Binswanger 1994; Vermillion 1996) They also address several systematic collective action problems, including the high upfront cost of building and maintaining systems for transporting water to multiple users and enforcing water rights and responsibilities for individuals (Bretsen and Hill 2006; Ghimire and Griffin 2013).

The integration of PES programs with CPRM has been identified as one of the primary challenges for realizing PES related conservation goals (Hayes et al. 2015; Kerr et al. 2012; Pascual et al. 2010). PES programs require new institutions to be integrated into the existing institutions that guide resource management decisions (Munoz et al. 2013). A number of authors have suggested that the interaction between PES programs and CPRM institutions have a critical influence on landowner participation or adoption of desired conservation behaviors Corbera et al. 2009; Kerr et al. 2014).

Research on participation in water transactions has largely focused on the individual characteristics that influence participation such as education, age, wealth, and farm size (Pannell et al. 2006; Wheeler et al. 2009).While useful for understanding how water right holders respond to economic incentives, these studies largely ignore the social and institutional contexts in which these decisions are made. Findings about motivations for individual participation have been largely inconclusive as a result, suggesting that economic motivations are inconsistent or that other external factors may be influencing participation (Cook and Rabotyagov 2014; Garrick and Aylward 2012).

Despite growing interest in PES programs in the U.S. and use of water transactions programs, few assessments of how local-level institutions like districts respond to the institutional changes necessary to establish and run new PES programs (Garrick et al. 2013; Adhikari and Agrawal 2013). Likewise, existing studies of water transactions indicate that participation in these programs can vary widely within watersheds, but explorations of why these variations exist is largely missing (Brewer et al. 2007; Cook and Rabotyagov 2014; Garrick and Aylward, 2012).

This article presents data from interviews with district managers across Oregon, U.S., aimed at understanding how district norms, rules and contexts affect institutional alignment with environmental water transactions. Exploring differences between districts as CPRM institutions and their influence on the feasibility of PES programs can serve to: (1) explain variations in water transaction participation; (2) identify potential barriers for PES program adoption; (3) help adapt water transaction programs to the localized context of districts (e.g. unique goals, rules, and operation) and thus increase rates of participation; and (4) enhance theoretical understanding of how districts, as CPRM

institutions, interact with larger institutional changes that promote PES programs. These insights are important for the development of water transactions and other PES programs in the western U.S. or other developed countries where incentive-based mechanisms are being integrated with local CPRM (Libecap 2009). Where adapted to local circumstances, these arrangements could help facilitate local integration with larger institutional and ecosystem changes (Paveglio et al., 2016).

Background

Water management institutions in the western U.S.

Water resource management in the western U.S. is a complex and multi-layered system that involves federal, state, and local institutional entities. The federal government has played a role in developing the water for irrigation use by funding the construction of dams and infrastructure for water conveyance (for a review see Hansen et al. 2010). In many places districts have contracts with the Bureau of Reclamation (BoR), a federal entity, for delivering and storing water. States allocate water rights for surface and ground water use. Districts manage the local delivery of surface water to patrons within a defined service area.

One of the primary functions of districts is to enforce the state's system of water property rights known as prior appropriation (Bretsen and Hill 2006). Prior appropriation provides access to water for private individuals as a private, usufruct right, according to the order in which water uses were first established (Getches, 2009). It also established responsibilities of water rights holders to ensure that water was being put to a societally beneficial and specified use (Getches, 2009).

Water rights in Oregon fall into three classifications: (1) state, where water is publically owned, held in trust by the state, which issues water rights for private use; (2) communal, where water rights can be owned jointly by individuals and the district that deliver their water; and (3) private, usufruct rights, where an individual is given the right to use water for private benefit and provided access conditional on the rules of prior appropriation (Aylward, 2013; Getches, 2009; Oregon Supreme Court, 2008). These multiple layers of property rights, ownership and local management pose challenges to developing tradable water rights for water transactions (Rosegrant & Binswanger, 1994). The argument has often been made that clear property rights for water do not exist; transaction must be negotiated among multiple competing parties that have divergent interests.

At the state level three important institutional changes were made in Oregon during the mid-1990's to facilitate water transactions. Those changes included: (1) allowing instream flows to be considered a 'beneficial use' under prior appropriation; (2) creating a state-run program through which water transactions could be legally performed; and (3) allowing individuals to retain up to 75% of the water saved from water efficiency upgrades, which can be applied to new lands, but requiring they put at least 25% of the water saved back instream (Aylward, 2013).

Water transactions

These state-level changes were important for federal agencies like the Bonneville Power Administration (BPA), which created the Columbia Basin Water Transaction Program (CBWTP) that funds local non-profits to buy or lease water from local users for

improvement of salmon spawning habitat. These non-profits are now the primary buyers of water for instream flows across the Columbia Basin (Garrick and Aylward 2012). It is important to note there are many forms of water transactions. Temporary leasing, permanent sales of water rights, transfers of conserved water constitute the major categories. This research focuses primarily on temporary leases, which are yearly or multiple year agreements to keep water instream.

Observations of the CBWTP reveal that adequate stream flow and water quality conditions have not yet been fully realized in many critical salmon streams, and suggest that institutional differences across and within states are one reason for heterogeneity in outcomes (Garrick and Aylward, 2012; Neuman, 2004). One way districts can influence water transactions is through their impact on transaction costs, where transaction costs are the resources necessary to connect buyers with sellers, build trust, and complete an exchange (McCann and Easter 2004; Garrick and Aylward 2012). Several authors argue that districts increase transactions costs and impede transactions by adding constraints to individuals' ability to perform transactions (Bretsen & Hill, 2009; Ghimire & Griffin, 2013; G. D. Libecap, 2009).

Districts may oppose water transactions for a number of reasons, some of which include: (1) fear of losing control over water rights due to mistrust of government and environmental non-profits, (2) negative externalities, or third party effects, such as when instream leasing decreases the volume of water a district can divert, which decreases the hydraulic pressure necessary for delivering water to patrons at the end of a canal, and (3) increased monitoring and administrative costs associated with changing water uses (Cook and Rabotyagov 2014; Libecap 2011; Neuman 2004; Rosegrant and Binswanger 1994).

Alternatively, districts could facilitate transactions by creating rules that minimize risks, reduce costs, and even encourage participation if some of the benefits of leasing can be captured by districts. However, to date relatively little research has explored the localized conditions that determine how different districts within the same state react to integrating water transactions into existing water management institutions and why.

Methods

Study site

This research focused on districts where instream flows are critical for salmon spawning and rearing habitat. This includes districts in central and eastern Oregon—arid and semi-arid parts of the state where irrigated agriculture accounts for approximately 88% of surface water use. The availability of surface water in these regions is expected to diminish in coming years due to climatic changes that reduce snow pack in the Cascade mountain range (Franczyk and Chang 2005). Coastal areas and districts surrounding the greater Portland metropolitan area were excluded because surface water quantity issues have not historically been a problem.

Analysis framework

The approach used in this paper segments districts into similar groupings based on attributes identified in past research on CPRM to better understand how local contexts can influence the integration of new institutions (Agrawal, 2001). Segmentation of districts by key attributes can help identify common challenges or opportunities that influence the strategies those districts take when adapting to external institutional

changes. This is similar to the approaches used in Huber-Stearns et al. (2015) and Paveglio et al. (2015) with regards to investigating group characteristics to understand institutional and social responses to natural resource issues.

The segmentation used here is based on five enabling conditions/characteristics for CPRM: (1) resource characteristics; (2) group or user characteristics; (3) relationships between resource systems and group characteristics; (4) institutional arrangements; and (5) external environment (Agrawal, 2001). We combined conditions two and three as the two are closely related in the context of irrigation. Agrawal (2001) notes that each condition includes numerous attributes, and for each attribute a spectrum of variation may exist. Four CPRM characteristics and attributes (Table 1.1) were used to segment districts into similar groupings, and then relate these district groupings to rule changes about water transactions and the use of water transactions within those districts.

Data collection

We conducted key informant interviews to understand if and how districts have integrated with institutional reforms that support water transactions. Researchers selected district managers as key informants because they could provide insight on the biophysical, social and institutional contexts that influence how each district operates. Key informants are individuals with in-depth knowledge that provide unique insights for a phenomenon under investigation (Huberman, 1994). Two criteria related to Oregon districts were used in the purposeful (i.e. nonrandom) approach for selecting the districts studied during this research: (1) a primary purpose of delivering water to water rights holders and (2) membership in the Oregon Water Resources Congress (OWRC). The

OWRC represents the interests of districts in the state legislature and provides publically available contact information for their members. A total of 25 districts (out of 41 OWCR districts) fit the criteria outlined above. Sixteen responded to requests for interviews. At least two attempts were made to reach each district of the 25 districts.

In addition to the sixteen interviews with district managers, four interviews were conducted with state and regional level managers of district associations and water transactions programs. District managers indicated that these informants could provide an over-arching perspective of water transactions and the role of districts in water leasing programs, and these interviews were used to contextual interviews with district managers. The first author conducted all twenty interviews in the winter of 2014; a co-author participated in a subset of the interviews to facilitate initial description of themes. Interviews lasted between 20 minutes and 1 hour and 30 minutes, and were recorded for later transcription and analysis.

Interviews followed a semi-structured interview guide developed by the researchers. Given the relative lack of research regarding how districts interact with of PES-type programs semi-structured interviews were determined to be an appropriate exploratory approach (Huberman, 1994). The protocol focused on institutional changes regarding water transactions, water transaction activity, infrastructure, water uses, district history, and local user demographics. Interviewees were asked follow-up questions to obtain more information about topics discussed in their response. Interviewers also prompted managers to discuss formal rules about water management as well as their perceptions of informal rules regarding water transactions within the district.

Data analysis

Two researchers performed the transcription, coding, and qualitative analysis software using NVivo 10. A first round of coding identified preliminary themes from each of the four characteristics of CPRM and their associated attributes (Table 1), and examples of formal and informal rule changes within a district. Coders then completed an exploratory phase of coding where they identified additional emergent but unexpected themes related to district characteristics and rule changes (Greene 2007). This was followed by a descriptive phase where the pre-determined and emergent characteristics and attributes were used to group districts into three categories based on similar responses.

Two of the authors performed three independent rounds of coding on two interview transcripts and compared codes for consistency of theme content. Agreements occurred when both coders assigned a passage or paragraph to the same theme. Disagreements occurred when researchers coded the same statement differently or when researchers did not include the same interview segment into a theme. Cohen's Kappa was calculated to evaluate the level of agreement between coders about the themes found across interviews; the final three rounds of coding produced a Cohen's Kappa of 0.75. A Kappa of 0.7 or higher suggests a substantial amount of agreement between coders (Hruschka et al. 2004). After coding reliability was established, the first author coded the reaming interviews.

After coding researchers looked at variation across each CPRM characteristic to compare districts and create clusters of districts with similar characteristics (Paveglio et al. 2015). For example, in the CPRM condition 'resource characteristics,' there were three groupings: senior water rights, mixed, and junior water rights holders. We started

creating archetypes by creating groupings across characteristics. This process began with an indeterminate number of potential groupings but expected two or more and fewer than ten groups. We looked at differences across each of the CPRM characteristics and then began sorting districts into groups based on shared characteristics. Three distinct groups emerged (Table 2): These three groupings were related to formal and informal rule changes that occurred within the districts, and used to explain why districts have taken different approaches to dealing with changes to state water laws regarding instream flows (Wheeldon & Ahlberg, 2011).

Results

The three groupings of districts that emerged were: (1) water rights protectors: districts that were hesitant to adopt new rules related to water transactions; (2) cautious converters: districts that made incremental changes to water use rules and infrastructure; and (3) new pioneers: districts characterized by strong formalized institutional rules, highly efficient water delivery systems. Descriptions of their CPRM characteristics are summarized in Table 2 and described in the results section.

Water rights protectors

Districts that fall within the water rights protectors group tend to serve agriculture-dependent communities. Managers emphasized that land values in these districts are strongly tied to availability of water rights for land. One district manager described that irrigating crops made a large difference in profits:

"You get up there on the dry farms and you are talking about $100, $200 bucks

> an acre, and down on the irrigated ground, you are talking [$5,000 to $6000] an acre… If you miss a watering on your potato field your production drops 20 percent."

District managers in the water rights protectors group described individuals as having large farms – and consequently having substantial water rights for that land. Patrons were generally more homogeneous in their water use for agricultural production.

Managers conveyed a sense that their patrons knew these rules and the fewer changes meant more consistency and less confusion. This was coupled with slow rates of turnover in district manager and board positions. It was common for managers to describe that board members or the manager had held their positions for 20 or 30 years. District managers and district board members were often agricultural producers.

Managers in these districts noted that it is important to keep water with the land. Allocating water rights to other uses, like instream flows, elicited sentiments of trepidation and mistrust toward the state or other entities interested in utilizing the water for other purposes. As one eastern Oregon district manager articulated:

> "I think a lot of our patrons are pretty scared to do anything different, thinking that somebody from somewhere else might take that and run with it. And they don't want to get in a situation like that."

District mangers in the water rights protectors group indicated they did not have particularly strong working relationships with other organizations, agencies or districts. While most of the districts reported some piping and in-district efficiency projects, on-

going efforts to continue piping and improve efficiency were not a priority because of the high upfront costs and long payback periods for infrastructure investments. Several managers in the water rights protectors group said they would not seek funding from the state to help pipe their canals because doing so would require allocating a minimum of 25% of the water savings to instream flows. They indicated that their districts rarely work with outside groups to fund water efficiency projects, due in part to the requirement of putting some of the saved water back instream.

Cautious converters

Districts in the cautious converters group focused on maintaining compliance with state and federal rules. Many of the managers described a need for clearly defined rules so they can figure out how to operate most efficiently. These district managers described how water was becoming increasingly scarce, either because of growing demand or due to managing junior water rights. Water diversion and delivery infrastructure in these districts created significant costs and managers often discussed the need to replace or update this infrastructure.

Managers from the cautious converter grouping described their patrons as increasingly heterogeneous. Several managers noted that the mix of users is driven by the conversion of agricultural land to suburban development, therefore shifting water from irrigation to domestic uses. Agriculture as a livelihood was still a major part of the patron base but these districts also reported serving an increasing number of hobby farmers and suburban populations. District managers often reported struggling to meet a growing

demand for water.

Nearly all of the managers in the cautious converter group discussed improving water delivery efficiency projects as a way to meet demand. They considered state programs requiring that a portion of conserved water be dedicated to instream flows as an acceptable compromise for better efficiency. Many of the managers in the cautious converters group sought funding to address aging infrastructure. However, the financial resources remained a limiting factor in completing these projects. While funding from partners was necessary, managers noted that it often came with conditions and more stringent regulatory requirements. As one manager noted:

> "We just have to spend the money that the district can in cost-share with the bureau, or grants, and play the game that way and that's all we can do."

Patron-to-patron water leasing as a means to meet new and growing water demands was prevalent in cautious converters districts. Instream leases were allowed through board approvals, but typically no formal rules existed to guide the transactions process. Managers often described instream flows programs as a less preferable option to leasing between patrons, because the latter could respond to internal agricultural demands. While most districts representatives reported that instream leasing was infrequent, a few reported that it could be a beneficial tool to "park" water to avoid claims that water was not being put to beneficial use.

New pioneers

Districts in the new pioneers group are best characterized as pushing innovations and actively seeking ways to improve water management through technological and

institutional rule changes. Interviewees from these districts described the completion of many large-scale efficiency projects, establishing funding partners for large projects, adding in-pipe turbines for hydro-electricity production to reduce costs or generate revenue, and contributing to instream flow restoration efforts.

The majority of managers in the new pioneer districts reported that their districts held senior water rights on their water supply. Often this coincided with being positioned to draw water from tributary streams in the upper reaches of a watershed, which is of particular importance for salmon habitat. Interviewees described these situations through the refrain 'Not all water is created equal.' Thus, the positioning of the new pioneer districts often makes them attractive partners for environmental groups.

District managers suggested that the composition of water users in their districts was heterogeneous, with a mixture of high-value crop farmers (e.g. cherries, pears, apples), hobby farmers and growing suburban communities. Agricultural-intensive patrons in this group had installed high-efficiency irrigation technology such as micro-sprinklers and drip irrigation. These irrigation techniques were possible because districts had piped irrigation systems, which were able to supply pressurized water. Patrons using more efficient systems reduced their demand for water, leaving more water to be put to instream or transferred to other users.

Many of the managers in the new pioneers group came from outside of the district, bringing with them new ideas and perspectives on water use and water management. One manager even referred to running the district akin to running a small utility company, where the objective was to provide a reliable service at the lowest cost possible while also being good stewards and neighbors. Respondents from the new

pioneers described districts as having a role to play in improving environmental conditions, but noted the need for collaboration within the district and with outside partners to achieve those goals. As one respondent articulated:

> "The river was dry for 100 years. And it wasn't one guy that did it. It was everybody, and we're not going to bring those fish back over night…we've done it incrementally. And DEQ, EPA guys, those are some of our biggest allies."

Districts in the new pioneers group sought out multiple partners to work on large infrastructure projects. They frequently described utilizing external funding from state or federal programs for improving infrastructure, which contribute some percent of water back to instream flows. Large infrastructure projects were described as long-term investments that require time and resources in order to reap benefits.

District managers in the new pioneers group indicated that piping projects served to substantially reduce operation and management costs through reduced pumping costs or through electricity-generating projects. Most of the new pioneer districts had fully piped systems. As one manager described:

> "We are looking for ways to do projects that put water instream to improve the water quality… We might only be able to add 3-5 cfs, but that water is 10 degrees colder."

Districts managers in the new pioneers group were willing to allow their patrons to perform water transactions both between users and for instream flows. Two of the districts noted that they had made rules that prohibit permanent transactions that put water instream because it would diminish the amount of water the district manages.

Temporary instream leases however, were seen as an important tool and a common, albeit a low percentage, of the districts' water use.

Discussion

In this section we highlight the institutional, user and resource characteristics of irrigation districts that emerged as factors impacting districts' approaches to rule changes regarding water leasing. We discovered large differences in how districts adapted to state level rule changes promoting instream flows. On one hand, some districts leveraged new incentives to modernize their operations and provide flexibility to their users. Other districts shielded their existing operations from changes. Neither the water right protectors nor the cautious converter districts had fully integrated with state level changes that encouraged water transactions. This may help explain why water transaction programs were under-performing in Oregon. Infrastructure upgrades also emerged as an important characteristic that may enable flow transactions. Finally, we explore the role of districts as CPRM institutions and their potential to directly and indirectly influence participation in environmental water transactions in this section.

Existing institutions

District process and frequency of rule changes emerged as an important institutional context that structured how and when districts integrated with state-level institutional changes. New pioneer districts reported regularly updating (annually or bi-annually) to align local rules with changes to state laws. This helped provide guidance to their members that leases were an allowable water use. In general, we found that new

pioneer and cautious converter districts reported more heterogeneity among water users and clearer formal rules. Demographic changes in these districts may have weakened informal norms surrounding water use and created a need for clear rules since new members would be unfamiliar with social norms that inform water use decisions (Agrawal, 2001; Kingston & Caballero, 2006).

Most cautious converters dealt with leases on a case-by-case basis. The pressure to change rules had yet to outweigh the potential risks and specific costs of making those changes. Water rights protector districts suggested that their rules change very little from year-to-year. That slow pace of change appears related to the presence of strong social norms that support water use for agriculture. In settings where users are more homogeneous, social norms were adequate to coordinate collective action among members. These findings support Roland's (2004) work suggesting that reliance on norms may slow institutional responses external changes.

Infrastructure

The need to replace, repair, or upgrade water delivery infrastructure emerged as an important characteristic that had implications for the districts' physical capacity to allow leasing. Upgrading delivery infrastructure eliminates an important collective action constraint posed by some instream leasing arrangements (Rosegrant & Binswanger, 1994). Piping projects can reduce third party effects, which are the negative externalities for other users (e.g. diminished delivery due to reduced upstream diversion). Upgrades to water infrastructure could be a critical step in moving from managing water as common pool resource to having it be managed as a private, tradable resource. Such

upgrades warrant further investigation as a means to lower transaction costs for entities interested in developing water markets.

Paying for upgrades to improve water infrastructure poses significant challenges for district managers. Clear differences emerged regarding how districts prioritized and paid for water efficiency projects. New pioneer and some cautious converter districts formed collaborative partnerships to help finance piping projects. In exchange, these districts forfeited a portion of their water savings to the state for instream flows. While managers acknowledged that the state, tribal and local partners who helped finance their projects often had different end goals, they were capable of negotiating arrangements resulting in mutual benefits that could otherwise not be achieved. This suggests that trust between partners is important for implementing programs that produce win-win outcomes (Kingston and Caballero 2006).

In contrast, water rights protectors took more incremental approaches to piping their systems. Several managers explained that upgrading "piece-by-piece" could avoid the need for external funding assistance, allowing the district to retain all of their water savings from efficiency improvements. This may suggest that water rights protectors are loss averse, foregoing benefits, like cost-savings, by incrementally upgrading their system (Elmqvist & Maltby, 2010). Additional research is needed to explore loss aversion among districts.

Water rights protectors often described potential funding partners like the state, environmental groups, and Native American tribes as competitors for water. This sense of competition may exacerbate loss aversion, perhaps because it frames the control of water rights as a zero-sum game. Funding efficiency upgrades may represent an important

opportunity for engaging new districts in leasing. However, these arrangements may require negotiating the amount of conserved water dedicated to instream flows. Efficiency projects may help develop relationships, improve trust, increase resource security for the districts and eventually reduce transactions costs of future instream flows.

Resource characteristics

We found that the characteristics of water rights, including seniority, location, and allocation, can determine where incentives are offered and the value of those incentives. Incentives to lease water instream were responsive to the relative value of a water right. This variation in value may shape how districts respond and pressure from patrons to integrate water transactions (Baland & Platteau, 1997).

New pioneer districts held more senior water rights, which gave them more leverage and exposed them to less risk when allowing transactions. On the other hand water rights protectors districts generally held more junior water rights, posing some risk that water rights may not be completely filled. Individual decisions to lease water rights could negatively impact other users in these districts. During water shortage, managers may pool all water rights and share water to lessen impacts on the most junior water right holders. Instream leasing could reduce water availability, thus exposing districts with more junior water rights to more risk.

Lessons for PES

Broader lessons from this research stem from the finding that water transaction programs designed for individuals are mediated through irrigation districts operating as

local level CPRM institutions. The response of local institutions to PES programs may vary, with the potential to affect participation. The development of irrigation district archetypes helps reveal that some districts may be better suited or situated to achieve gains from institutional changes for water transactions.

The influence of CPRM institutions on water transaction programs have largely been characterized as only inhibiting transactions (Libecap 2009; Bretsen and Hill 2009). This assumes that water is either managed as a tradable private property that promotes transactions, or it is managed through districts under a hybrid system of CPRM and private property that is prohibitive to water transactions. Our research demonstrates that some districts encourage water transactions by creating the local rules and conditions necessary to manage water as private property. This highlights that while some districts create friction for water transaction others are providing essential conditions (Saleth & Dinar, 2004).

Our findings also suggest that districts inhibit participation in transactions may do so in order to protect collective benefits for their members. CPRM research commends local institutions capable of protecting group interests over individual gains as being more resilient institutions (Ostrom 1990; Hayes 2007; Kerr et al. 2012). As CPRM institutions, districts are attempting to maximize benefits at the group level while minimizing their costs and exposure to risk. They do this on behalf of all their members. Leasing water can present risks to some districts; in others, those risks are lower and leasing represents a new opportunity for members to realize private benefits. There remains an important need to understand how the behaviors promoted by PES programs affect, or are perceived to affect, the collective benefits realized from local CPRM

institutions.

Despite the high transactions costs, investments in technology (e.g. water infrastructure) and institutional capacity are necessary steps for creating conditions conducive to using incentive-based programs (Garrick and Aylward 2012). For example, helping districts invest in piped systems as an initial step in building a leasing program could reduce risks and build trust between buyers and sellers. Designing transaction programs that provide complimentary services such as adjudicating water rights in exchange for development of local water leasing rules may help reduce perceived risks. They could also make transactions more tenable for districts and potentially accessible for individuals. These kinds of integrative strategies help build upon existing institutions rather than replacing them (Meinzen-Dick, 2007).

Conclusion

The objective of this study was to increase our understanding of how a PES-type program was integrated across CPRM institutions in the context of a developed country. Specifically, we wanted to better understand the diversity and potential influence of irrigation districts on water transactions for instream flows in Oregon. The finding that districts have different responses to external institutional changes and that those differentiated responses have (re)shaped the intended outcomes of water transactions aligns with both theory and empirical findings on institutional change (North 1990; Ostrom 2008). The differential responses to transactions across districts in this study represent a range of different priorities, existing resource and user conditions, and perspectives on the future. This points to a need to first assist local institutions in creating

local conditions to operate incentive-based in PES programs.

Understanding districts as CPRM institutions is operationally important to PES program designs because it demonstrates that intermediary institutions shape incentives and add to the rules framing participation in PES programs (German and Keeler 2010; Ostrom 1994). This raises questions about how much influence local institutions have on individuals' resource management decisions, a topic on which more research would be welcome. Based on these findings we would expect to find variation in the amount, type, effectiveness and direction of influence exerted by districts on water users.

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Tables

Table 1.1: Analysis Framework

CPRM Enabling Characteristics	District Attributes	Attribute Descriptions	Supporting literature for attributes
Resource Characteristics	Water availability	Water availability – level of scarcity or uncertainty	(Slaughter & Wiener, 2007)
	Water source	Water source – physical location and surface water type	
	Water right priority	Water right priority is the order in which the district receives water relative to other districts in the basin.	
User Characteristics	Water dependence	Water dependence – district member reliance on water for livelihood	(Agrawal 2001; Ostrom 1990)
	Homogeneity	Homogeneity – similarity of water use within a district	
	Group size	Group size – the number of patrons served by a district.	
Existing Institutions	Water sharing/ Transfers	Water sharing – Ability to lease or transfer water to other patrons within the district	(Garrick and Aylward 2012)
	Infrastructure	Infrastructure – Physical capacity to physical move water	
	Delivery efficiency	Water delivery efficiency – how easily water can be moved with minimal waste	
External Environment	Relationships with other entities	Quality of relationships that districts have with other organizations.	(Agrawal 2001)

Table 1.2: District Groupings

CPRM Characteristics	***Water Rights Protectors***	***Cautious Converters***	***New Pioneers***
Resource Characteristic	Mix of junior and senior water rights	Junior water rights	Senior water rights
	Low costs for water delivery	High cost for water delivery	Low cost for water delivery
	Low efficiency water delivery	Seeking opportunities for replacing aging infrastructure	High efficiency water delivery
User Characteristics	Homogenous, High agricultural dependency	Increasingly heterogeneous suburban uses	Heterogeneous, high profit crops
Existing Institutions	Static formal rules, accompanied by social norms	Dynamic formal rules	Dynamic formal rules
External Environment	Few connections to other entities, typically contractual agreements with BoR	Increasingly integrated, collaborating to improve water security or address environmental concerns	Highly integrated with other districts, state and federal agencies, and local watershed institutions
Integration with transactions	Instream leasing informally discouraged	Instream leasing allowed lack formal mechanism for instream leasing	Provide mechanisms for allowing instream leasing

CHAPTER 2

MOVING BEYOND PAYMENTS: UNDERSTANDING DETERMINANTS OF PARTICIPATION IN ENVIRONMENTAL WATER TRANSACTIONS

Introduction

Water has been over-allocated during the past 150 years across much of the western United States (Scott et al., 2013). An estimated 80% of surface water in the West is used for irrigated agriculture (Brewer et al. 2007) and population growth is creating even greater strain on water allocation with increasing municipal water needs (Libecap 2005). Meanwhile, efforts to keep water "instream" to sustain flows, maintain water quality standards and provide suitable fish habitat are receiving increased support from state and federal governments, establishing a contentious context for reconsidering current water use and allocation (Garrick & Aylward, 2012; Shupe et al., 1989). While infrastructure developed to divert water for agricultural, domestic and industrial uses in the West provided social and economic benefits, the environmental costs of moving the majority of surface water out of rivers and streams was originally overlooked. Consequently, there are currently insufficient instream flows, which negatively impact riverine ecosystems and diminish ecosystem services such as natural reproduction of native fish populations and recreation (Baron et al. 2002).

The decline in ecosystem services has prompted the government to create programs encouraging landowners to adopt behaviors that protect and conserve those ecosystem services. Payment for Ecosystem Service (PES) programs have been successful in changing landowner behaviors where property rights and the delivery

ecosystems are well defined (Wunder and Albán 2008; Sattler, Matzdorf, and Schomers 2013; Engel, Pagiola, and Wunder 2008).In the U.S., Canada and Australia, water transactions have emerged as a form of PES, targeting landowners who hold surface water rights by paying landowners to leave water "instream" to provide and preserve ecosystem services. Despite claims that PES are a direct and efficient means of reallocating water to provide ecosystem services at their societal value, individual participation in water transactions have fallen short of expectations (Cook and Rabotyagov 2011; Garrick et al. 2009; Neuman 2004) As a consequence, these programs have failed to reach ecological restoration goals (Garrick and Aylward 2012; Neuman 2004).

Most PES programs in developed countries operate on the premise that farmers are economically rational actors seeking to maximize profits (Sattler, Matzdorf, and Schomers 2013). Therefore, it is assumed that a farmer using water to grow crops sold for income would accept an equivalent payment to instead leave water instream. However, individual water rights holders are not autonomous actors. Water management in the West has required the use of collective action. These local, institutional arrangements that require cooperative behaviors for managing water complicate the implementation of individually targeted PES programs to conserve or restore instream flows.

Given the complex institutional arrangements of water rights in the western U.S., the purpose of this research was to test the influence of irrigation districts on farmers' willingness to participate in PES programs for instream flows. Most of the literature on participation in PES programs has focused on economic and individual characteristics (Peterson 2007; Jack, Kousky, and Sims 2008; Wheeler et al. 2009). For example,

Fielding et al. (2005) suggests that younger farmers and those with more education tend to have higher rates of participation in new programs. Other research suggests that individuals with more wealth and land resources have more flexibility and can afford to be less risk averse, and will therefore be more willing to participate (Zbinden and Lee 2005). In seeking to understand variations in participation not explained by economic or individual characteristics (Bowles 2008) we extend beyond individual profit maximization and attempt to capture the influence of local, collective action institutions that influence individual behaviors manage common-pool resources (J. M. Kerr, Vardhan, and Jindal 2014; Hayes, Murtinho, and Wolff 2015; Adhikari and Agrawal 2013).

We use a survey of 77 irrigation district members in the state of Oregon and develop a binary regression model to explain stated willingness to participate. In addition to controlling for opportunity costs expected to influence participation, we use the Theory of Planned Behavior (TPB) to measure farmers' attitudes, subjective norms and perceived behavioral control toward water transactions, several of which are linked directly to formal and informal social norms of irrigation districts (de Groot and Steg 2007). Additionally, we control for district-level variation through a categorization of districts into those that 'discourage' and 'encourage' transactions. This is one of the first studies testing the role of collective action institutions, like irrigation districts, on participation in a PES program in a developed country context for water transactions for instream flows. Exploratory research from developing countries demonstrate that local institutions shape the rules of participation and benefits in PES programs (Hayes, Murtinho, and Wolff 2015; Kerr, Vardhan, and Jindal 2012). Understanding how participation in PES is

shaped by existing local institutions provides insight on tailoring of PES programs to compliment common-pool resource management situations and provides empirical evidence on the importance of social values versus economic incentives in individual decision-making.

In the next section we connect the roles of institutions with TPB, establishing a theoretical foundation for understanding institutional influence on individual decision-making. In the Methods section we expand upon the contextual details of the water transaction program as a PES program in Oregon. We provide details on survey data collection and logistic regression analysis. In the Results section we provide evidence that membership in irrigation districts may alter individuals' decisions. Finally, the discussion elaborates on implications of these findings for recognizing the role of institutional influence, and social norms in particular, on natural resource management decisions.

Background

Irrigation districts and social norms

In most western states, water resource management institutions formed in an explicit effort to avoid over-extraction of water resources that would result in a tragedy of the commons (Hardin 1968). This system, known as prior appropriation, specifies a quantity, a sequential order for allocating water (first in time, first in right), a location of withdrawal to help manage access (point of diversion) and responsibilities of water right holders (beneficial uses) (Getches 2009). While the institutional framework for water

management is based on private property rights, it also created a large role for common-pool resource management institutions, in the form of irrigation districts, in water management.

With prior appropriation in place, substantial infrastructure development was necessary to transport water through irrigation canals and increase the security of supplies by building systems of dams and reservoirs. These projects were made possible by federal and local partnerships where agencies like the Bureau of Reclamation built major infrastructure projects allowing local irrigation districts to access water and help pay back the federal loans for the project (Hansen, Libecap, and Lowe 2010). Irrigation districts took on the role of managing the delivery of water and collecting payments from water rights holders to pay back loans and operate canals. Irrigation districts use collective action to solve issues inherent to common-pool resource allocation, providing services at cost and monitoring and enforcing rules to prevent the over-extraction of the resource (Ostrom 1990; Rosen and Sexton 1993). As a result, private property rights for water have been influenced by the oversight and enforcement of irrigation districts in their role to ensure collective management goals are met and to prevent over-extraction. For example, during times of drought some districts share water shortages rather than strictly apply rules of prior appropriation.

Irrigation districts use both formal rules and informal social norms to set expectations for water-users by relying on a variety of incentives and sanctions. They serve to enforce rules that marshal collective action (Agrawal 2001). Simultaneously, districts offer incentives for individuals to cooperate (Rosen and Sexton 1993; Ostrom 1990). Rules and norms encourage members to cooperate and take up collective actions,

foregoing individual, self-maximizing behaviors in order for irrigation districts to provide collective action benefits (Heinmiller 2009). Districts do not have the resources to financially incentivize these behaviors, nor do they always have the resources to monitor and punish individuals for non-compliance. However, districts possess the power to influence behavior by setting social norms. Social ties allow districts to encourage cooperative behaviors through the use of social norms, which are enforced by rewards of social acceptance and the threat of social ostracization. As Uzzi's(1996) work on social embeddedness points out, the strength of social ties can affect economic outcomes in business transactions. Also, constructs of social acceptance and individual identity as a community member provide non-monetary values for individuals (Akerlof & Kranton, 2010).

The role of social norms in producing pro-social behaviors is a well-established tenet of individual decision-making (Schwartz 1977). Social norms serve to guide behaviors by establishing expectations and rewards for compliance and punishments for non-compliance. Group homogeneity and interconnectedness are often associated with strong adherence to social norms (Agrawal 2001; Ostrom 1990). Social norms play an important role as informal institutional mechanisms that guide behaviors toward collective actions that produce benefits for all members. In this regard, social norms provide the expectations and value systems to produce pro-social behaviors.

The introduction of PES into the management of surface water fundamentally alters the allocation of surface water in the West. The introduction of new incentives that have the potential to change water-use options for district members could be viewed as an opportunity or a threat to district managers. The extent to which transactions are

perceived to threaten the sustainability of water management varies from district to district (Plumb et al., in review). For example, attributes of the water rights that districts hold and the diversity of water uses within a district emerged as important indicators for understanding districts' responses to environmental water leasing. In districts with junior water rights, leasing was perceived as another demand where water was already scarce. In place where leasing had the potential to pose costs on other users, districts were likely to discourage water transactions through social norms and sanctions.

Plumb et al. (in review) found that irrigation districts can be grouped into two types of districts: those expected to discourage transactions through social norms and those expected to allow transactions. The first group discourages transactions because they are perceived as imposing costs to district members, increasing competition for water or reducing district control over water allocation and management. The second group allows transactions, using them as a tool to protect water rights when they are not fully allocated and in some cases may even encourage their members to participate in transactions. We hypothesize that belonging to a district that discourages transactions is likely to decrease the willingness of an individual participating in a water transaction.

Theory

Theory of planned behavior

Participation in voluntary and incentive-based conservation programs varies by demographic and socio-economic characteristics of households (Peterson 2007). For example, while younger individuals are often expected to be more likely participants,

Wheeler et al. (2009) found that age positively correlated with participation in water transactions in the Murray-Darling Basin in Australia. In addition to demographic and socio-economic variables understanding individuals' evaluations of water transaction programs can provide insights that inform why individuals may choose to participate, not just if they participate

TPB is a well-established theoretical framework that can be used to assess the behavioral and institutional determinants of participation in PES. For example, the cumulative effects of individual characteristics, district influences and individual behavioral determinants can be measured in the TPB framework and be used to understand the likelihood that an individual will participate in a water transaction. TPB is a well-established model of individual decision-making (Ajzen, 2012). TPB has been used extensively in studies on voluntary environmental behaviors such as recycling, energy consumption, and farmer enrollment in best management practice programs for agricultural land (Klöckner 2013; Carrus, Passafaro, and Bonnes 2008; Fielding et al. 2005). TPB specifically targets voluntary, non-habitual behaviors (Nye and Hargreaves 2010). Decisions to lease water fit this description well, as they are voluntary conservation behaviors that require making new and different decisions about how to use water.

TPB suggests that individuals form intentions to perform behaviors before the behavior occurs, and that these intentions are the strongest predictors of performing a behavior (Ajzen 2012). The formation of behavioral intentions are determined by an individual's attitudes, subjective norms and perceived behavioral control (Ajzen, 2012). These three constructs can be used to incorporate individuals' evaluative beliefs about the

outcome of a behavior, social implications and ability to perform the behavior.

Attitudes are the expected outcomes of the behavior and the perceived likelihood of that outcome occurring. In the case of water transactions, attitudes may include consideration of things like the economic implications of selling water, the environmental benefits and/or the agricultural impacts. Positive attitudes toward an outcome of a behavior are expected to be associated with forming a behavioral intention. The use of incentives directly targets the formation of positive attitudes toward the desired behavior.

Perceived behavioral control represents the individuals' beliefs about their ability to perform the behavior. For this study, this construct may be related to how easy or challenging it would be to participate in a water transaction. If an individual does not know about water transaction rules or otherwise believe they are restricted from participating, they are unlikely to form these beliefs. Water transaction programs and changes to state laws have attempted to make leasing as easy as possible. We expect perceived behavioral control to be positively correlated with leasing.

Subjective norms are an individual's perception of what relevant others think about a behavior. Subjective norms are often conceptualized as the normative expectation of a referent individual. We prescribe irrigation districts as this reference group because of their central role in managing water. Districts can use norms to inform and influence their members' behaviors to ensure compliance with rules that enforce collective action. District norms are expected to discourage water transactions. Relying on findings from Plumb et al. (in review), districts that discouraged transactions relied less on formal rules and more on informal norms. A second important component of norms is the measure of

an individual's willingness to comply with norms. Individuals are hypothesized to be motivated to comply if they perceive a connection with their district. Taken together these components help assess influence of norms. In this research social norms are expected to be negatively correlated with transactions.

Methods

Study site

The Columbia River Basin drains approximately 260,000 square miles of land of the northwestern United States and southwestern Canada. Before European settlement, an estimated 10 to 16 million salmon and steelhead trout (Oncorhynchus spp.) returned to the basin every year to spawn. Today, the annual salmon and steelhead return is estimated at around one million fish, most of which are raised and released from hatcheries (NWPPC, 2005). The decline in salmon and steelhead populations, initially caused by overharvesting and exacerbated by habitat degradation from the construction of dams that block access to spawning habitat and the diversion of water out of streams for agricultural irrigation (Gustafson et al. 2007; Northwest Power and Conservation Council 2009).

The listing of salmon as an endangered species in the mid-1990s prompted federal and state governments to design and fund programs aimed at increasing salmon populations. The Columbia Basin Water Transaction Program (CBWTP) is one example of a federally funded PES operating in Idaho, Montana, Oregon and Washington. CBWTP offers financial incentives to farmers to leave water instream to improve habitat for native fish (Garrick & Aylward 2013). Rivers and streams across the Columbia Basin

experience their lowest flows in late summer due to dry and hot weather conditions, dwindling snowpack and irrigation diversions (Aylward, 2013). This is also a critical spawning period for some anadromous fish. Low flows can impair water quality and physically limit availability of spawning and rearing habitat (Poff et al., 1997).

Water transactions are intended to keep water instream during summer months, which is also a critical period for irrigation. Thus, there is a need to compensate irrigators for the decline in crop production associated with taking water off of their lands. Water transactions vary in duration and may take several forms. For this paper we asked irrigators about water leases that offer a payment to temporarily leave water instream (Aylward 2013). Federal and state agencies have coordinated efforts to align water management policies to allow for water transactions to be legally performed.

Oregon leads many western states as one of the first to consider instream flows a beneficial use of water and to allow water transactions to transfer water for instream use. Oregon has been progressive in making state-level water policy reforms to restore salmon populations, including changes to state water law that encourage water transactions for instream flows (Neuman 2004). While the Oregon government has supported transactions, many rural, agricultural communities in the state have opposed programs that move water instream for salmon because they reduce water availability for agriculture. Agriculture is the primary private land use in Oregon, covering more than 16 million acres and generating USD $5.4 billion in 2012 (Oregon Department of Agriculture, 2012). Irrigation districts are critical to the success of agriculture across much of the state (Aylward 2013). Upwards of 50 irrigation districts operate in the state (Oregon Water Resource Council). Anecdotally, water transactions vary widely across

irrigation districts, lending support to the idea that local institutions may influence individual participation (pers. comm. CBWTP staff).

For this study, we targeted irrigators in northeastern Oregon across six irrigation districts. We selected northeastern Oregon as the study area because this region hosts a large number of districts that take different approaches to water transactions. Most agriculture in the area requires irrigation, and many of the streams and rivers that supply water for irrigation are also important habitat for migrating and spawning salmon.

Sampling method and survey instrument

The survey instrument collected information on willingness to participate in a hypothetical water transaction for instream flows scenario, TPB constructs, and socioeconomic and demographic information. Surveys included a total of 45 questions. The final survey instrument can be found in Appendix A.

We distributed surveys using a modified survey drop-off method, following a stratified systematic sampling design (Steele et al. 2001). The two irrigation district types from Plumb et al. (in review) were used as strata so that a proportionate number of surveys were delivered in each of the two irrigation district types. Surveys and pre-stamped envelopes were delivered by two research assistants to randomly selected, freestanding homes within a district boundary. Surveys were also delivered to irrigation district offices if irrigation district managers agreed to help distribute surveys. Respondents were asked to fill out the survey and return it by mail. A total of 360 surveys were dropped off, with approximately 60 surveys delivered across each of the six

districts. A total of 77 completed surveys were returned by mail for a response rate of 22%. Only 53 surveys could be used for the regression analysis due to incomplete survey responses. Survey data was entered into an on-line, Qualtrics version of the survey that was then transferred to Statistical Package for the Social Sciences for analysis (Leech, Barrett, and Morgan 2012).

Variables

Our primary interest for this study was to assess willingness to participate in a water transaction. Specifically we asked about a water lease. Water leases are time limited and the most frequently performed type of water transaction. We measured behavioral intention to perform a hypothetical lease as a proxy for actual participation in a water lease. Participants were provided with specific conditions under which a transaction would be offered, asking them to indicate a price (ranging between USD $10 and $200 per acre foot) at which she/he would elect to lease water, or choose, "I would not lease my water at any of these prices." Hypothetical participation was determined to be a better dependent variable than actual participation because of low rates of actual participation and variability in the value of water rights, therefore we would not be able to control for price offered with actual participation.

By allowing participants to choose their own level of compensation, we take into account the different opportunity costs of participation. The upper limit of $200 per acre-foot was expected to meet most economic opportunity costs for most agricultural producers. We based this range of values on discussions with organizations involved in environmental leasing, with the $200 per acre-foot representing the upper limit of what

might be paid for a water lease (Plumb, et al. in review). Providing a realistic range of water prices excluded intention to participate in transactions at prices beyond those realistically available. This stated preference of participating at different prices was collapsed into a dichotomous variable to form the dependent variable, where participants who provided a price were assumed to be forming an intention to participate, coded as '1', and those who said they would not participate were assumed to be not forming an intention to participate, coded as '0'.

To capture TPB constructs we included a series of Likert statements related to water transactions for instream flows and irrigation districts to measure an individual's attitudes, subjective norms and perceived behavioral control (Ajzen 2012). Three to five Likert statements were combined to form each attitudinal, normative and perceived behavioral control constructs. Likert statements were assessed on five-point (1-5), unipolar scales (Ajzen 2012). The questions that make up each of the three constructs are listed below in Table 2.1.

To check the reliability of these composite scores we used Cronbach's alpha; a score of 0.50 is recommended for composite variables with three to five items (Panayides 2013). We accepted a Cronbach's alpha at 0.50 to allow for the inclusion of additional constructs to increase heterogeneity in the measure of perceived behavioral control (Streiner, 2003). Composite scores were created by averaging responses across all statements included for attitudes, social norms, and perceived behavioral control. Each of these construct scores was used as a continuous variable in regression analysis.

The two categories of district type were recorded as a dichotomous variable. District types were determined before surveys were distributed. District type was verified

by matching the name of the district provided by the respondent with the list of districts where surveys were distributed. Districts that were categorized as opposing transactions were coded ‘0’ and those that promoted transactions as ‘1’.

We included a number socioeconomic variables in our survey related to opportunity costs, including farm size, years of farm ownership and acres irrigated. Finally, we collected information on demographic variables that have been correlated with participating in other PES programs, such as age, gender and education level.

Analysis

We first summarized descriptive statistics of all variables described above and compared the mean values across: 1) those who said they would participate and those who said they would not, and 2) district groupings. For continuous and normally distributed variables we used a t-test, and for categorical or dichotomous variables we used a Chi-squared test. This provides a first look at any statistical differences in those willing to participate and the influence of district type on participation and TPB constructs.

Second, we used a binary logistic regression to test which independent variables were correlated with willingness to participate (*WTP*). Based on theory, we explain the binary response of forming a behavioral intention to participate in a water transaction as a combination of TPB constructs (*AT*, *SN*, *PBC*), opportunity costs measures (FS, AI, YL) and district type (*DT*) (Table 2). We used a bivariate correlations table to test for collinearity.

We used three constructs (AT, SN, PBC) to account for the influence of TPB

variables (Table 1). We estimated the regression with opportunity costs using measures of farm size (FS), years of land ownership (YL) and acres irrigated (AI). We considered each of these first as a group, then individually with TPB and demographic variables as they may be orthogonal, explaining different constructs of willingness to participate in a lease. We provided coefficient values and interpret odds ratios for significant variables. Odds ratios are a measure of the association between the independent variables and willingness to lease. Odds ratios describe the relationship of the change in odds that an individual will decide to lease as independent variables change. We used Nagelkerke' R^2 to assess effect size because it is scaled between 0 and 1 and is therefore easier to interpret. We reported it as a measure of the effect size of the model. We used SPSS statistical software to run all regression analyses.

Results

Descriptive analysis

Survey respondents were mostly male (63%), between the ages of 54 and 90 (Table 2). Mean age for respondents was 79 years. On average, respondents were older than would be expected given county census data, however, national agriculture census data does suggest that well over half of agricultural producers are over the age of 55 (USDA, 2012). Median household income was around $82,000 per year and the majority of respondents (68%) had at least finished a bachelor's degree. The majority of respondents (71%) reported using some of their land for agricultural purposes. Mean farm size was 43.4 acres, with an average of 23.6 irrigated acres. Respondents had owned

their land an average of slightly more than 30 years. Agriculture accounted for about a quarter of household incomes.

A total of 31 respondents were members of Type 1 districts – districts less likely to support instream flows transactions – and 46 were members of Type 2 districts – districts more likely to support PES. The only variable that differed significantly across district types was years of landownership, with a mean of 36.5 years for members of Type 1 districts and 25.8 years for members of Type 2 districts (Table 3). Members in Type 1 districts irrigated more than twice as many acres as those from Type 2 districts, however that difference did not have statistical significance across groups. Means of all TPB variables were similar across district types. Results of a χ^2 test revealed that significant differences do exist between district types in terms of those who use their land for agriculture. Among Type 1 members, 84% used their land for agriculture, compared to 62% of Type 2 members ($X^2 = 4.497$, df 1, $p=.034$). Results of a χ^2 test revealed no significant differences in willingness to participate in water transactions across district types. The cross tabulation shows that 26% of Type 1 district members said they would consider a water transaction (Type 1: No 17, Yes 7), compared to 40% of Type 2 district members (Type 2: No 18, Yes 11).

Of the 53 respondents that provided an answer about their willingness to participate in a lease, 34% (n=18) of respondents indicated they would be willing to participate in PES, and 66% (n=35) stated they would not under any price offered.

When we looked at differences across those who indicated they would consider leasing water and those that would not lease, years of land ownership was again significantly different (Table 4). Those unwilling to consider leasing had owned land

longer (38.1 years) than those who would consider leasing (22.3 years). Non-leasers irrigated more than twice as much land (38.1) than those who would consider leasing (22.3), a finding significant at the level of $p<0.1$. Finally, subjective norms were significantly stronger for those who would not participate (12.7) than those who indicated they would (10.4).

Logistic regression

Before running logistic regression we checked assumption for collinearity using bivariate correlations between independent variables. Pearson's pairwise listings of predictor variables are listed in Table 5. Farm size and acres irrigated were strongly correlated $r^2=.96$. We elected to use acres irrigated as an approximation of opportunity cost associated with farm size. While other correlations were significant, relationships were determined to be acceptable and their inclusion important for exploring different dimensions of individual decision-making for water leasing.

We ran 11 logistic regressions using systematic combinations of variables listed in Table 2. Results for all regressions are listed below in Table 6. Here we will highlight the significant findings from different regression models. When all TPB variables are considered together, they significantly predicted individuals' decisions to lease water (Nagelkerke $R^2=.208$) (Table 6). The model that best predicted participation included all TPB variables and the demographic variable AGE, explaining about 38% of the variance in individuals formation of the intention to participate in a lease (Nagelkerke $R^2=0.38$). In this model, social norms (SN) was the best single predictor of participation. The odds ratio for SN was .601, indicating that for every unit increase in the strength of social

norms there was .601 decrease in the odds of participating in a lease.

When we incorporated opportunity costs (OC) measures into the regression equation we found that the model was significant when we included years of land ownership (YL) with all TPB variables (Nagelkerke R Square = .244) (Table 6). SN was significant in four of the eight models in which it was included, with an odds ratio ranging from .601 to .733.

Discussion

We assessed the role of collective institutions on individual participation in a PES program designed to increase instream flows in Oregon. Our findings suggest that participation in PES programs is mediated by existing local institutions. Specifically, our results suggest a statistically significant relationship between subjective norms and willingness to participate in water transactions. Norms discourage respondents' intention to participate in water leases. In this research, social norms provided a more powerful behavioral determinant than opportunity costs for participating in PES. While this is the case for hypothetical PES in northeastern Oregon, the power of social norms will be determined by the amount of experience, exposure and level of interdependency individuals have with their districts. While the influence of social norms on participation may vary in other parts of Oregon or the western U.S., finding from a meta-analysis of studies looking at adoption of best management practices offered complementary findings that social networks influence participation and recommend using social networks to encourage adoption of new technologies (Baumgart-Getz, Prokopy, & Floress, 2012).

Empirical findings from this research are important for understanding the rationality of individuals who are embedded spatially, socially and financially with broader governance structures such as irrigation districts. The relevance of norms may differ from district to district as norm formation and enforcement are affected by factors such as group homogeneity and land tenure. Where norms are relevant they appear to discourage acceptance of individual payments for water transactions. Individuals may forego monetary incentives from leasing water because accepting such payments may violate the social norms propagated by their districts (Kerr, Vardhan, and Jindal 2012). Our results suggest that sanctions for these violations of norms appear to outweigh the financial benefits of leasing. TPB provides a means of measuring the influence of subjective norms when making decisions about performing intentional behaviors. While more research is needed to understand the perceived costs of norm violation, the evidence of the relationship between subjective norms and participation highlights proximal determinants of behaviors based on nonmonetary incentives (Bowles and Gintis 2002; Bowles 2008).

Our findings that individuals' decisions are shaped by local institutions are consistent with other research that demonstrates institutions may develop norms to influence individual decision (Marshall, 2004). In the case of districts, where the scarce resource of water is being managed collectively, enforcing social norms is critical for producing collective benefits both historically and currently (Hayes, Murtinho, and Wolff 2015; Kerr, Vardhan, and Jindal 2014; Kosoy, Corbera, and Brown 2008).

Understanding the influence of social norms on pro-social behavior is useful in order to interpret these results. Our findings suggest that in strong agricultural districts

water leases for instream flow are not perceived to be pro-social but are considered detrimental to the collective interests of district members. This stands in contrast to the fact that participation in pro-environmental programs is a form of pro-social behavior in most PES (Hayes et al. 2015; Kerr et al 2014; Kosoy et al. 2012). Coordinating incentives and social norms has emerged as a topic of growing interest as more PES are introduced where collective action is used to manage resources. Bowles (2008) warn against crowding out pro-conservation behaviors promoted by collective action. This research highlights the importance of aligning the behaviors promoted through PES with institutionally and socially accepted practices (Adhikari & Agrawal, 2013).

PES typically promote behaviors that are both pro-social and pro-environmental by the very definition of ecosystem services (Costanza et al., 2014). More specifically, water transactions originated to generate pro-social benefits associated with healthy fisheries. However, at the most local level, instream leasing could have, or is perceived to have, negative social consequences are possible for irrigation districts and members such as inadequate flow for downstream members (Plumb et al., in review). Findings from this research reveal that individuals' decisions about water leasing may be influenced by their districts' inclinations on leasing of water. The relevance of social norms to respondents who want to comply with their district norms is that they are less willing to participate in water transactions. In turn this has created (or continues a narrative) that the pro-environmental behaviors being promoted by the state and federal governments are anti-social for irrigation district members and agricultural water users, so leases are therefore opposed by local district managers (Plumb et al., in review). One of the limitations of this research is the ability to disentangle how norms are developed and enforced. Regardless

of the origins of the normative expectations, the influence of district norms are an important source of influence.

The majority of respondents in this study were unwilling to participate in leases, and as the strength of social norms increased their willingness to participate decreased. This might suggest that a desire to comply with social norms overrides monetary incentives, which is consistent with other findings on planned, pro-environmental behavior (de Groot & Steg, 2007; Staats, Harland, & Wilke, 2004). This is relevant to the question of water leases, where leasing presents a potential harm to the function and members of irrigation districts. Districts that discourage leasing may do so because they perceive leasing to be a threat to current water management and the agricultural livelihoods that these districts support. Findings from t-tests show a significant difference in length of land ownership between those willing and unwilling to lease. This may suggest that members who are newer may be more responsive to incentives or less sensitive to social norms. Demographic changes have been linked to erosion of social norms and changes in resource use patterns in other natural resource contexts (Hayes, 2007) .The changing demographics of water users may increase opportunities to lease water, which creates greater access to water to outside members. Since districts are institutions that manage a common-pool resource for members, any change that introduces new actors who are not members and therefore not affected by social norms or district rules is a threat to institutional control (Ostrom, 1990). One of the primary purposes of any institution that manages a scarce resource shared among users is to ensure that outside groups and individuals cannot take or divert that resource (Agrawal 2001). In the case of agricultural users changing water use can incur negative

externalities on other members of the district. Furthermore, moving water off of agricultural land could negatively affect agriculturally dependent economies.

The concern among district managers may be that new actors change how water is used and allow for a broader array of end uses. Increased competition for water in the West has led to conflict with irrigation districts and companies that are threatened by the possibility of increased municipal water use (Scott, 2003). Districts may also be concerned that opening up to market-based transactions for environmental flows will set precedents for using water transactions to move water outside of their service area and fundamentally alter the system of control over water.

The new rules inherent to allowing water transaction are created by external actors. Some irrigation districts are inherently distrustful of the organizations that have created these leasing programs (Plumb et al. in review; Breetz et al. 2005). Moreover, instream flow programs were specifically designed to target individuals, largely dismissing the role that districts play in water management (Neuman, 2004). The lack of vertical integration between federal and state water management institutions with irrigation districts portends the protective and defensive posturing by districts who perceive leasing as a threat to their control over water (Freeman, 2000).

More research is needed to determine the complex arrangement of incentives, perceptions and physical constraints of water management institutions that shape water decisions at the individual level. While districts have been actively influencing behaviors for more than a century, changing water demands and user demographics are affecting the mechanisms that districts use to coordinate behavior. As district membership become more diverse, due to changing demographics, the social connection between water users

are likely to weaken and reduce the strength of norms that coordinate collective behaviors. PES introduces a new mechanism that attempts to reshape individual behaviors. However, unlike simply changing rules, PES does not necessarily change norms, which are salient and durable among members. Our findings support the importance of norms in determining individual behavior and suggest that this helps explain the adoption of PES for instream flows occurring at different rates among different irrigation districts.

Given low response rates and potentially skewed age representation we caution against over generalization of these findings. Our results are subject to problems of non-response bias, limiting the ability to extrapolate widely. We have highlighted insights that should be further explored with larger samples sizes.

Conclusion

This research provides important insight into the factors that shape individuals' decisions to participate in PES water transactions in Oregon, with lessons that extend beyond the western U.S. Specifically, this research demonstrates that social norms can influence individuals' responses to financial incentives. Therefore social norms are important for understanding individuals' resource management decisions. Moreover, foregoing payments in order to comply with social norms is rational behavior, particularly if it is understood as a pro-social decision to protect the collective interest of irrigation district members. This illustrates that existing institutions are not only important for understanding current resource uses, they are also stable and not easily replaced by new sets of rules and incentives. In particular, PES programs and their

payments are not likely to replace social norms in communities where individuals have been life-long participants of local institutions and whose livelihoods have depended on such institutions.

Combined with previous findings on the perceptions of irrigation districts related to water leases in the western U.S. (Plumb et al. in review), this research highlights the need to change how conservation programs align or work with the interests of districts. While demographic changes in districts may be changing the role of norms in some areas, with newer members more responsive to financial incentives and open to rule changes because they are not as socially embedded in their districts, this may be limited geographically. Districts will continue to be a necessary component of water management in many parts of the West, as water will remain a common-pool resource that requires collective action to be managed, even if it's treated as a tradable, private resource. Efforts to move water to environmental uses that provide important common-pool and public goods will likely be more successful if they work in coordination with districts rather than in opposition. Some districts may lease water as a tool to protect their water rights, but additional incentives for districts to encourage leasing and move excess water instream, even temporarily, could help align districts with leasing programs. Increasing participation may require greater program flexibility and a focus on relationship building with districts to begin changing perceptions and district norms about leasing. Lastly, emphasizing the pro-social, collective benefits of leasing (e.g. protected water rights through beneficial use, reduced risk of state or federal water calls for environmental flows) may help build support from districts and thus change normative expectations about water use.

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Tables

Table 2.1: Constructs included in TPB variables

TPB Variable	Survey questions (Constructs)	Cronbach's Alpha
Attitudes toward water transactions (AT) Components	1. Water transactions for instream flow could benefit me financially 2. Water leases for instream flows are beneficial for native fish 3. Water leases for instream flows are useful for demonstrating beneficial use of a water right 4. The option to lease water for instream flows could be good for my business 5. Leasing my water for instream flows could harm other water users (Reverse coded)	.701
Subjective Norms (SN): District Norms (DN) Motivation to Comply (MC)	1. DN: Leasing water for instream flows is uncommon in my district 2. DN: Leasing my water could have negative consequences for my irrigation district 3. DN: I consider how changes in my water use could affect other water users in the district is important in my decisions 1. MC: Being a member of this irrigation district is important to me 2. MC: Being a member of my water district has been beneficial for my livelihood 3. MC: I would consult with other district water users when considering the lease of my water 4. MC: I agree with the policies my irrigation district has about leasing water instream	.540 .668
Perceived Behavioral Control (PBC)	1. Participating in a water lease would be easy to do 2. My district has clear rules about water leases 3. I have a good working knowledge of my districts rules about water use	.552

Table 2.2 Variables considered in logistic regression model

Variables	Acronym	Description	Range	Mean/ Frequency	Std Dev	N	Reliability (α)	Exp Sig
Willingness to participate*	*WTP*	Indication of whether the participant would consider leasing water for instream flows	Dichotomous: 0,1	Counts: No = 35 Yes = 18	N/A	53	N/A	N/A
District Type	*DT*	Grouping based on Plumb et al. (In review) of districts either oppose leasing or allow leasing	Dichotomous: Type 1 - Oppose Leasing, Type 2- Allow Leasing	Counts: Type 1 = 31 Type 2 = 46	N/A	77	N/A	+
Age	*AGE*	Age in years	Years 54-92	79.6	7.7	45	N/A	-
Education	*EDU*	1=Some high school to 7 = Graduate degree	3 (some college) to 7 (graduate degree)	4.60	1.4	68	N/A	+
% Income from Agriculture	*PIA*	% of income from agriculture activities	0-100%	23%	29.7%	46	N/A	-
Opportunity cost measures								
Year of land ownership	*YL*	Number of years respondent has owned the land	Continuous: 1-105 years	30.21	24.42	77	N/A	−
Farm size	*S*	Acres owned	Continuous: Acres	43.4	69.1	72	N/A	-
Acres irrigated	*AI*	Acres irrigated	Continuous: Acres	23.6	47.4	68	N/A	-
Theory of planned behavior constructs								
Attitudes	*AT*	A composite of the average of 5 Likert scale questions about perceptions of water leasing	Continuous: 1-5, 1= unfavorable; 5 = favorable	2.96	0.52	59	0.74	+
Perceived Behavioral Control	*PBC*	A composite of the average of 5 Likert scale questions about perceived ability to make a decision to leave water	Continuous: 1-5, 1 = low ability; 5 = high ability	3.02	0.72	61	0.26	+
Subjective Norm	*SN*	Strength of district norms against water leasing multiplied times the individuals motivation to comply with those norms	Continuous: 1-25, 1= weak norms against leasing; 25= strong norms against leasing	12.22	4.18	58	N/A	−

Table 2.3. Difference across demographic and TPB variables by district types

Variable	Mean		Difference	T-score	P-values	N
	Type 1 District	Type 2 District				
AGE	77.2	81.2	4	-1.59	.12	46
EDU	4.43	4.74	-0.31	-0.85	0.40	67
PIA	25.13	20.83	4.30	.49	0.63	45
YL**	**36.50**	**25.67**	**10.83**	**1.98**	**0.05**	**77**
FS	54.26	39.67	14.59	0.61	0.29	71
AI	34.36	15.80	18.56	-0.26	0.11	67
ATT	2.89	3.01	-0.12	-1.06	0.30	77
SN	12.26	11.47	0.79	1.35	0.18	77
PBC	2.85	2.79	0.06	.55	0.59	77

Table 2.4. Differences by willingness to participate

Variable	Mean		Mean Difference	t-score	p-value	N
	Will not lease	May lease				
AGE	80.91	78.62	2.30	0.83	0.41	35
EDU	4.29	4.78	-0.49	-1.11	0.27	52
PIA	27.78	22.80	4.98	.47	0.64	37
YL**	38.11	22.33	15.78	**2.17**	**0.04**	52
FS	50.60	52.56	-1.96	-0.84	0.93	47
AI*	34.01	12.97	55.91	**1.89**	**0.07**	46
AT	2.93	3.07	-0.14	-0.88	0.38	53
SN**	12.76	10.43	2.32	**2.74**	**0.01**	53
PBC	2.78	2.82	-0.04	-0.24	0.81	53

Table 2.5. Bivariate correlations for independent variables

	AGE	EDU	PIA	YL	FS	AI	AT	SN	PBC
AGE	1								
EDU	0.41	1							
PIA	0.03	0.36	1						
YL	0.46	-0.06	0.52	1					
FS	0.36	0.00	0.15	0.51	1				
AI	0.41	-0.01	0.29	0.47	0.96	1			
AT	0.07	-0.26	-0.65	-0.02	0.01	0.02	1		
SN	-0.61	-0.07	0.53	-0.07	0.14	0.14	-0.20	1	
PBC	-0.73	-0.41	-0.26	0.01	0.24	0.28	0.23	0.10	1

Table 2.6 Logistic Regression model output

Logistic Regression runs	1	2	3	4	5	6	7	8	9	10	11
Independent Variables						**Regression Coefficients**					
DT			-0.01		0.075	0.088					
Demographic Variables											
AGE	-0.037						-0.043				
EDU	0.098							0.159			
PIA	-0.005								.004		
Opportunity Cost Variables											
YL		-0.019	-0.019		-0.015					-0.02	
AI		-0.01	-0.01		-0.008						-0.011
TPB Variables											
AT				-0.342	-0.049	-0.347	0.30	-0.302	-.418	-0.045	-0.202
SN				*-0.398	-0.231	*-0.398	*-0.509	*-0.385	-.417	-0.311	-0.26
PBC				-0.092	0.047	-0.105	-1.052	-0.094	.255	-0.176	0.142
Constant	2.444	0.129	0.148	5.19	2.538	5.056	11.56	4.202	4.842	4.123	2.813
Model Summary											
Cox & Snell R Sq.	0.025	0.182	0.086	*0.15	0.133	0.15	0.275	0.16	.147	*0.177	0.115
Nagelkerke R Sq.	0.034	0.247	0.119	*0.208	0.183	0.208	*0.376	0.221	.199	*0.244	0.159
Cases (N)	34	34	45	53	46	53	36	53	38	53	46
Omibus Test of Model Coefficients $\chi 2$	0.857	4.151	7.163	8.643	9.514	8.645	11.56	9.233	6.043	10.295	5.638
Omibus Test of Model Coefficients Sig.	0.83	0.13	0.06	*0.03	0.21	0.07	*0.02	0.06	.20	*0.04	0.22

* $p<.05$

Note: The number of cases (n) vary across regression analyses due to different combinations of variables and a data set with incomplete survey responses

CHAPTER 3

PAYING FOR, OR INVESTING IN, ENVIRONMENTAL SERVICES: ASSESSING FINANCIAL INSTRUMENTS USED IN ENVIRONMENTAL WATER TRANSACTION IN OREGON

Introduction

Water demands in the western United States continue to increase, despite the fact that current demands already exceed annual supplies. A recent surge in population growth, along with economic development and efforts to sustain ecosystem functions, compete with traditional agricultural uses of water necessitating the reallocation of water (Brewer, Glennon, Kerr, & Libecap, 2007; Colby, 1990; Garrick, Siebentritt, Aylward, Bauer, & Purkey, 2009). Variability of precipitation patterns and associated droughts across much of the arid West compound these problems (Luce, Abatzoglou, & Holden, 2013). In response, federal agencies and states' governments have altered institutional arrangements for managing water to facilitate changes in use – primarily transferring water from agriculture to domestic, industrial or environmental uses.

In lieu of unpopular regulatory reallocations, water transactions, which constitutes any exchange of water right or change in use of a water contingent upon monetary incentives, emerged as a more equitable and efficient means to reallocate water. Incentive-based transactions are a preferred means to reallocate water because they are voluntary and offer individual water rights holders' compensation while increasing the economic efficiency of water use. Water transactions are market-based mechanisms that involve one buyer and one seller that negotiate a price to reallocate water to a different use (Garrick et al., 2009;

Rosegrant & Binswanger, 1994).

Federal, state, and non-governmental agencies began using water transactions to protect and increase instream flows in response to growing recognition of the societal value provided by aquatic ecosystems (Aylward, 2013; Baron et al., 2002). Instream flows generate ecological benefits in the form of protection of fisheries and other biological diversity and habitat, water filtration and regulation functions (MEA, 2005). At current levels instream flows are inadequate for sustaining aquatic ecosystems, resulting in a loss of public goods (e.g. clean water or sustainable fisheries). The public good characteristics of ecosystem services require government and quasi-government involvement to use collective action to pool resources for transactions. State agencies invested heavily in changing policies to allow water transactions to put water instream.

Federal agencies and non-governmental organizations are investing financial resources in water transactions, often serving as the 'buyers' and water rights holders – typically farmers – as 'suppliers.' Despite these investments, low rates of participation impede success of water transactions. In particular, participation in environmental water transactions programs varies across institutional boundaries, across states due to different configuration of state-level laws and local-level irrigation district rules and norms (Garrick & Aylward, 2012; Plumb et al., in review).

Inquiry into lack of participation of water transactions in general, and environmental water transactions specifically, focus their analysis on correcting circumstance that create market failures such as, pricing (to include environmental values) and transactions costs (Colby, 1990; Garrick & Aylward, 2012; Johansson et al., 2002; Saleth & Dinar, 2005). However, inquiry into constraints from the perspective of buyers and the institutions that

deliver water can offer insights and suggest new areas of emphasis for policy makers and practitioners. This body of scholarship has helped create and correct existing programs for environmental water transactions (Garrick et al., 2009; Neuman, 2004). However, locally developed institutions, such as irrigation districts, emerged for the collective benefit of irrigation district members and have been found to problematize the assumptions of a market basted and individual transaction in water leasing programs. Rosen and Sexton (1993) estimate that irrigation districts manage approximately half of all surface water resources in the West.

In this paper we turn to the Payment for Environmental Service (PES) literature to frame a mixed-methods case study analysis of environmental water transactions in Oregon over the past 20 years. We identify PES literature as a broader perspective for using incentives to produce environmental benefits. We argue that environmental water transactions are a type of PES that fits Wunder's (2015) definition of " a voluntary transaction between service users (buyers) and service providers (sellers) that are conditional upon agreed rules of natural resource management for generating offsite services" (Wunder, 2015: 241). An emerging focus on institutional alignment in PES programs marks a shift away from conceptualizing PES as strictly market-based transactions. Where market-based solutions assume that sub-optimal ecosystem service provision occur due to market failures, in many cases the decline in ecosystem services is the result of social dilemmas. Social dilemmas occur when individuals' interests are at odds with the collective interests (Muradian, 2013). We hypothesize that inadequate instream flows are a social dilemmas. We look for evidence of conflicting interests between individuals and societal interests by looking at the trends in transactions the reasons that individuals are or are not choosing to

participate in transactions.

We contextualize trends in transactions with interviews from sixteen irrigation district managers in the state of Oregon; we use state level transactional data and qualitative interviews to shed light on perceptions of leases and efficiency upgrades in practice. Finally, we draw from water user surveys to further explore preferences for PES-based environmental water transaction program instruments. We discuss these findings in-light of recent theoretical PES literature; specifically we argue that market-based water transaction programs are not achieving optimal participation because these programs are predicated on the assumption that water rights are functionally private goods, when often water rights secure access to a common pool resource that is managed through collective action that are subject to strong social norms. Therefore, we hypothesize that the lack of instream flow is not the product of a market failure, but rather the result of a social dilemma. As a common pool resource, water requires collective action for delivery and management, thus market-based solutions that target individuals undermine the interest of the irrigation district as a whole. In this paper we attempt to address the following research questions:

1. Is the current lack of instream flows the result of a social dilemma or a market failure?
2. Given current institutional conditions of water management in Oregon what is the preferred type of environmental water transaction to produce instream flows?

Background

Water rights and irrigation districts

The Prior Appropriation Doctrine operates as the foundation of freshwater allocation in the western United States. Prior appropriation established private property rights for water, a common pool resource, in an attempt to encourage the development of water resources for economic purposes (Getches, 2009; Tarlock, 2001) Water was 'privatized' by granting a right to use a specified amount of water for a specified time, location, and use. Water rights were granted according to a system of 'first in time, first in right.' When water is scarce it is allocated according to the order that water rights were claimed. This stipulation was critical for encouraging settlement in the West since the assurance that water would be prioritized for early actors incentivized early economic development (Tarlock, 2001). A second principle of prior appropriation, known as the beneficial use clause, requires that water be used for a specified economic purpose. Initially, this encouraged economic efficiency by prioritizing uses that promoted a robust agricultural system as an economic base for the developing region. States determine what uses qualify as beneficial. Individuals may apply to change their beneficial uses of their water rights. This provides some flexibility for how water is used.

Prior appropriation solved many of the critical problems facing water development and succeeded in allocating all of available water resources to out-of-stream, economic use. The allocation of water "rights" also encouraged the development of irrigation districts. The high individual cost of moving water to farmland came at great expense. Through collective action irrigation districts formed to build delivery infrastructure and manage water rights more efficiently than if performed individually. Irrigation districts remain an important

organizational component of the institutional complex used to manage water under prior appropriation (Merrey, 1996; Rosen & Sexton, 1993).

Today irrigation districts function as self-governing, local organizations that manage and enforce the institutional arrangements that allow for the delivery and use of water for irrigation (Merrey, 1996). Districts use rules and norms to protect the collective interests of all members to prevent free-riding and individual maximizing behavior (Ostrom, 2011). Through collectively created institutions districts provide an efficient means of enforcing and monitoring water rights under the rules of prior appropriation (Libecap et al., 2010). Thus, while prior appropriation appears to 'privatize' use rights water is managed through the collective action that creates interdependencies among users (Getches, 2009; Tarlock, 2001).

Restoring instream flow in Oregon

Oregon is often depicted as a state with abundant freshwater resources. While this is true for the western half of the state, eastern portion of the state is high desert (Franczyk & Chang, 2009). Agriculture is the primary private land use in eastern Oregon, in large part due to the development of irrigation districts. Agriculture covers more than 16 million acres and generated USD $5.4 billion in 2012 (Oregon Department of Agriculture, 2012). Irrigation systems depend upon snowmelt from the Cascade, Blue, and Wallowa mountain ranges. Water is diverted directly from water from rivers and stored in reservoirs to provide water during the warmest and driest parts of the year after runoff has occurred (Oregon Water Resources Department, 2016).

Using surface water for irrigation creates tradeoffs for the production of other ecosystem services. Diminishment of instream flows and development of irrigation

infrastructure has contributed to decline in native salmon populations. Salmon are keystone species that play a major role in ecosystem function and constitute a prominent ecosystem service, due to their cultural and economic importance to communities in the Pacific Northwest (Garibaldi & Turner, 2004). The listing of thirteen distinct salmon populations (including steelhead) as threatened or endangered under the Endangered Species Act prompted federal and state governments to implement programs aimed at increasing salmon populations. Increasing instream flows is viewed as one of the primary means to sustain and increase wild salmon populations (Northwest Power and Conservation Council, 2009).

The Columbia Basin Water Transaction Program (CBWTP) attempts to reallocate water from agricultural to instream flows through water transactions. CBWTP is funded by the Bonneville Power Administration and administered by the National Fish and Wildlife Foundation (Northwest Power and Conservation Council, 2009). The CBWTP operates in Idaho, Montana, Oregon and Washington and funds local non-profits that use a variety of types of water transactions to allocate water to instream uses (Garrick & Aylward 2013). Water transactions funded by the CBWTP come in a variety of forms, including: (1) short term leases where a water use is changed to instream flows for 1 to 5 years in exchange for a payment; (2) permanent transfers that involve a change in ownership of a water right and change in use of a water right to an instream flow for more than 25 years in exchange for a payment and; (3) allocations of conserved water (only in Oregon), where financial incentives are used to pay for all, or part of, an efficiency upgrade in exchange for a portion of the water savings being committed instream (Aylward, 2013).

Water leases and permanent transfers are market-based transactions in that they provide payment in exchange for foregoing the use of water for out of stream uses. Leases

are more flexible because the time commitments are flexible and do not constitute a change in ownership. Permanent transactions are less common but constitute an important source of instream flows because they help ensure more reliable flows from year to year (conditional upon the priority date of the water right being purchased).

Efficiency upgrades can occur at various points within the irrigation system. Generally speaking, efficiency projects improve water delivery efficiency, which is the irrigation districts primary function of moving water from the stream to the water user (Aylward, 2013). Delivery efficiency projects are the most costly because they require large infrastructure improvements, but they also have large potential for water saving. As much as half of the water that irrigation district draws out of a stream may be lost during delivery due to seepage and evaporation. Thus, these projects incur large payments for substantial quantities of water.

On-farm efficiency projects are scaled to water-user levels and decrease the amount of water consumed and the amount diverted by decreasing losses due to seepage (Aylward, 2013). These improvements are targeted at individuals and therefore come with less upfront financial burden. Common on-farm efficiency measures include upgrading to more center pivot sprinklers and drip irrigation.

All three types of environmental water transaction have been used in Oregon and any type of formal transaction is documented by the Oregon Water Resource Department. Transactions require documentation of the change in use, the change in location of use, and any change in ownership of the water right. Allocations of conserved water move water rights from individuals to being property of the state of Oregon. Permanent transfers typically involve changing the water user from the seller to the individual or entity buying the water.

Theory

Economic incentives for reallocating water

Instream flows generate numerous environmental benefits. While sustaining salmon fisheries with instream flows is just one of many ecosystem services provided by freshwater ecosystems, it has been prioritized because of its social and ecological importance (Chan et al., 2012). This is an important assumption to understand, since ecosystem services represent environmental benefits for people, who are theoretically willing to pay for those services if the proper institutional arrangements are in place (Loomis, Richardson, Kroeger, & Casey, 2014). In this case, the tradeoffs between agriculture benefits and instream flows are in part the product of the institutional arrangements set forth by prior appropriation.

Proponents of water transactions therefore characterize the decline in ecological functions as a market-failure where existing arrangements create negative externalities born by society (Engel, Pagiola, & Wunder, 2008). This view is based on the conception that the loss of these ecosystem services results from information distortion, inflated transaction costs and/or inadequate pricing that produce market failures (Garrick and Aylward, 2012). Market-based solutions to these problems aim to internalize these costs through price adjustments or the creation of markets but prior appropriation and the irrigation districts that support this institutional framework are widely regarded as distortionary constraints because they help keep water prices artificially low and restrict or outright block trading of water rights between rights holders (Bretsen & Hill, 2009; Libecap et al., 2010).

The economic theory behind the conception that facilitating trading among water rights holders will produce a more socially efficient allocation of water is based on the Coase

theorem (Wunder et al., 2008). The Coase theorem proposes that establishing property rights for both resources and the externalities produced through use of those resources will allow affected parties to negotiate the most efficient solution (Ruml, 2005). Since water rights are already allocated to users, the use of bargaining can be used to negotiate more efficient allocations by allowing payments to offset water rights holders for the opportunity cost of unrealized agricultural production while producing greater economic total welfare by leaving water instream (Tacconi, 2012). This would occur by creating a right associated with the public good benefits produced by instream flows and allowing beneficiaries to trade in order to preserve those benefits (Wunder, 2015).

Programs where the beneficiaries of ecosystem services pay for, or incentivize, the supply of ecosystem services are most commonly known as PES (Wunder, 2005b, 2015). As originally conceived, PES were designed to provide economically efficient means to achieve conservation (Engel et al., 2008; Ferraro & Kiss, 2002; Wunder et al., 2008). In this way, environmental water transactions are modeled after the same Coasean economic principles as PES (Engel et al. 2008). Under this type of transaction individuals will sell the right to their water if their opportunity costs are met by incentives. This allows buyers to access water that would otherwise not be available and use it in an end use of higher value to society (Johansson et al., 2002).

In practice most PES programs are often implemented as incentives for collective action (Muradian 2013, Wunder 2015; Vatn 2010). In the case of water transactions, it has been noted that there are often unintended consequences due to the way water rights are allocated between senior and junior water rights holders (Garrick et al., 2009). Environmental water transactions performed by individual members of a district could

impose costs on other members of the district, due to the collective action arrangements created through districts (J. M. Kerr et al., 2014) . Thus, districts may discourage transactions by imposing additional transaction costs. Rather than distortions, this barrier to trade is proportional to the opportunity cost faced by the group. High transaction costs due to the physical characteristics and existing institutions of water management decrease the utility of market-based solutions (Garrick & Aylward, 2012; Muradian, 2013). Other sources of transaction costs include the lack of trust between sellers, that tend to be agricultural producers, and buyers, which are governmental organization and environmental groups.

The issue of high transaction costs created by collective action institutions necessary for managing water, a common pool resource, and water rights as semi-private property, is evidence that the negative externalities created through the institutional arrangement of irrigation districts is actually an issue of a social dilemma. For one, the management of water for irrigation districts and the management of water by state and federal agencies for fish occur at different institutional and spatial scales (Muradian, 2013; Ostrom, 2010). Muradian (2013: 1161) describes social dilemmas as "situations where to pursue the individual interest in the short run leads to socially undesirable situation." By using collective action to represent their individual members interests districts uphold the social dilemma created between water for fish and water for irrigation. PES research points to the alignment of property rights with PES incentive schemes as a critical component for enabling participation and overall success of PES (Bremer, Farley, & Lopez-Carr, 2014; Muradian, Corbera, Pascual, Kosoy, & May, 2010; Vatn, 2010).

One means of aligning institutions is by ensuring that the behaviors promoted by PES and the financial instruments used to promote those behaviors are congruent with existing

institutions. Muradian (2013) characterized PES as three kinds of instruments: rewards, markets and incentives. Using this framework, instream water leases and permanent transfers are more similar to market-based transactions while efficiency upgrades are more inline with incentive based transactions. Both use monetary payments to encourage the reallocation of water instream, however leases and transfers prompt behaviors that individuals would not take without a payment (no motivation) and commoditization of private capture of benefits is high. Efficiency upgrades are more like incentives, where payments encourage behaviors that individuals may take without a payment (existing motivation) and for which commoditization is lower (Muradian, 2013).

If we consider water the transactions through the lens of PES, an important distinction emerges between water lease and water-use efficiency programs. The uses of direct individual payments characterized programs that attempt to address market failures by using payments to pay for the opportunity costs associated with behaviors that reduce externalities from traditional uses. Incentives for efficiency upgrades at both individual and district levels lower the barrier to entry for beneficial behaviors that individuals or district may already want to take that also reduce negative externalities. Due to the characteristics of water as CPR and the formation of "hybrid" collective action institutions what expect to find are social dilemmas. Social dilemmas need changes in management to realign institutions to meet new goals, which requires trust and buy-in first, then it may be possible to add on to new institutions to allow for market-like transactions. Both market failures and social dilemmas exist in the case of water transactions. Under these circumstances decisions about the kinds of water transactions can be made to maximize collective benefits.

The current institutional context of irrigation districts and water allocation in the

western United States creates what many economists refer to as “distortionary” constraints that prevent water from being used to maximize social efficiency (Johansson et al., 2002). Irrigation districts simultaneously play a critical role in managing water while hindering the allocation of water toward public good outcomes (Bretsen & Hill, 2006; Brewer et al., 2007). Doing away with, or significantly altering the system of prior appropriation or the role of irrigation districts is untenable and frankly unattainable. Rather than replacing water management institutions, PES is a retrofit to prior appropriation that leaves water rights, and all accompanying institutions in place, but provides incentives to encourage the voluntary reallocation of water toward providing greater social goods.

Water-use efficiency programs are based on the principal of Pareto efficiency that encourages actions that reallocate resources to allow for an increase in total net benefits (Johanssen et al., 2002). Water efficiency upgrades typically replace infrastructure for conveyance and modernizes water application for irrigation. Water losses due to inefficient conveyance account for up to 50% of water diversions (Aylward, 2013). Piping or lining canals can save significant amounts of water because conveyance infrastructures move water for all users in a district. Conveyance infrastructure improvements are immensely costly but they have potential to re-allocate a large amount of water from very low value use (conveyance) to higher value uses. Conveyance infrastructure can also facilitate the use of on-farm efficiency by providing pressurized water (Aylward, 2013). On-farm water-use efficiency improvements aim to increase the percentage of water that can actually be used for crop production. Low-efficiency water applications like flood irrigation account for significant losses at the farm level. Upfront costs for installing on-farm water use efficiency technology are modest and are therefore appealing (Aylward, 2013).

Water savings in some states remain instream for the next priority user to fill unmet water rights. This approach is a remnant of prior appropriations beneficial use clause. States such as Oregon have changed this rule to split water savings between water rights holders and instream flows if any public funding is used for the project. This approach has helped create win-win outcome by increasing incentives for water right holders and increasing the provisioning of public goods. From a theoretical standpoint, these programs encourage Pareto efficiency, in that these upgrades move toward maximizing efficiency, but doing so without making anyone worse off (Tsur and Dinar, 1997).

Methods

We use a mixed-method inquiry to analyze trends in water transactions in Oregon and provide insight on perceptions and preferences for water transaction instruments. First, we assess environmental water transaction data provided by the Oregon Water Resources Department. In addition to the twenty-year record of transactions we add qualitative insights from irrigation district manager interviews. Interviews provide local institution perspective of the conflicts and synergies that arise from the introduction of environmental water transactions. Interviews also provide insights on opportunities for strategic development and institutional investments necessary to create conditions that support water transaction programs. We look for evidence of market failures where individuals or districts are responding to water pricing signals. We look for evidence of social dilemmas where individuals or districts are not responding pricing and instead looking to protect group interests despite foregoing their own best interest.

Finally, we draw from a survey of irrigation district members to provide additional insight on individuals' perspectives and preferences for water transaction instruments. Using this combination of data we highlight potential next steps for increasing instream flows in Oregon by engaging in market-based leases, permanent transaction or allocation of instream flows from increased efficiency.

Oregon water transaction data

We used 20 years of voluntary, market-based water transactions reported to the Oregon Water Resources Department from 1995 to 2016 to observe trends across three types of water transactions. Data was obtained from the Oregon Water Resources Department in the Fall of 2012 for all records of water transactions from 1995 through 2012. Data includes all instream leases, permanent transfers of water instream and allocations of conserved water dedicated instream from efficiency projects. Supplementary data was then obtained in 2016 to add an additional three years (2013-2015).

We used descriptive statistics to analyze trends in transactions. We were unable to link transactions to specific irrigation district locations without more information about water rights holders and locations. Due to the nature of these data and the privacy rights of the individuals involved, these data reflect the cumulative total of all transactions that occurred in Oregon from 1995 to 2016. However, by drawing on our interviews and water provider surveys below, we can draw conclusions about the nature of these transactions by comparing these different data sets.

Irrigation district interviews

We conducted interviews with key irrigation district managers in order to understand how districts have responded to market-based solutions or if they have implemented them into their management strategy. A total of 16 interviews (six in-person interviews and ten phone interviews) were conducted in the Fall of 2014. Two criteria related to Oregon districts were used in the purposeful (i.e. nonrandom) approach for selecting the managers and districts studied (Huberman, 1994): (1) a primary purpose of delivering water to individuals with water rights and (2) membership in the Oregon Water Resources Congress (OWRC). The OWRC represents the interests of districts in the state legislature and provides publically available contact information for their members. Interviews lasted between 20 minutes and 1 hour and 30 minutes, and were recorded for transcription and analysis. Although these interviews covered a range of relevant topics, this analysis focuses on responses to questions intended to prompt responses about districts utilization of water markets and water efficiency upgrades. Interviews were performed until saturation was reached across all major thematic topics. Interview analysis and coding were thematically coded to identify discussions of approval, neutrality or rejection of water leasing, permanent transactions, and efficiency improvements.

District member surveys

We used a household survey instrument to collect information on water users attitudes toward water transactions, water efficiency and socio-demographic information. We sampled water users within six irrigation districts in Northeastern Oregon. We opted to survey districts in this region of the state because of high density of irrigation districts, the

variety of district approaches to water transactions and the variety of irrigation water uses, ranging from highly industrialized agricultural water users and fruit growers to hobby farmers and domestic users (lawns and gardens). The streams in this region where most irrigation water is sourced provide important salmon spawning habitat.

We used a modified survey drop-off method, following a stratified systematic sampling design (Steele et al. 2001). Two research assistants delivered surveys and pre-stamped envelopes to randomly selected, freestanding homes within an irrigation district. If respondents were home they were asked if they owned a water right and then asked if they would be willing to fill out a survey regarding their water right, water use and irrigation district. Respondents were asked to fill out the survey and return it by mail. A total of 360 surveys were dropped off, with approximately 60 surveys delivered across each of the six districts. A total of 77 completed surveys were returned by mail for a response rate of 22%. Survey data was entered into an on-line, Qualtrics version of the survey, then transferred to Statistical Package for the Social Sciences for analysis (Leech, Barrett, & Morgan, 2012).

Results

Oregon water transactions data

Over the past ten years, leases put instream about 550 Cubic Feet per Second (CFS) per year, which is nearly triple what has been allocated instream from either permanent transactions (141 CFS) or allocations of conserved water (ACW) from efficiency improvement programs (ACW in Figure 1) (182 CFS). However, it is worth noting that leases must be renewed annually or semi-annually (2 to 5 years). The number of leases performed annually grew steadily from 1999 through 2006, but since 2007 has leveled off

remaining between 108 and 120 leases per year.

State data on leases also shows that about half of these leases are initiated by third parties, non profits such as the Freshwater Trust and Deschutes River Conservancy (OWRD, 2016). The number of leases occurring annually has leveled off around 110 leases. Despite rapid increase in transaction over the first ten years of the program, the past 10 years has seen a slight decline in overall leasing activity. Leases in 2012 and 2103 (Figure 2) nearly doubled the average CFS leased instream. However, in the subsequent years the amount of water leased returned to levels slightly below average, with 450 CFS in 2014 and 490 CFS in 2015. Over the past ten years the average lease has allocated 1.4 CFS instream.

The two other types of water transactions, permanent transfers and ACW, increased slowly from 1996 to 2005 but steadily increased from 2006 to 2015, both in number of transactions and amount of water allocated instream (Figure 1). Over the past 20-years permanent transfers allocated 141 CFS to instream flows. On average, permanent transfers have added almost 10 CFS annually, with an average of almost eight transactions annually. The total number of transfers more than tripled from the first ten years (1996-2005) to the last ten years (2006- 2015) from 30 to 125.

ACW are responsible for an additional 180 CFS of permanent instream flows. Instream transfers add close to an annual average of 14 CFS during the past 10 years, with an average of about 4 transactions every year. ACW are larger in quantity than permanent transactions. Records of these transactions show that most of the allocations of conserved water come from water irrigation district managers and large water rights holders, such as municipalities.

Qualitative interviews

Interviews conducted with district managers regarding efficiency upgrades, leasing and transfers add insights on these trends, particularly in regard to members perceptions of leases and ACW. Permanent transfers are not common in districts and during interviews district managers unanimously stated that permanently transferring water out of the district was against district policies. Permanent transfers require a change in user, and district managers noted that they would oppose moving water rights to users that would not be using water for agriculture.

Leasing was discussed as a more acceptable form than permanent transactions of water transaction. Leasing for instream flows by individual members was reported in some districts but was typically regarded as uncommon occurrence. Many district managers described using leasing as a tool for demonstrating beneficial use when water rights were not being fully utilized by members. Here it is important to note the distinction that the districts, rather than the individual, were accepting lease payments.

A few districts managers report that leases for instream flows performed by individual were a common practice. These district identified water leasing as a flexible mechanism for balancing water needs among competing demands. In these districts, managers noted that the district helps coordinate leases with multiple water rights holders so they can lease their rights in exchange for a monetary incentive, such as paying for the member's district's water assessment fees. Another benefit that these managers noted was that under pressurized systems they had greater flexibility in moving water and were not constrained to minimum flow requirements in their delivery systems.

The remaining district mangers acknowledge that leasing is allowable but uncommon

in their district. Managers noted that if water was going unused there were other farmers willing to lease it for agricultural purposes. Leasing for instream flows was described as a secondary option for water use. If water was not being used for agriculture or other beneficial uses, district managers suggested they would rather have that water leased to other users. One manager described the constraints districts may put on leasing and a sentiment toward leasing characteristic of district managers where leasing was not occurring:

> "We'll let them [lease], if they feel like they want to do that, we can have them lease it to the river, but four years they've got to come back and raise a crop on the ground. Because if you don't use this water, if the ground sits five years or longer, there is a very real possibility the state will take it away."

By contrast these managers noted that leases would need to go before the district's board members for approval. This is an indication that requests for leases are infrequent and are dealt with on a case-by-case basis,

Unlike leasing, most district managers viewed water efficiency improvements favorably. Districts managers highlight the cost savings from reduced maintenance and water saving from reduced seepage as the primary reasons for upgrading to pipes. Water savings were particularly important for districts managers that noted concerns about water security. Managers also noted conveyance infrastructure has the potential to encourage on farm efficiency because piped systems could provide pressurized water that is required for high efficiency sprinklers and drip irrigation:

"With a pressurized conveyance [members] have been able to cut down a lot of their costs from pumping... They also don't have to filter their water because we filter the water.

They've put a lot of those costs, believe it or not, back into on-farm efficiencies. So they are able to reduce their use to around 2 acre feet per acre …which is pretty cool."

Several managers made the point that improving on-farm efficiency only made sense once the district had piped the system. For the most part, the district managers supported improved efficiency. The biggest constraints expressed were the capital costs. Most districts have used public funding to help pay for piping projects and were therefore required to put some of the water saving instream. For most districts this seemed like an acceptable, even necessary compromise. As one manager puts it:

"[E]arly on, a lot of districts, users were leery of doing [projects], thinking if we put it instream we're never going to see it again.' Well, that's become more of a reality than a danger. I mean it has happened, not that they've lost water but they've been able to put that water instream because of the water conserved has still let them have whatever their water right calls for and they're duty is called for, they can do that because they're conserved, and that just shows how much water was being lost over the years through inefficient delivery."

Taken together these data points suggests that the incentives for increasing efficiency through conveyance projects at the district level creates other opportunities for on-farm efficiency and may also help increase trust between irrigation districts and the organizations financing efficiency projects. While some districts have improved efficiency through the incentives offered by government program other districts aim to self-finance the remaining improvements. The following quote highlights how one district has structured its rules around allocation of conserved water to continue improving efficiency:

"We did one [piping project] on our own and got a grant on the other. The problem is when you do these grants and you get money to OWEB or the USDA, they always want you

to set aside 25% of the saved water... Well, we need all that water, we can't just give away 25% of whatever we think we saved. We finally said we're not doing any more grants because of that. If a [farmer] wants [pipe] water somewhere, we'll help them out. If they buy the pipe we'll put it in for them."

This quote resonates the interest that many irrigation district managers' expressed in increasing water efficiency with or without incentives. Managers are sensitive about losing water rights through incentive programs even when financial benefits and water savings are available. The It also suggests water endowments both quantity and quality, in terms of water right priority may be a determining factor in determining how much district managers are willing to give up in exchange for financial assistance for efficiency upgrades.

Survey results

Individual district member surveys elucidate several points that show support for efficiency versus leasing. Most members have already engaged in efficiency upgrades (Table 3.1) and they hold positive perceptions of on-farm and district level efficiency upgrades (Table 3.2).

Members are largely undecided about the benefits of leasing and most say that they would not participate in a lease transaction in the future. When ask if they would consider a lease 8% percent said they would consider leasing, while 38% said they didn't know, 54% said it was unlikely that they would perform a lease.

These results caveats the state-level data by suggesting that individual district members are not likely to be contributing to instream flows through either leases or efficiency upgrades. With regard to leasing, uncertainty about the benefits and the low rates

of participation suggests either unfamiliarity with the program or the presence of institutional barriers.

In-line with these findings, 83% of individuals said they would support their district decision to improve its delivery efficiency. This adds evidence that members support irrigation district managers in their efforts to increase district level water efficiency. This also suggests that there is demand for more district level efficiency projects. Members were undecided about the benefits of leasing, leaving room for improved understanding of leasing, while 74% of respondents said they would consider further improving on-farm efficiency improvements at the farm and irrigation district levels.

Discussion

Drawing from all three data sources we infer that the lack of recovery of instream flows persists as a result of social dilemmas rather than market-failures. We found that individuals within irrigation districts do not favor participating in market-based programs. Social dilemmas for allocating water instream exist at two points. First, it occurs between irrigation districts and the federal, state, and non-governmental agencies attempting to sustain salmon populations as public goods. By performing their primary function, drawing water out of stream for use by their members, districts are perpendicularly oriented to the institutions aimed at restoring instream flows. Muradian (2013) describes this arrangement as often leading to the types of social dilemmas that often under produce ecosystem services.

If the lack of instream flows results from market-failure we would expect the market-based solutions already in effect to have been successful. Instead, market-based transactions have only been moderately successful (Neuman, 2004; S. Wheeler, Zuo, Bjornlund, & Lane Miller, 2011). Furthermore, this presents a second social dilemma. There is a second social

dilemma emerging between district members and their irrigation districts due to the incentives offered to individual members. Through water transactions individuals have the opportunity to act in their own short-term interests by accepting payments for water leases or permanent transfers. However, performing these transactions can create undesirable situations for the rest of the members in their district by reducing the districts control of water, increasing operation costs for the district.

Water leasing

District managers report using rules to prevent certain types of transactions from occurring. The high transaction costs, which emerge from these mechanisms and inherently connected water rights of district members violates the premise of Cosean transactions (Garrick & Aylward, 2012; Wunder, 2015). While irrigation districts, and other forms of collective action, are criticized for their disruption of environmental transactions, their interference is often done to protect the property rights interests of other members of the group (Fennell, 2011; Marshall, 2004). Under current institutional conditions of prior appropriation and irrigation districts, the expansion of market-based leases and transfers is limited (Bretsen & Hill, 2009; Libecap, 2011; Libecap, 2009; Meiners & Scarborough, 2010).

However, overhauling the system of prior appropriation is a politically and socially untenable proposition. Thus, the focus shifts to alterations of the institutions being employed to reallocate water within the system. Building from our understanding of the lack of instream flows as a social dilemma the focus of this discussion turns to incentive programs that target complimentary institutions (Muradian, 2013). Furthermore we explore how these interventions can better align with exiting institutions that define water-use in the West and

encourage greater flexibility within those systems (Meinzen-Dick, 2007).

District manager interviews show that managers oppose permanent transfers and possess the power to limit them. This institutional reality demonstrates that water rights are privatized only on paper. The necessary collective action conditions for districts to manage water, a common-pool resource, negates the ability to treat water as a discrete, tradable good (Ostrom et al., 1999). However, districts are not uniform in their approach to leases.

The conditional acceptance of leases by some district managers offers two insights for the design of incentive-based interventions. First, leases were performed by district when leases provided collective benefits (protection of water from forfeiture due to non-use). Under current program payments to individuals to induce an unfamiliar behavior may be targeting payments at the wrong level. Shifting from payments to individuals to incentives for districts could help scale-up the size of leases and more properly target incentives such that they are complimentary to, and not competitive with existing institutions (Baland & Platteau, 1997; Fisher, Kulindwa, Mwanyoka, Turner, & Burgess, 2010; Ostrom, Dietz, Dolsak, & Stern, 2002). Second, because leases do not require permanent changes the ownership of water rights and are only temporary, they are more flexible. In this regard they may offer a low risk trial of environmental water transactions. This idea of using leasing as a way for individuals to "test out" water transactions highlights the importance of trust building by using low risk financial and contractual commitments.

Increasing efficiency

The primary limitation for both water leasing and permanent transfers are the persistent high transaction costs due to third-party externalities that arise from common-pool resource characteristics of water. Interviews with district managers reveal concerns about

potential impacts on the other users if the water rights from the district were allocated instream. This set of externalities, related to water delivery can be ameliorated through technological upgrades in the form of increased water delivery efficiency. As we discovered in the interviews the districts that are allowing, and even coordinating instream leases with their patrons are also the districts that have high-efficiency water delivery systems (Ostrom et al., 1999). We do not have evidence to suggest a causal relationship (alternative explanations abound). However, managers noted that the added flexibility that came with upgrading to pressurized, piped systems addressed some the potential third-party externalities that irrigation districts are designed to guard against (Pagiola, 2005).

Increasing efficiency also presents an opportunity to reallocate water from a very low value use (conveyance) to much higher values uses, (instream, on-farm or domestic) (Aylward, 2013). While this type of efficiency projects requires large investments and long lead times, the benefits attained are of high value to both parties. In this way incentives for efficiency upgrades might change structural characteristics to allow for cooperative behaviors to benefit individuals, districts and society (Biel & Thøgersen, 2007; Fisher et al., 2010; Hayes et al., 2015).

Our results show that district members support their districts efforts to improve efficiency and that they want to further increase their own, on-farm efficiency. This highlights yet another opportunity for environmental water transaction programs to incentivize an activity for which the actors are already motivated to perform. The addition of monetary or in-kind incentives leverage existing motivation to promote mutually beneficial behaviors. Again, the distribution of benefits needs to properly align with existing institutions. However, barriers for increasing participation at the individual level may be

lower (Kosoy et al., 2008).

Lastly, infrastructure projects present an opportunity to build trust through the working relationships necessary to coordinate these large-scale projects. Trust through shared experiences can facilitate additional opportunities for cooperation and mutual understanding, affording the opportunity to coordinate future leasing and efficiency transactions (Wunder 2015; Kolinjivadi, Adamowski, & Kosoy, 2014). In tandem, reducing potential for negative externalities on other district members and increasing trust through infrastructure upgrades can help create conditions more conducive to using market-based leasing programs.

Conclusion

This research explores the idea that the over-allocation of water and lack of instream flows is a social dilemma rather than a market failure. Addressing a social dilemmas require programs that provide mutual benefits to individuals as well as those with collective interests in the resource. The findings presented here are applicable for programs and practitioners in Oregon but touch on issues that are likely to arise in other contexts where PES solutions are being introduced as a way to increase efficiency for the management of common-pool resources (Muradian et al., 2010). The inadequate recovery of instream flows results from a mismatch of program design and the problems it aims to address. Currently, water transactions are market-based programs designed to address market-failures. We propose adapting environmental water transactions to incentivize behaviors that serve to provide benefits to individuals, the collective action institutions that manage resources, and to society. This expands the definition of win-win-win solutions and recognizes that equity impacts can extend beyond the individuals that participate in PES programs to the member of shared institutions that are designed to help manage resources.

Insights garnered from this research are in-line with the past decade of PES literature and reveal the possibility of successfully altering resource management at the local level to incentivize the production of ecosystem services while simultaneously promoting the objectives of local institutions when the nature of the problem is properly understood (Vatn, 2010). This research also supports the assertion that incentives can help leverage the utilization of existing technology that promotes improvements in the efficiency and enables more efficient and equitable management of common-pool resources (Ostrom et al., 1999).

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Tables

Table 3.1: Changes in members' water management

Individual reports of participation in the following activities (*n=76*):	**(Yes)** Participated	**(No)** Have not participated
Lease or Permanent Transfer	3%	97%
Efficiency Upgrades	82%	18%

Table 3.2: Perceived economic benefits of changing water management

***Individual belief that performing the following activity will have a positive financial benefit* (*n=66*):**	**Agree**	**Don't Know**	**Disagree**
Lease	**12%**	**71%**	**12%**
Efficiency Upgrade	**92%**	**7%**	**1%**

\

Figures

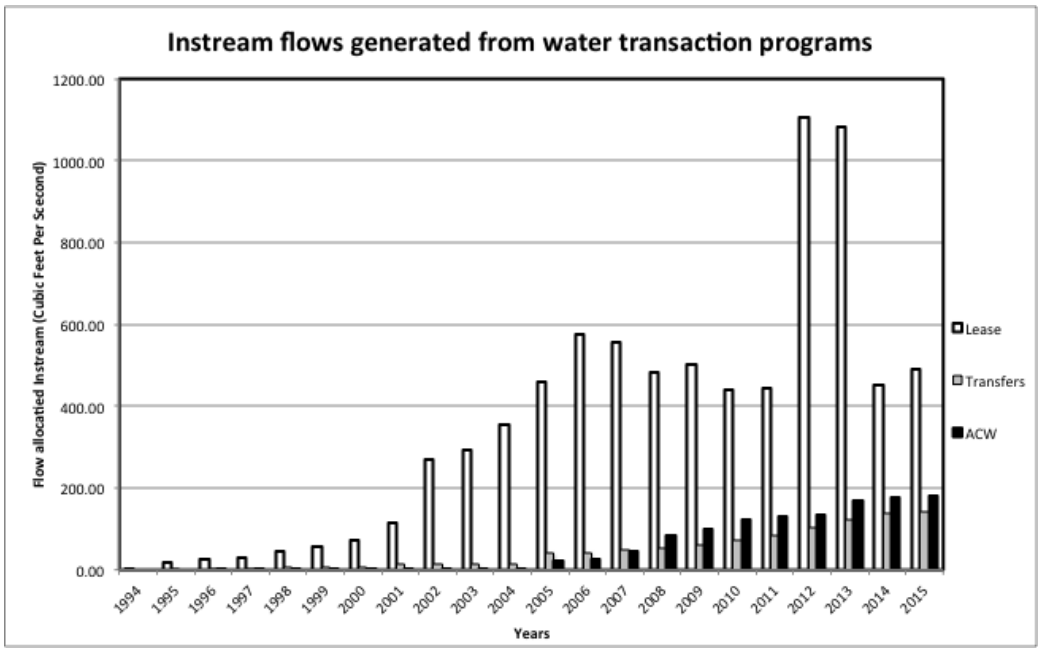

Figure 3.1: Number of instream water transactions in Oregon over the past 20 years

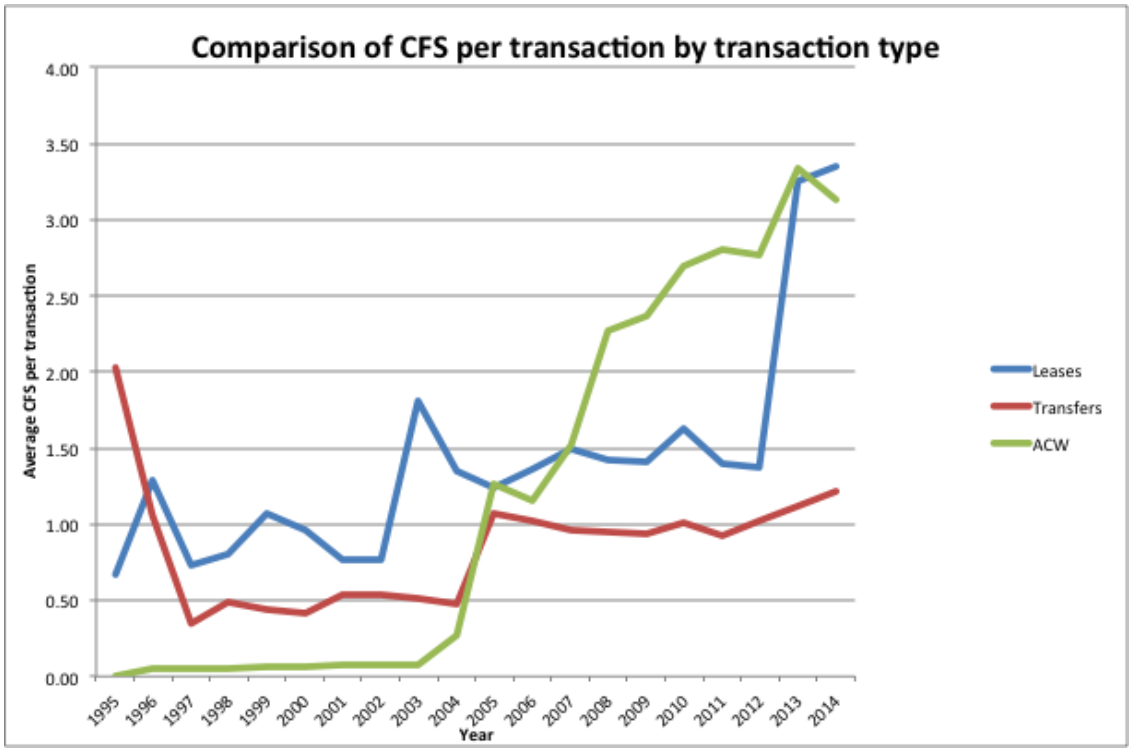

Figure 3.2: Average cubic feet per second (CFS) per transaction

CONCLUSIONS

Looking across all three chapters of this dissertation, this conclusion synthesizes our findings with four final points: First, irrigation districts established to manage water rights for agricultural users have important roles to play in increasing water efficiency and allocations to environmental flows. Districts manage substantial quantities of water and successfully represent a diversity of individual water interests. Even with market-based mechanisms in place the services provided by districts are still essential to the delivery and management of water. Districts can serve to encourage or discourage individual participation in water transactions for any purpose and will discourage transactions that work against the irrigation district as a group. While market-based mechanisms are based on the idea that individuals can act autonomously and treat water rights as atomized, private property, the common-pool characteristics of water that necessitates collective action and gives irrigation districts the ability to set rules and norms violates this assumption.

Second, understanding local conditions within districts can help explain why districts elect to engage or disregard organizations interested in buying water rights for instream flows. Moreover, identifying the combinations of conditions and how they shape districts rules about water transactions provide insights into the enabling conditions necessary to minimize collective costs while increasing collective benefits. Any successful program needs the adaptability to fit these local conditions.

Third, the importance of engaging districts is further supported by the findings that individuals may respond to the normative pressures invoked at the district level. Norms that discourage participation reflect the collective costs (perceived or real) that districts and their members face when presented with the opportunity to sell water to uses outside of the

district. Even after rules are established to compliment irrigation district ends and local conditions, the cultural norms of irrigation districts need to be considered in order to properly incentivize individuals.

In conclusion, the institutional changes made to enable transactions must reflect the collective nature or water management rather than attempt to replace it. Water delivery efficiency and on-farm efficiency improvements are examples of potential ways to provide collective benefits, allocate water instream, and encourage greater flexibility via individual autonomy for water management decisions that meets conditions of Pareto efficiency. Furthermore, these infrastructure oriented projects engage participants by incentivizing familiar and already desirable technology. Additional intangible benefits include building trust while creating mutual benefits through improved efficiency.

Future research is needed to explore outcomes of different PES programs across a variety of types of collective action institutions. Furthermore, applied research is needed for comparing different incentive models and finding a balance between local group equity and individual incentives, which could help increase participation in PES programs across a variety of types of resources, institutions and types of services.

Demographics

The following questions ask for information about you. We want to accurately represent irrigators in Oregon in order to make suggestions about potential management and policy changes. Knowing the following information about you can help us better understand how water management can be improved.

36. What is your sex?

○ Male	○ Female

37. What year were you born? _____

38. What is the highest level of education you have completed? Please mark only one.

○ Some high school	○ Associates degree
○ High school diploma or GED	○ Bachelor degree
○ Some college	○ Advanced degree (Professional, Master, or Doctorate)

39. Which of the following best describes the average annual pre-tax income of your household?

○ Prefer not to answer	○ $120,000 - $149,999
○ Below $30,000	○ $150,000 - $179,999
○ $30,000 - $59,999	○ $180,000 - $209,999
○ $60,000 - $89,999	○ $210,000 - 239,999
○ $90,000 - $119,999	○ Above $240,000

40. Please estimate the percent of your household income that comes from agriculture (crops and livestock)?

Estimated % of income from agriculture

41. How would you describe your political views?

○ Very Conservative	○ Conservative	○ Moderate	○ Liberal	○ Very Liberal

Thank you for completing our survey!

Your time and opinions are appreciated. If you have any additional thoughts about any of the above topics or the survey itself, please share them below.

Oregon Irrigator Survey

This anonymous survey is being administered as a part of a research project conducted by Spencer Plumb, a Ph.D. candidate at the University of Idaho.

If you have any question regarding the survey please contact Spencer by phone: (406) 579-1476, or by email: splumb@uidaho.edu

University of Idaho
College of Natural Resources

Thank you for taking the time to help us by completing this survey. Droughts, uncertain water supply, and increasing demands for water are driving changes to Oregon water policy.

- **Your input is important for understanding how those policies are implemented at local levels.**
- **Your answers can also help influence water policy decisions and decisions by irrigators.**
- **Your participation is completely voluntary.**
- **You do not have to participate if you do not want to.**
- **If you decide to participate, you are free to discontinue participation at any time.**

Your Land and Water Rights

The following questions ask about your land and water right. We want to ensure proper representation of the uses for land in your irrigation district and how water rights help achieve them.

If you own land in more than one district please respond for the district that you own the majority of your land.

1. How many years have you or your family owned your land?

2. Do you use your land for agriculture?

   ○ Yes
   ○ No

3. How many acres of land do you own?

   _____

4. How many acres of your land do you consistently* use for agriculture?
   (*Consistent means agricultural use during each of the past five years)

   _____ Acres

5. Please list the types of crops you plant on a consistent basis and estimate the number of acres you plant in each crop type.

CROP TYPE	ACRES PLANTED
1.	
2.	
3.	
4.	
5.	

33. How many acre feet of water would you consider leasing at the minimum price you indicated?

_____ Acre Feet

34. Now consider whether you would participate in a one-year lease if you did not receive a price per acre foot of water but instead, if the buyer covered your annual water bill from the irrigation district. As an example, if you normally pay $150 / acre / year to your irrigation district for water delivery, the buyer would pay this bill on your behalf. You would not pay any fees for participating in the lease nor receive any additional money. Under these conditions how many acre feet of water would you lease?

_____ Acre Feet

35. Below are some reasons why irrigators might choose not to participate in leases. Please indicate the degree to which you agree or disagree with each statement. Please mark only one answer for each.

	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Instream flow transactions are not allowed in my district	○	○	○	○	○
Farmers should not lease water instream	○	○	○	○	○
The financial incentives for instream flows are inadequate	○	○	○	○	○
Other water rights holders could be negatively affected	○	○	○	○	○
My irrigation district could be negatively affected	○	○	○	○	○
Other (Please Describe) _____	○	○	○	○	○

Hypothetical Water Lease

32. The following hypothetical scenario asks you to consider participating in a lease for instream flows. We recognize water leasing for instream flows is not allowed in all districts nor is it appropriate in all places. However, we are interested in the diversity of views regarding the acceptability of water leases and so ask that you consider a hypothetical situation where you have a water right that can be leased.

Please consider the following components of the hypothetical opportunity to lease an acre foot of your water right for instream flows. Indicate the minimum price at which you would lease one acre foot of your water right.

- You are being asked if you would lease (not sell) an acre foot of your water for one full growing season (April- October).
- You are making the decision in January for the coming irrigation season.
- By leasing your water you are meeting the Oregon state requirement for beneficial use and there is no danger of relinquishing your water right because of the lease.
- The buyer of your water lease would pay all application and transaction fees, leaving you with no direct expenses for the transaction.
- You have clear title to your water rights and there would be no legal costs. You are allowed to lease water by your irrigation district.
- The different offer prices (per acre foot) are indicated below.

Please mark the minimum price at which you would lease an Acre Foot (AF) of your water right given the conditions described above.

❍ $10/AF	❍ $80/AF
❍ $20/AF	❍ $100/AF
❍ $30/AF	❍ $120/AF
❍ $40/AF	❍ $140/AF
❍ $50/AF	❍ $160/AF
❍ $60/AF	❍ $180/AF
❍ $70/AF	❍ I would not lease an AF of water at any of these prices **(If selected please skip to Question 35)**

6. Do you raise livestock? *If yes, please estimate the total number of acres you dedicate to grazing?*
❍ Yes
[ ] Acres dedicated to grazing

❍ No

7. Please provide the average acreage of land you irrigate on a consistent basis.

[ ] Average irrigated acres

8. Do you lease any land **from** another landowner? *If Yes, please enter the number of acres you lease.*
❍ Yes
[ ] Acres leased

❍ No

9. Do you lease any of your land **out to** farmers or ranchers? *If Yes, please enter the number of acres you lease to other farmers.*
❍ Yes
[ ] Acres leased

❍ No

10. How much water does your water right allow you to use in a year?

[ ] Acre Feet/Year

11. Do you know the priority date* of your water right? *The priority date is the date that a water right was first established for beneficial use. *If Yes, please enter the priority date of you water right*
❍ Yes
[ ] Priority Date Year

❍ No

12. Do you have a groundwater right? *If Yes, please enter the quantity of your water right in gallons per minute.*
❍ Yes
[ ] Gallons Per Minute

❍ No

13. Which of the following water right priority categories best describes your water right?
❍ Senior water right
❍ Junior water right
❍ I don't know
❍ Other _____

14. Do you know the name of the irrigation district that delivers your water?
- ○ Yes
- ○ No

15. Please indicate the extent to which you agree or disagree with the following statement.

In an average water year I am confident that I will receive my full water right				
○ Strongly Agree	○ Agree	○ Neither Agree Nor Disagree	○ Disagree	○ Strongly Disagree

Water Management Practices

Please answer the following questions about water management practices for irrigators. Our interest is in understanding your water management practices and attitudes toward those practices. We are not concerned with promoting any type of practices. Below is an explanation of what is meant by water transaction and water lease.

- ***Water transactions*** *include allocations of conserved to instream flows allocations of conserved to instream flows, leases, or permanent sales of a water right without the transfer of land)*
- ***Water Leases*** refer temporary transfers of water to another use or entity

16. Mark whether you have performed any of the following water conservation measures. ***Check all that apply***
- ❑ Water piping
- ❑ Sprinkler Systems
- ❑ Drip Irrigation
- ❑ Low water use crops
- ❑ Soil moisture monitoring
- ❑ Other (Please describe) _____
- ❑ None

17. Please indicate the extent to which you agree or disagree with the following statement:

To the best of my knowledge my district allows water leasing between patrons in the district:		
❍ Agree	❍ Disagree	❍ I don't know

18. Please indicate the extent to which you agree or disagree with the following statement:

To the best of my knowledge my district allows water leasing for instream flows:		
❍ Agree	❍ Disagree	❍ I don't know

28. To what extent do you agree or disagree with the following statements about being a member of an irrigation district. Please mark only one answer for each statement.

Statements about being a member of an irrigation district	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
I agree with the policies my irrigation district has about leasing water instream	○	○	○	○	○
I would consult with other district water users when considering the lease of my water	○	○	○	○	○
Being a member of this irrigation district is important to me	○	○	○	○	○
Being a member of my water district has been beneficial for my livelihood	○	○	○	○	○

29. Mark the ONE statement that best describes how often you vote for irrigation district board members.

○ Always vote	○ Sometimes vote	○ Rarely vote	○ Never vote

30. How many irrigation district board meetings have you attended during the past five years?

○ None	○ 1	○ 2	○ 3	○ 4	○ 5	○ More than 5

31. How likely or unlikely is it that you would participate in an instream water lease at some point in the future?

○ Very Likely	○ Likely	○ Undecided	○ Unlikely	○ Very Unlikely

26. To what extent do you agree or disagree with the following statements about being a member of an irrigation district. Please mark only one answer for each statement.

Statements about being a member of an irrigation district	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
I should be able use my water however I see fit	○	○	○	○	○
My irrigation district expects that I would only use water for irrigation	○	○	○	○	○
Generally speaking, I would do what other farmers expect me to do regarding water leases	○	○	○	○	○
Considering how changes in my water use could affect other water users in the district is important in my decisions	○	○	○	○	○
Generally speaking, I would do what my irrigation district expect me to do regarding water leases	○	○	○	○	○
Most water users in my district approve of leasing water instream	○	○	○	○	○

27. To what extent do you agree or disagree with the following statements about your ability to participate in a water lease. Please mark only one answer for each statement.

Statements about your ability to participate in a water lease	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Leasing water for instream flows is uncommon in my district	○	○	○	○	○
Participating in a water lease would be easy to do	○	○	○	○	○
Oregon state processes for leasing water are too complicated and prevent me from attempting a water lease	○	○	○	○	○

19. Have you received information about water transactions from any of these groups?
Check all the apply

- ❑ My irrigation district
- ❑ An agriculture extension office
- ❑ Soil and water conservation district
- ❑ The Freshwater Trust
- ❑ The Deschutes River Conservancy
- ❑ Other members of my irrigation district
- ❑ Tribal groups
- ❑ Other (Please describe) _____

20. Have you participated in any of the following types of water transactions?
Check all that apply

- ❑ Lease for instream flows
- ❑ Lease to another water-user
- ❑ Permanent sale of water right for instream flows
- ❑ Permanent sale of water right to another water-user
- ❑ Allocation of conserved water instream
- ❑ Other (Please describe) _____
- ❑ I have not participated in a water transaction **(If selected please skip to Question 22.)**

21 . To what extent do you agree or disagree with the following statements about your participation in water transactions. Please mark only one answer for each statement.

Statements about participation in water transactions	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
I participated in a water transaction to improve native fish habitat	○	○	○	○	○
I participated in a water transaction to demonstrate beneficial use* of my water right	○	○	○	○	○
I participated in a water transaction to help pay for the cost of my irrigation water bill	○	○	○	○	○
I participated in a water transaction because it provided additional income	○	○	○	○	○
I participated in a water transaction because my district encourages participation in such transactions	○	○	○	○	○
I participated in a water transaction to help other farmers	○	○	○	○	○
I participated in a water transaction because my district encourages participation in such transactions	○	○	○	○	○
I participated in a water transaction to help other farmers	○	○	○	○	○

Attitudes and Perceptions

This next set of questions will ask you about your interactions with the irrigation district that serves you and about the role the district plays as a local water manager. Some of these questions also ask about water transactions and water conservation because these are programs that state policies have created. Your opinion will provide better insights about how these programs are managed by irrigation districts and how they affect local water users.

22. To what extent do you agree or disagree with the following statements about water leases. Please mark only one answer for each statement

Statements about water leasing	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
I participated in a water transaction to improve native fish habitat	○	○	○	○	○
I participated in a water transaction to demonstrate beneficial use of my water right	○	○	○	○	○
I participated in a water transaction to help pay for the cost of my irrigation water bill	○	○	○	○	○
I participated in a water transaction because it provided additional income	○	○	○	○	○

23. To what extent do you agree or disagree with the following statements about water use rules in your irrigation district. Please mark only one answer for each statement

Statements about water use rules in your irrigation district	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
It is important that the irrigation district makes rules about water use clear and readily available to their members	○	○	○	○	○
I have a good working knowledge of my districts rules about water use.	○	○	○	○	○
My district has clear rules about water leases	○	○	○	○	○
It should be the districts job to determine if water leases are an option available to the patrons	○	○	○	○	○

24. To what extent do you agree or disagree with the following statements about water leases. Please mark only one answer for each statement

Statements about water leases	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Water transactions for instream flow could benefit me financially	○	○	○	○	○
Water leases for instream flows are beneficial for native fish	○	○	○	○	○
Water leases for instream flows are useful for demonstrating beneficial use of a water right	○	○	○	○	○
The option to lease water for instream flows could be good for my business	○	○	○	○	○
Leasing my water could have negative consequences for me	○	○	○	○	○
Leasing my water for instream flows could harm other water users	○	○	○	○	○
Leasing my water could have negative consequences for my irrigation district	○	○	○	○	○

25. To what extent do you agree or disagree with the following statements about irrigation water efficiency. Please mark only one answer for each statement

Statements about irrigation water efficiency	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
Investing in efficient irrigation equipment is a wise financial decision	○	○	○	○	○
I would support increased water delivery efficiency in my irrigation district	○	○	○	○	○
I would support the district working with other patrons to increase on-farm water use efficiency	○	○	○	○	○
I would work with my district to increase my own on-farm water use efficiency	○	○	○	○	○
I would support my irrigation district monitoring water use by its patrons	○	○	○	○	○

APPENDIX B

Irrigation District Manger Interview Guide and Consent Form

Consent Form

Thank you for agreeing to meet. You are invited to participate in my Ph.D. research study. My research is aimed at understanding how irrigation districts and water rights' holders make decisions about water use. I am especially interested in specific area of interest is how the introduction of water markets, or water transactions, have influenced how water is managed in Oregon.

If you decide to participate, I will interview you once. The interview will last no more than one hour. With your permission, I would like to audio record the interview so I can make sure I know exactly what you said and review your responses in more detail. All information that you provide will remain confidential and I will not release your name to anyone. Your identity will be kept confidential. All my write-ups protect all individuals' identities by not giving individuals' names or potential identifiers, such as names of specific places. Additionally, I will keep all materials that contain your real name in a secure location.

The University of Idaho Institutional Review Board has certified this project as Exempt, meaning participating in this research presents no risks to you. We can select a time or place for the interview that is convenient for you. Although you will not benefit directly from the study your participation will help further the understanding of the role of irrigation districts in water management decisions. If you have questions about the study or interview, you can ask me at any time or contact my advisor.

Your participation in this research is voluntary. You do not have to participate if you do not want to. If you decide to participate, you are free to discontinue participation at any time.

If you do have any questions, please feel free to contact:

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If you have questions regarding your rights as a research subject, contact the Office of Research Assurances at the University of Idaho by phone at (208) 885-6580. You have been given a copy of this form to keep.

Your signature indicates that you have read and understand the information provided above, that you willingly agree to participate, that you may withdraw your consent at any time and discontinue participation without penalty, that you have received a copy of this form, and that you are not waiving any legal claims, rights or remedies.

Print Name_____

Signature_____ Date _____

Interview Guide

- Could you please describe your role in the ID?
    - How long you have been working in this position?
    - Tell me how you initially got involved with the ID.
- Can you give me a physical description of the district?
    - What type of irrigation infrastructure is present in your district?
    - What are the primary sources of water for the district?
- In your time here, have there been any major changes in infrastructure?
    - What were the reasons for those upgrades?
    - How was the project developed?
    - What other entities were involved?
- Can you tell me about the community that this water district serves?
    - What is the range of water uses?
    - How important is agriculture to the community?
- During your time with the district how have ecological or biophysical conditions influenced how the district has operated?
    - For example, how are floods or droughts managed by the district?
    - What other external events have impacted the management of the irrigation district?
- How do you describe the purpose or mission of your district?
    - How does the district achieve this mission?
    - In your time here has that mission changed?
    - Why was it changed?
    - What were the results of those changes?
- In your time here have there been any major changes to the rules or bylaws of the district?
    - Can you describe that process of how rules are changed?
- How are water rights held in the district?
- How does the district maintain contact with its water rights holders?
- In your time here, has the district been involved in water transactions?
    - If yes, what kinds of transaction?

- Are individual members of this district involved in water transactions?
  - What kinds of transactions are common?
  - What role does the district play in those transactions?
  - What role has the state of Oregon or the Federal government played in transactions?
  - When did the first transactions start happening?
  - What is the general opinion about water transactions?
- Have water transactions been discussed during district meetings or in district mailings?
- Has your district changed any rules or management practices due to water transactions?
- What other organizations does the district work directly with?
  - What kinds of projects do you collaborate on?

Additional Information

- If I have follow up questions about this interview may I contact you? What is the best way to be in contact?
- Can you share a copy of your bylaws Mission Statement, Operating Plan and bylaws?
- Would you be willing to fill out a short survey about characteristics of the irrigation district? Would you prefer to complete it online, by hard copy or over the phone?
- Who else in your water district would you recommend I talk to about water management and transactions? Would you be willing/able to share the contact information of your members so that they may be invited to participate in a household survey of water rights' holders about these issues?
- Would you be willing to advocate for district members' participation in the household survey (for example, by including a short statement or letter of support with the household survey)?