DISSERTATION

INVESTMENTS IN WATERSHED SERVICES: UNDERSTANDING A NEW ARENA OF ENVIRONMENTAL GOVERNANCE IN THE WESTERN UNITED STATES

Submitted by

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ABSTRACT

INVESTMENTS IN WATERSHED SERVICES:
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Issues around sustainably managing freshwater resources are one of the most challenging and timely issues affecting the globe. In response to rising social and ecological complexities, decision makers are faced with designing new policies and programs to effectively govern water resources. This shift towards new freshwater resource management approaches is in line with recent movement toward incentive-based mechanisms such as "Investments in Watershed Services" (IWS). The western United States contains one of the most concentrated IWS populations, in a time when population growth, intensifying land uses, and climate-induced environmental changes are stressing ecological systems in the region. My dissertation focuses on understanding this new arena of environmental governance aimed at freshwater conservation in the US West. Through three sets of data and analytical lenses I explore: the characterization of this new arena of governance, what led to its recent and significant growth, and what changes have occurred with respect to how such water resources were traditionally governed. I employ a mixed methods approach, using quantitative approaches to characterize the study population and temporal changes, and qualitative approaches to dive deeper into understanding specific phenomena. First, I improve understanding of IWS as an institution, and demonstrate the importance of dynamics between institutional factors for external context, program structure, and other related analytical domains in shaping how PWS is applied to water resources challenges

globally. Through an institutional analysis of IWS and the use of cluster analysis to group programs around buyer types and management actions, I highlight the role of government, influence of geographic context, and role of both regional and local conditions in shaping IWS design and structure. Second, I demonstrate that government actors are essential to IWS in the region, expanding beyond existing regulations and traditional roles. This exploration of the role of government within adaptive governance shows the evolving and expanding role of government over time, from federal regulations driving early water quality management, then state legislation driving water quantity programs, and more recently, federal agencies partnering on local water source protection efforts. Third, I show how key individuals and organizations create voluntary IWS in response to risk, aligning policies, politics and problems into solution framing, which suggests policy process theories more explicitly consider social-ecological complexities. These programs constitute the most recent expansion of IWS in the US West, and applying a policy process theory sheds light into the formation of the IWS, and the political, economic, ecological and social components that aligned to make the programs possible. My research shows this new arena of environmental governance as adaptive, place and problem-based, learning and collaboration-focused, accepting of uncertainty, and containing nimble and adaptive government across scale. My work also creates a baseline of IWS in the region, and identifies areas for future research as IWS matures over time.

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"There is only one way to learn. It's through action. Everything you need to know you have learned through your journey." - Paulo Coelho, The Alchemist

The journey toward my PhD has been one of learning, discovery, and action. While the achievement of a PhD may result only in a single degree, it is possible due to the influence and efforts of dozens of people.

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In addition, I would like to thank my collaborators, especially Genevieve Bennett at Forest Trends' Ecosystem Marketplace, and Todd Gartner at World Resources Institute, who facilitated

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I am honored to thank my friend and colleague support network- Ch'aska, Mairi-Jane, Shayna, Kathie, Faith, Kat, Drew, Scott, Ted, Sarah, and EGWG and CCC networks, all of whom made this journey enjoyable. My healers also helped me, encouraging a healthier and more balanced future, especially Kent Nixon of Old Town Acupuncture; and Dr. Kuroiwa, Carol, and Anne of the CSU Health Network.

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Finally, to my faithful companions-Alan and Toby, who have been there with my every step: Alan's pursuit of his true life calling as an educator, and zeal for a life of action is a source of constant inspiration.

DEDICATION

To Alan,

For this and every other adventure yet to come

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CHAPTER ONE: INTRODUCTION

1.1. Introduction

Sustaining the quality and quantity of freshwater resources to meet environmental and societal needs is one of the most vexing governance challenges affecting the globe (Pahl-Wostl, Holtz, Kastens, & Knieper, 2010). The asymmetric distribution of water, growing social demands for both human uses and environmental protection, and changing climate are intensifying water resource governance challenges (Bates, Kundzewicz, Wu, & Palutikof, 2008; Pahl-Wostl et al., 2010; Scholz & Stiftel, 2005). In response to these rising social and ecological complexities, decision makers are faced with the challenge of designing policies, principles, and organizations to be effective in governing watershed protection and water resources (Gallaher et al., 2013; Olsson et al., 2006).

Authority to set standards, enforce rules, and act as arbitrators pertaining to freshwater resources has historically rested with local, state and federal levels governments (Gerlak, 2006; Hardy & Koontz, 2009; Kenney, 2005a; Koontz & Newig, 2014; Sabatier et al., 2005; Scholz & Stiftel, 2005). The fluid nature of the resource, and mismatch between political boundaries and water basins, often results in water management implemented by multiple institutions working across different scales and in various arenas, with policy responses often motivated by crisis (Gerlak, 2006; Kenney, 2005a). The past three decades have seen a shift in the historic role of government, as water managers and users gradually understand that government command-and-control policies are not sufficient to address the complexity of current water resource issues (Sabatier et al., 2005, Koontz, 2004; Koontz & Newig, 2014; Kettl, 2002; Scholz & Stiftel, 2005), and that governance mechanisms facilitating cooperation among nongovernmental actors previously outside the policy process can be more effective than government regulation and

control (Holling & Meffe, 1996; Lemos & Agrawal, 2006; Muradian & Rival, 2013). Similarly the paradigm of water management is shifting, due to new mechanisms like partnerships and collaborative efforts in water resources increasingly occurring on more local levels (Gerlak, 2008; Koontz et al., 2004; Leach & Pelkey, 2001; Sabatier et al., 2005; Sabatier, Weible, & Ficker, 2005; Wondolleck & Yaffee, 2000). As the complexities of nature resource, such as freshwater management, continue to increase, collaborative governance approaches will likely become increasingly common, as such issues defy the ability of any one authority to address on their own, even with regulations in place (Kettl, 2015).

This shift in both government and nongovernmental roles is in line with movement, noted both nationally and globally towards more incentive-based and problem-oriented investment mechanisms aimed at addressing the provision and enhancement of ecosystem services (Bennett & Carroll, 2014; Gerlak, 2006). These approaches, broadly termed, "Investments in Watershed Services" (IWS) have emerged over the past decade as one of the fastest growing segments of the broader conservation strategy of payments for ecosystem services (PES). At least 347 programs are actively operating in 29 countries for a minimum estimated market value of $9.57 billion in 2013 and a total value of $66 billion from 1995-2013 (Bennett & Carroll, 2014). One of the largest areas of growth in IWS has occurred in the western US, with two-thirds of new US programs between 2011 and 2014 emerging in the region, and such trends set to continue, with five of the seven developing US programs (as of 2014) also in the west (Bennett & Carroll, 2014).

IWS represent significant new approaches to watershed governance in that they leverage new funding options, involve new and diverse stakeholders, can provide more economically efficient means to achieve conservation goals, and often include collaboration to address water-

related risks across both public and private lands. The western United States, an area with a history of water conflicts, is no exception to the increasing complexity of water resource management across the globe. This is particularly true as increasing population, land use, and climate-induced environmental changes (i.e., drought, increasing fire frequency and severity), intensify ecological system stress (Gleick, 2002; Scholz & Stiftel, 2005). This makes empirical research on growth of IWS both timely and valuable for understanding how water resource governance is changing across the region.

The overarching question explored in this dissertation focuses on understanding this new arena of environmental governance aimed at freshwater conservation in the western United States. Through three specific analytical lenses aspects of IWS are explored, including: the characterization of this new arena of governance, what led to its recent and significant growth, and what is different about IWS with respect to how such water resources were traditionally governed (e.g. how has the influence and/or role of government changed). This research has implications for future water resource management in this new realm of governance, contributes to the relatively recent IWS literature, and informs theory on governance adaptation and policy processes in the face of complex social-ecological systems.

1.2. IWS and the Western US

IWS encompass groups of interacting organizations and institutions that combine elements of the state, markets, and civil society to address collective-action dilemmas in novel ways (Armitage, de Loë, & Plummer, 2012; Muradian et al., 2013), typically focusing on geographically defined responses to water issues (Bennett & Carroll, 2014). Literature inventorying and analyzing IWS programs has identified substantial diversity in the types of program drivers, actors, target ecosystem services, financing mechanisms, and other institutional

factors that are being categorized under the umbrella of IWS, or similarly, payments for watershed services (PWS) (e.g., (Bennett, Gosnell, Lurie, & Duncan, 2014; Bennett & Carroll, 2014; Bennett, Carroll, & Hamilton, 2013; Brouwer, Tesfaye, & Pauw, 2011; Hanson, Talberth, & Yonavjak, 2011; Majanen, Friedman, & Milder, 2011; Porras, Grieg-Gran, & Neves, 2008; Smith, de Groot, Perrot-Maitre, & Bergkamp, 2006; Talberth, Gray, Branosky, & Gartner, 2012). IWS are defined as, "transactional (cash or in-kind) agreements between or more parties that compensate a land manager for restoring, maintaining or enhancing the natural infrastructure that maintains clean water supplies" (Bennett & Carroll, 2014, p. xxii).

IWS has emerged from the broader field of Payments for Ecosystem Services, which is based on the assumption that, "the undersupply of ecosystem services is the result of market failures, and therefore valuing and paying for such services will help solve these environmental externalities" (Muradian et al., 2013, p. 275; Engel et al., 2008). Both practitioner and policy maker interest has been spiked by these "win-win" scenarios where both the suppliers and beneficiaries of the ecosystem services benefit (often including both conservation and development interests) Muradian et al., 2013). As Sattler and Matzdorf (2013) explain,

> PES schemes aim to connect people who function as ES (Ecosystem Services) providers (sellers), such as ecosystem managers or safeguards, to people who are the direct or indirect beneficiaries of these ES (buyers) in contract-like arrangements. In this way, a market or quasi-market is created where the ES that was formerly provided for free suddenly gets a price tag and is valued as a commodity in a trade (p. 2).

PES is based in the Coase theorem, which provides that external effects or concerns can in certain contexts be addressed through negotiation between those affected parties, in this case the PES buyers and sellers (Engel et al., 2008; Coase, 1960). This concept in description is simple, however, in practice, PES is complex, faces many challenges, and must fit well within existing social and ecological contexts (Sattler & Matzdorf, 2013).

Academic literature is still in debate about the merits of these "market-based" environmental policy instruments, including their: functionality, efficiency and effectiveness (Naeem et al., 2015; Lockie, 2013; Robertson, 2006); social impacts (McAfee, 2012; Vatn, 2010); commodification of nature (McAfee and Shapiro, 2010; Kosoy & Corbera, 2010); and simplification of complex ecosystems into economic commodities for ecosystem markets (Robertson, 2006) (see also: Muradian et al., 2013; Wunder 2014; Jack et al., 2008; Kinzing et al., 2011; Redford & Adams, 2009). The specific issues of debate related to PES vary, due in part to the diverse theoretical framings and disciplinary perspectives employed by different PES studies, which makes clear understanding of the potential and challenges of PES in practice challenging (Bennett & Gosnell, 2015).

Despite these concerns, IWS has continued to grow in response to increasing water complexity across the globe, expanding rapidly in both developed and developing countries (Pattanayak et al., 2010). In order to explore this relatively new phenomenon of incentive-based water programs, I focused my research on understanding IWS as a governance arena in the US West. While specifics differ, the region embodies global characteristics of water access, quality and availability (Gleick, 2002; Kenny, 2005). Such social-ecological issues of water resource competition and tension cut across international contexts, and an improved understanding of how government as an institution, and as actors regulate, facilitate or participate in IWS, can shed light on roles of government, the future of IWS, and inform future research. This region is a valuable focus to advance understanding of IWS as an institution, because: first, it represents one of the most concentrated regions globally for active programs (Bennett & Carroll, 2014); second, programs in the western US are subject to both common regional (e.g., US federal policies, similarities in western US water law) and diverse local (e.g., state management of instream

flows, land ownership patterns) institutional conditions; and third, the US west is a microcosm of the complex socio-ecological challenges at play globally that are contributing to the implementation and expansion of IWS (e.g., competing demands on water for human and environmental uses, increasing fires, droughts, and other catastrophic events threatening water resources (Fahlund, Choy, & Szeptycki, 2014; Loehman & Charney, 2011; Robbins et al., 2009; Theobald et al., 2013; Warziniack & Thompson, 2013; West, 2011).

1.3. Study Region: The Western US

The study region for this dissertation encompassed the eleven most western states of the US including Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming (Figure 1.1). These states cover approximately 3.1 million square kilometers (32% of the US), are home to over 73.5 million people (23% of US population), and contain the highest concentration of federal land ownership in the contiguous 48 states (47% of land area in the region) (Fahlund et al., 2014; Gorte, Hardy, Hanson, & Rosenblum, 2012; U.S. Census Bureau, 2010; U.S. Census Bureau, 2014). Competing water demands for domestic, agriculture and environmental needs are rising (Anderson, Scarborough, & Watson, 2012; Fahlund et al., 2014), which are made particularly challenging in a region with variable precipitation patterns across a generally arid and water limited region (Fahlund et al., 2014; Theobald et al., 2013). Drought-induced risks such as water supply and wildfire are important issues facing urban and rural communities (Warziniack & Thompson, 2013; West, 2011).

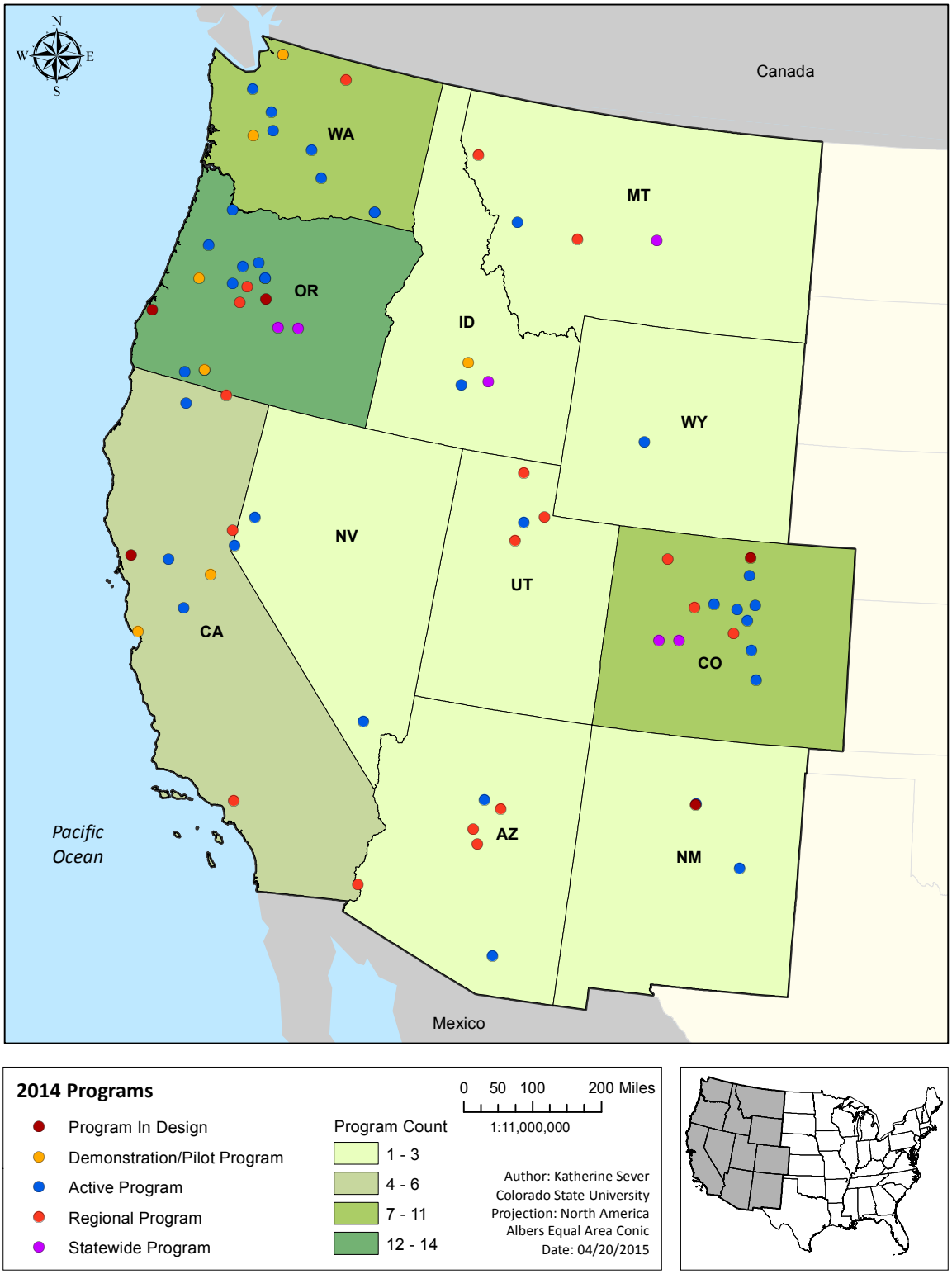

Figure 1.1. Map of all identified IWS programs in the western US by program phase in 2014. In some cases, program dots might overlap. "Program Count" shows the actual count of separate programs by state (Darker the shading of the state, the more programs it contains).

Legal structures regulating access to water are an important component of the region, with federal and state governmental policies comprising the institutional framework for how water resources in the US west are managed and specifying the authorities under which government agencies may act. For the purposes of this dissertation, institutions are defined as, ‘‘systems of rules, decision-making procedures, and programs that give rise to social practices, assign roles to the participants in these practices, and guide interactions among the occupants of the relevant roles’’ (IDGEC, 1999, p. 14; Gupta, 2010). Although these rules and roles include both formal rules (government regulation), and informal rules (social patterns of engagement) (Gupta, 2010; Arts 2006), my research focuses mainly on formal rules for which I collected relevant data. These formal rules include western states adhering to the “prior appropriation” doctrine, and water rights and access affected by policies, rules and decisions from the local (e.g., water districts and roundtables) to state (e.g., water court and legislature) and federal levels (e.g., federal agencies, Congress, U.S. Supreme Court) (Gallaher et al., 2013).

1.4. Research Questions

Previous research has shown that no one sector or scale of government contains sufficient resources, authority or knowledge to address increasing social-ecological complexities on their own through existing policies and forums; they require the collaborative efforts of multiple actors playing new roles and employing new mechanisms for directing desired actions (Armitage 2012; Bressers, O’Toole & Richardson, 1995; Imperial 2005; Kettl, 2015). I explore this concept of governance as the range of political, economic, social, and administrative processes in place to influence and respond to conditions in a system (Pahl-Wostl, 2009; from United Nations Development Programme definition, 2000), focusing on IWS in the western US. At the outset, my supposition was that IWS represented a new arena of environmental governance for the

region. What was less clear is *how* IWS: involved different funding sources, actors, and positions; was located spatially across the region; and created new decision-making forums to address water-related risks across land types.

Therefore, to advance this understanding of governance change in the specific context of IWS in the western US, and to contribute to the literature on IWS and governance of freshwater systems, I had two research objectives. First, I wanted to use three different analytical lenses to understand how IWS came about, its structure, and its role in governing freshwater resources. To address this research objective, my specific research questions were:

1. What does IWS look like across the western US? Specifically, who is involved, in what roles, and what is new or innovative about the mechanisms and forums created by IWS?
2. What is different about the role of local, state and federal government in IWS, as opposed to their traditional roles in water resource management?
3. Why and how are the majority of voluntary IWS programs emerging, in absence of any regulatory drivers (e.g. formal policies or rules driving creation)? Specifically, how are IWS forming in response to catastrophic ecological drivers (e.g., wildfires and subsequent flooding) and what conditions occurred to facilitate this?

The second research objective was to return to the overarching dissertation question of understanding this new arena of environmental governance in freshwater resource management in the western US in order to evaluate how the selected analytical lenses proved helpful in answering these questions. This research objective is addressed in Chapter 5: Conclusions. In the remainder of this introduction, I provide an overview of my methods, and a brief introduction to the three main dissertation chapters, Chapters 2, 3, and 4.

1.5. Methods

This research used a mixed methods approach, employing quantitative approaches to characterize the study population and temporal changes, and qualitative approaches to dive deeper into understanding specific phenomena within certain research questions (Creswell, 2002). This approach allowed me to identify and characterize the broad landscape of IWS across the region, providing an overview of what this new and emerging population looks like. This also allowed me to explore certain programs and aspects of IWS in depth, thus balancing the need for both census data on the IWS population, as well as detailed case study findings. This research consists of three, distinctly different data sets. Details about the specific methods associated with each data set are explained within each respective chapter.

For Chapter 2, I created an institutional analysis framework based primarily on Ostrom's Institutional Analysis and Development (IAD; 2011) and social-ecological systems analysis (2009) frameworks, and Corbera et al.'s (2009) PES framework, as well as a review of literature on institutional analysis of PWS and PES, (including: (Brouwer et al., 2011; Engel, Pagiola, & Wunder, 2008; Majanen et al., 2011; Muñoz Escobar, Hollaender, & Pineda Weffer, 2013; Muradian et al., 2010; Vatn, 2010) to identify common variables of interest. Using this framework, I designed and administered an online survey in 2012 to collect information on the population of active IWS programs in the US West. The survey was conducted in partnership with Forest Trends' Ecosystem Marketplace, which was undertaking its second global review of PWS programs (Bennett et al., 2013), identifying 41 active IWS programs in the western US. I conducted quantitative analysis in SPSS (Version 20), using K-Means cluster analysis to cluster programs by similar program characteristics (Ganglmair & Wooliscroft, 2001; Norušis, 2012),

basing variable similarity on an object's attributes and its resemblance coefficients (Beaman & Vaske, 1995).

In Chapter 3, I used data obtained from another online survey conducted in partnership with Forest Trends' Ecosystem Marketplace, for their third global review of PWS programs (Bennett & Carroll, 2014) in 2014, identifying a population of 48 active IWS programs in the western US (a 17% increase in programs in the region from 2012). To conduct the analysis, I used survey data specifically to explore how the roles of government at the local, state and federal levels have changed in response to inadequate legal regulatory frameworks (specifically policies related to water noted by survey respondents). This analysis approach enabled my examination of what patterns emerge in how government responds to different water issues over time. I organized survey data in quantitative analysis software SPSS (Version 22), which included creating new variables from the data to group programs by biophysical condition (main water resource concerns of flow, quality and/or protection), and government-related rules and roles. I used descriptive statistics such as cross tabulations to examine the relationship between government roles in programs and other program characteristics, with a focus on understanding how the differences in water resource concerns shaped community attributes and rules, and how different IWS programs were located within these groupings. Since both this study and the 2012 data set were census data sets of IWS in the study region, inferential statistics were neither necessary nor appropriate. There was no need to make inferences about a broader population since I had collected data on the entire population, so analysis focused instead on describing the IWS population.

In Chapter 4 I used data from the 2014 survey to identify the area of most growth within IWS from 2012 to 2014: Watershed Protection Partnerships (WPPs) in Colorado. These IWS

arrangements comprise downstream water users providing financial compensation for work performed by upstream landowners to reduce wildfire risk through forestry treatments. I then conducted case studies of the five WPPs in the state based on 1) review of publically available documents from each WPP and 2) semi-structured interviewees with WPP participants. I identified interviewees using a purposeful sampling strategy, which involves selecting interviewees for study based on their role and involvement with the WPPs and likely ability to provide information on the topics in question (Patton, 2002). I included in my sample all the main contacts within each partnership from each participating organization, resulting in interviews from 26 individuals directly involved in the formation and/or ongoing operation of the partnerships, all noted as key contacts for their organization's role in the partnerships, and including at least one contact from each organization involved in a partnership. I transcribed and analyzed data from each interview using the qualitative data analysis software NVivo 10 for Mac (QSR International, 2014). My process tracing method (Tansey, 2007) used interviews to uncover and analyze the events, people, processes, and decision points that led to the formation of WPPs. I used a modified ground theory approach to review data and code for themes via an open-coding methodology (Strauss & Corbin, 1990), modifying it by approaching the interviews with a set of attributes to look for and questions to ask (my interview guide), instead of approaching a phenomena without any preconceived notion of what to examine. The application of the policy process theory of Multiple Steams identified attributes of: windows of opportunity; politics, policy and problem streams; and entrepreneurs, all of which guided the resulting case study data as sensitizing concepts (Bowen, 2006). The theory was used as a lens to guide and organize my collected data, in order to understand how different political, policy and ecological factors came together to form the partnerships.

1.6. Chapter Overview

Chapter 2 explores the landscape of IWS within the western US, a region containing one of the highest concentrations of IWS globally, through an institutional analysis of IWS. Analysis of IWS sits within the broader evaluation of institutional frameworks for PES (Brouwer et al., 2011; Corbera, Soberanis, & Brown, 2009; Muradian & Rival, 2013; Tacconi, 2012; Wunder, 2013). Institutions have important influence in the design and performance of PES (Corbera et al., 2009), and related frameworks can highlight linkages between design and ecological, economic, and social performance within specific contexts (Ostrom, 2005). Despite the increasing attention to and focus on institutional analysis in PES, corresponding empirical research is limited (Muradian et al., 2010; Vatn, 2010). There is a need for a more integrated understanding of PES, taking in to account both the existing social and biophysical context in which PES is embedded (Bennett & Gosnell, 2015). Here, I addressed this gap by characterizing and analyzing key institutional factors that describe the population of IWS programs in the western US. My aim was to provide an institutional characterization of the region's IWS population, and from comparing and contrasting programs in the region, develop broader insights to advance theory and practice for how IWS is being deployed as an institution to address socio-ecological challenges.

Chapter 3 focuses specifically on understanding the changing role of government in IWS in the western US. While specifics differ, the region embodies global characteristics of water access, quality and availability (Gleick, 2002; Kenny, 2005). These increasingly complex social-ecological systems that surface from freshwater water resource concerns shape government response, both as regulatory drivers, and in their participation. The past three decades have seen a shift in the role of government, as an increasing awareness grows among water managers and

users that government command and control policies are not sufficient to address the complexity of current water resource issues (Kettl, 2002; Kettl, 2000; Koontz & Newig, 2014; Koontz et al., 2004; Sabatier, Weible, et al., 2005; Scholz & Stiftel, 2005). The majority of ecosystem services approaches are considered voluntary mechanisms; however, the strong presence of government regulations and/or participants in most IWS in the US (Bennett & Carroll, 2014) suggest that such mechanisms are not likely to address both market and public good goals, and encourage sufficient investors without regulatory drivers and structures (Wayburn & Chiono, 2010). I focused my research on understanding the presence and changes in the role of government in IWS in the western US, specifically: 1) what the broad landscape of IWS and government influence looks like across the region; 2) how the government is affecting IWS programs, including how the specific water resource concerns shapes government rules and roles. I used adaptive governance literature to guide this study. I anticipated that the answers to these research questions would not only better inform my understanding of government response to specific IWS water concerns, but that it would also have implications for understanding government rules and roles in addressing social-ecological complexities of freshwater resources.

Chapter 4 studies the area of largest growth in IWS in the region between 2012 and 2014, through case studies of watershed protection partnerships (WPPs) in the state of Colorado. Colorado's increasingly catastrophic wildfires over the last 15 years have served to focus attention on forested watershed health issues, resulting in challenges to design policies, principles, and organizations to be effective in governing watershed protection and water resources (Busenberg, 2004; Steelman & DuMond, 2009). I explored the formation of five WPPs between federal agencies and large water providers that have emerged in recent years to support forest watershed protection through joint planning and funding of activities on public lands to

maintain ecosystem services. Developments such as the WPPs are representative of incremental institutional innovations, a form of natural resource governance change that occurs outside of more infrequent or episodic legislative or administrative policy changes (Steelman, 2010). How governance systems evolve in response to increasing ecological change is an important area of theory-building, but existing literature and empirical work in this arena is still limited (Boyd & Folke, 2012a; Pahl-Wostl, 2009). To advance the understanding of governance innovation in the context of a complex and changing social-ecological system, I used the emergence of several Colorado WPPs as case studies. To do this, I utilized a policy process theory, Kingdon's (2003) Multiple Streams Approach (MSA), which explores the political, problem and policy events in a given place and time that can align to create windows of opportunity for change (in this case, the creation of the WPPs following major wildfires). I used MSA as a "sensitizing concept" which meant it guided my inquiry and shaped my presentation of the data (Bowen, 2006). This allowed me to address my two research objectives, which were: 1) To understand the pathways and mechanisms that facilitated the creation of WPPs; and 2) To provide insights into how and why institutional innovation and change occurs in response to social-ecological challenges.

1.7. Dissertation Roadmap

The following three dissertation chapters seek to answer these research questions by deconstructing the concept of environmental governance, in order to better understand the range of political, economic, social, and administrative processes in IWS, their response to increasingly complex water resource concerns, and their influence as a new forum of environmental governance. Each chapter covers one of the three research questions in depth, exploring major details and findings, to be summarized in the dissertation conclusion. The final chapter (5) provides conclusions relating to the overall dissertation research question.

The reader might note slight redundancy between Chapters 2, 3 and 4, as they are intended to be standalone journal articles. At the time of dissertation publication, articles based on the following chapters were in preparation or undergoing review for peer-review journals with listed co-authors:

- **Chapter 2**: Institutional analysis of payments for watershed services in the western United States, by Heidi R. Huber-Stearns, Joshua H. Goldstein, Antony S. Cheng, and Theodore P. Toombs. In review at *Ecosystem Services* (as of 26 February 2015).
- **Chapter 3:** The evolving role of government in the adaptive governance of freshwater social-ecological systems in the western United States, by Heidi R. Huber-Stearns and Antony S. Cheng. Prepared for submission to *Ecology and Society*.
- **Chapter 4:** From catalyzing event to governance change: Examining the emergence of forest watershed protection partnerships in Colorado, USA, by Heidi R. Huber-Stearns, Courtney Schultz, and Antony S. Cheng. Prepared for submission to *Policy Studies Journal*, or another similar policy-oriented journal.

Additionally, data collected for Chapter 3 were also used in the creation of a report by World Resources Institute: "Investing in natural infrastructure: Lessons from source water protection programs in forested watersheds in the United States", by Todd Gartner, Heidi Huber-Stearns, Sylvia Tognetti, and Nat Litchten, in review at World Resources Institute (as of June 2015).

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CHAPTER TWO: INSTITUTIONAL ANALYSIS OF PAYMENTS FOR WATERSHED SERVICES IN THE WESTERN UNITED STATES

2.1. Introduction

Payments for watershed services (PWS) have emerged over the past decade as one of the fastest growing segments of the broader conservation strategy of payments for ecosystem services (PES). At least 347 programs are actively operating in 29 countries for a minimum estimated market value of $9.57 billion in 2013 and a total value of $66 billion from 1995-2013 (Bennett & Carroll, 2014). Payments for watershed services are defined as, "Mechanisms where a clear buyer and seller (generally, representing the "beneficiary" and "provider" of watershed services, respectively) exist, where some form of remuneration for providing those services takes place, and where the primary motivation is clearly water" (Bennett et al., 2013, p. 3).

Payments for watershed services encompass groups of interacting organizations and institutions that combine elements of the state, markets, and civil society to address collective-action dilemmas in novel ways (Armitage et al., 2012; Muradian et al., 2013). Literature inventorying and analyzing PWS programs has identified substantial diversity in the types of program drivers, actors, target ecosystem services, financing mechanisms, and other institutional factors that are being categorized under the umbrella of PWS (e.g., Bennett et al., 2014; Bennett & Carroll, 2014; Bennett et al., 2013; Brouwer et al., 2011; Hanson et al., 2011; Majanen et al., 2011; Porras et al., 2008; Smith et al., 2006; Talberth et al., 2012).

There is a need for a more integrated understanding of PES, taking in to account the existing social and biophysical contexts in which PES is embedded (Bennett & Gosnell, 2015). The variety of disciplinary perspectives applied to PES provides a multitude of insights about

PES. However, there is a need for using integrative frameworks that bring many of these multiple perspectives together, in order to more systematically understand the potential and limitations of PES (Bennett & Gosnell, 2015). One such area of PES includes institutional analysis.

Analysis of PWS sits within the broader evaluation of institutional frameworks for PES (Brouwer et al., 2011; Corbera et al., 2009; Muradian & Rival, 2013; Tacconi, 2012; Wunder, 2013). Institutions have important influence in the design and performance of PES (Corbera et al., 2009). Existing institutions, including legal frameworks, property rights and social perceptions, affect how PES can be used as a mechanism for land management across a variety of actors (Vatn, 2010). Applying an institutional lens to PES can, for example, identify interactions with existing policies, impacts on natural resource managers, issues of participation and access, and linkages between local contexts and potential program participants, all of which can inform PES design and operation, and advance institutional theory (Corbera et al., 2009). Institutional analysis frameworks can help researchers discover linkages between design and ecological, economic, and social performance within their cultural contexts, and help identify, disassemble, and resolve ineffective parts of institutions (Ostrom, 2005).

Despite the increasing attention to and focus on institutional analysis in PES, corresponding empirical research is limited (Muradian et al., 2010; Vatn, 2010). Here, I address this gap by conducting an institutional analysis of the 41 active PWS programs in the western United States (US) as of 2012. This region is a valuable focus to advance understanding of PWS as an institution, because: first, it represents one of the most concentrated regions globally for active programs (Bennett & Carroll, 2014), second, programs in the western US are subject to both common regional (e.g., US federal policies, similarities in western US water law) and

diverse local (e.g., state management of instream flows, land ownership patterns) institutional conditions; and third, the western US is a microcosm of the complex socio-ecological challenges at play globally that are contributing to the implementation and expansion of PWS (e.g., competing demands on water for human and environmental uses, increasing fires, droughts, and other catastrophic events threatening water resources (Fahlund, Choy, & Szeptycki, 2014; Loehman & Charney, 2011; Robbins, Meehan, Gosnell, & Gilbertz, 2009; Theobald, Travis, Drummond, & Gordon, 2013; Warziniack & Thompson, 2013; West, 2011).

To conduct my analysis, I identified common variables of interest to create an institutional framework, informed primarily by Ostrom's (2011; 2009) well-established and widely utilized Institutional Analysis and Development and social-ecological systems frameworks and Corbera et al.'s (2009) PES-specific institutional framework. The components of these two frameworks, as described in the Methods section (see 2.2.2. Study Design), provide a way to systematically identify and organize institutional components of interest from my data. I used this framework to characterize and analyze key institutional factors that describe the population of PWS programs in the western US. My aim is to provide an institutional characterization of the region's PWS population, and from comparing and contrasting programs in the region, develop broader insights to advance theory and practice for how PWS is being deployed as an institution to address socio-ecological challenges.

2.2. Methods

2.2.1. Study Region

My study region encompassed the eleven states of the western US including Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. These states cover approximately 3.1 million square kilometers (32% of the US), are

home to over 73.5 million people (23% of US population), and contain the highest concentration of federal land ownership in the contiguous 48 states (47% of land area in the region) (Fahlund et al., 2014; Gorte et al., 2012; U.S. Census Bureau, 2010; U.S. Census Bureau, 2014).

Competing demands on water for growing populations (especially cities), agriculture and environmental needs are rising (Anderson et al., 2012; Fahlund et al., 2014). These needs are made particularly challenging in a region with variable precipitation patterns across a generally arid and water-limited region (Fahlund et al., 2014; Theobald et al., 2013). Drought-induced risks such as water supply and wildfire are important issues facing urban and rural communities (Warziniack & Thompson, 2013; West, 2011).

Legal structures regulating access to water are an important component of the region, with states adhering to the "prior appropriation" doctrine. This doctrine allocates water use through the principle of 'first in time, first in right', meaning the order in which water users started diverting water from rivers created the delineation of water use priority over time (Landry, 1998). Prior appropriation developed in the arid (western) portion of the United States, where water had to be diverted far from riverbeds for activities like mining and agriculture (Getches & Van de Wetering, 2005). In the more humid eastern states, where there was little need to move water out of rivers and streams, riparian rights developed (Getches & Van de Wetering, 2005). Riparian rights emphasize equitable sharing and responsible use of water Getches & Van de Wetering, 2005). In contrast, the private use strategy of prior appropriation has historically not considered conservation, nor provided any incentive to conserve water; water rights users take all the water to which they are allocated or allowed in any given water season. In line with this, prior appropriation did not initially consider instream water flows for environmental benefits as a defined beneficial use. However, states did create a legal mechanism

for water rights transfers to support instream flows (thus addressing the restriction imposed by prior appropriation) beginning in the 1960s and 1970s (Anderson et al., 2012; Landry, 1998). The state-by-state assignment of value to instream flows provided a new incentive to conserve water, and/or to use unneeded allocated water in a different manner. In addition to the prior appropriation doctrine, water rights and access are affected by policies, rules and decisions from the local (e.g., water districts and roundtables) to state (e.g., water court and legislature) and federal levels (e.g., federal agencies, Congress, US Supreme Court) (Gallaher et al., 2013).

2.2.2. Study Design

I created a framework for my institutional analysis based primarily on Ostrom's Institutional Analysis and Development (IAD; 2011) and social-ecological systems analysis (2009) frameworks, and Corbera et al.'s (2009) PES framework. I also reviewed literature on institutional analysis of PWS and PES, (including: (Brouwer et al., 2011; Engel et al., 2008; Majanen et al., 2011; Muñoz Escobar et al., 2013; Muradian et al., 2010; Vatn, 2010) to identify common variables of interest. IAD provides an established policy analysis framework for evaluating and comparing programs with differing structures, as is the case in my study region of the western US (Ostrom, 2005). This framework includes the external context, such as the existing governance system, actors, resource system and units that exist in my study region as components for institutional analysis. The institutional analysis components also include a common set of Program Structure variables to characterize PWS structures related to program participants (or actors) and how programs produce outcomes (Ostrom, 2005). These components include variables such as Actors and Roles, Actions, Participation, Financial Incentives and Deterrents, and Outcomes (Table 2.1).

Corbera et al.'s (2009) analysis on institutional dimensions of PES identified five analytical domains, which I drew upon for my analysis (listed as Analytical Domains of PWS in Table 2.1). These domains include:

1. Institutional design: how rules are designed, change over time, and affect goals;
2. Institutional performance: how ecosystem services (or main water related concerns) provision is measured (e.g., increases in water flow, tons of sediment removed) and monitored, and understanding if an institution is achieving its goals;
3. Institutional interplay: how PES accounts for and affects other existing institutions (this includes preexisting formal rules, such as policies and programs into which PES is embedded, for example the Clean Water Act);
4. Organizational capacity: the capacity of actors involved and the effects of capacity on performance;
5. Scale: how the design and performance of PES is affected by scale, and the role of cross-scale work.

I adopted these components of IAD and institutional dimensions of PES as the basis for my survey questions and analytical framework, by identifying variables that explain the institutional components of PWS (Table 2.1).

Table 2.1. Institutional aspects and variables for PWS program survey

External Context[1]: *Factors that characterize the external context in which the PWS program operates*	
Project location & size	Where project is located, watershed catchment(s), acres and scale
Main water concerns	Specific water quality or quantity issues of key concern to the program
Land ownership	Types of land ownership in project area
Year established	Year when program began operating
Program Structure[1]: *The internal architecture of the PWS arrangement and where policy choices are made*	
Actors and Roles	
Buyers	Communities, companies, NGOs, government bodies, or other actors that pay for watershed conservation actions.
Suppliers/Sellers	People, households, organizations, or other groups that are paid (in cash or otherwise) for actions to restore or protect watershed resources and functions.
Project administrator	The organization that oversees the compensation mechanism.
Intermediary organizations	Any other organizations participating through delivering compensation, carrying out management actions, registering and/or verifying credits, etc.
Actions	
Management actions	Management interventions used to achieve desired environmental outcomes
Participation	
Buyer participation	Voluntary or required contributions of funding. Explain drivers: e.g., taxes, public utility fees, or mechanism to comply with an environmental law
Seller participation	Voluntary or required program participation and drivers Explain drivers: e.g., taxes, public utility fees, or mechanism to comply with an environmental law
Financial Incentives & Deterrents	
Compensation	Type of compensation to suppliers (e.g., payment for land practices or specific water quality outcomes)
Compensation rate	Rate of compensation ($ per pound, acre, action, time), in cash or in kind
Payment timing	Payments made on a regular or on-going basis, and at the beginning, during or after the program ends.
Funding sources	Sources that fund work and non-cash payments description
Outcomes	
Monitoring	If ecological, economic and/or social program outcomes were monitored
Conservation measures	What outcomes were measured, and how measured
Measurement units	Units such as: cubic feet per second of water flow, pounds of nitrogen, dollars invested, or acres restored
Social and environmental co-benefits	Any benefits generated by project beyond water-related benefits.
Analytical Domains of PWS[2]: *Cross-cutting institutional dimensions of PES*	
Institutional design	How rules are designed, change over time and affect goals
Institutional performance	How ecosystem services provision is measured and monitored, and how an institution achieves its goals
Institutional interplay	How PES accounts for and affects other existing institutions (encompassing policies and programs)
Organizational capacity	The capacity of participating actors and the effects of capacity on program performance
Scale	How the design and performance of PES are affected by scale, and the role of cross-scale work

1 Ostrom, E. (2011). Background on the Institutional Analysis and Development Framework. Policy Studies Journal, 39(1), 7-27.

2 Corbera, E., Soberanis, C. G., & Brown, K. (2009). Institutional dimensions of Payments for Ecosystem Services: An analysis of Mexico's carbon forestry programm. Ecological Economics, 68(3), 743-761.

2.2.3. Survey Design and Administration

I designed and administered an online survey from July to October 2012 to collect information on active PWS programs in the western US. Programs were defined as active, if transactions had occurred in the period 2009-2012. I conducted the survey in partnership with Forest Trends' Ecosystem Marketplace, which was undertaking its second global review of PWS programs (Bennett et al., 2013). I obtained information on 41 active programs, which included surveys completed online, by telephone, and through document review, which represented a 95% response rate. In selecting programs, I did not explicitly consider additionality, meaning a demonstrated improvement in the target ecosystem service relative to the baseline condition. Additionality is a component of some but not all PES definitions; as such, I chose not constrain my analysis beforehand to only those programs that have demonstrated additionality.

To administer the survey, an email was sent to the primary identified program contact requesting completion of an online survey maintained by Ecosystem Marketplace. I conducted follow-up phone calls to confirm survey responses, connect with those who had not filled out the survey, obtain program documents, and to ask additional explanatory questions. Survey questions were focused around the institutional considerations detailed in Table 1. For some survey questions, respondents were able to select more than one response if applicable (e.g. *main water concerns* and *management action* variables; see Table 1), which means that not all categories were mutually exclusive.

2.2.4. Data Analysis

I conducted quantitative analysis in SPSS (Version 20) with the resulting survey data for all 41 active PWS programs for which I collected information. I used K-Means cluster analysis to cluster programs by similar program characteristics (Ganglmair & Wooliscroft, 2001; Norušis,

2012). With this method, similarity is based on an object's attributes and its resemblance coefficients (Beaman & Vaske, 1995). For the analysis, categorical variables were recoded into dichotomous variables (yes/no). I focused cluster analysis on institutional components of PWS programs by exploring clusters involving the Program Structure variables that constitute a common set of variables for description and analysis, specifically Actors and Roles, Participation, and Financial Incentives and Deterrents (Table 2.1).

While my data included nearly the entire identified population of active PWS programs in the western US, the relatively small size of the dataset ($n = 41$) resulted in low statistical power. This was not an issue for my analysis, since my data collection was a census of IWS in the western US, and therefore did not require the use of inferential statistics to make generalizations about a broader population. I conducted cluster analysis with a focus on effect sizes of variables within clusters for determining which variables provided the most explanatory power (Vaske, 2008) and to identify the most appropriate types and number of clusters (Norušis, 2012) to inform my institutional research focus. I used eta (η) as my effect size test, which "measures the association of a continuous level dependent variable and a dichotomous or independent variable" (Vaske, 2008, p. 108). Based upon Vaske (2008), I categorized effect sizes as minimal ($eta = 0.10$), typical ($eta = 0.243$), and substantial ($eta = 0.371$) relationships.

2.3. Results

2.3.1. External Context of PWS in the Western US

The active PWS programs in the western US include at least one program in each state, with the highest concentration of programs in the Pacific Northwest region (Oregon and Washington; $n = 10$ and 7, respectively; Fig. 2.1, shading of polygons show number of programs in each state). I also identified one multi-state program that was implemented in different

watersheds in multiple states across the western US. The map below illustrates the number, concentration, and location of programs across the study region. In terms of age, the oldest programs (n = 9) were established in the 1960-70s. In the past decade alone, the number of programs has doubled.

Fifty-six percent of programs identified as operating across multiple counties and/or watersheds ("regional" scale). Thirty-two percent of programs operated in just one county or watershed ("local" scale), and the remaining 12% identified as state-wide programs (Fig. 2.1). The majority of programs (90%) included privately managed land, 34% included public (mainly federally managed lands), and 24% contained both municipal and utility owned lands.

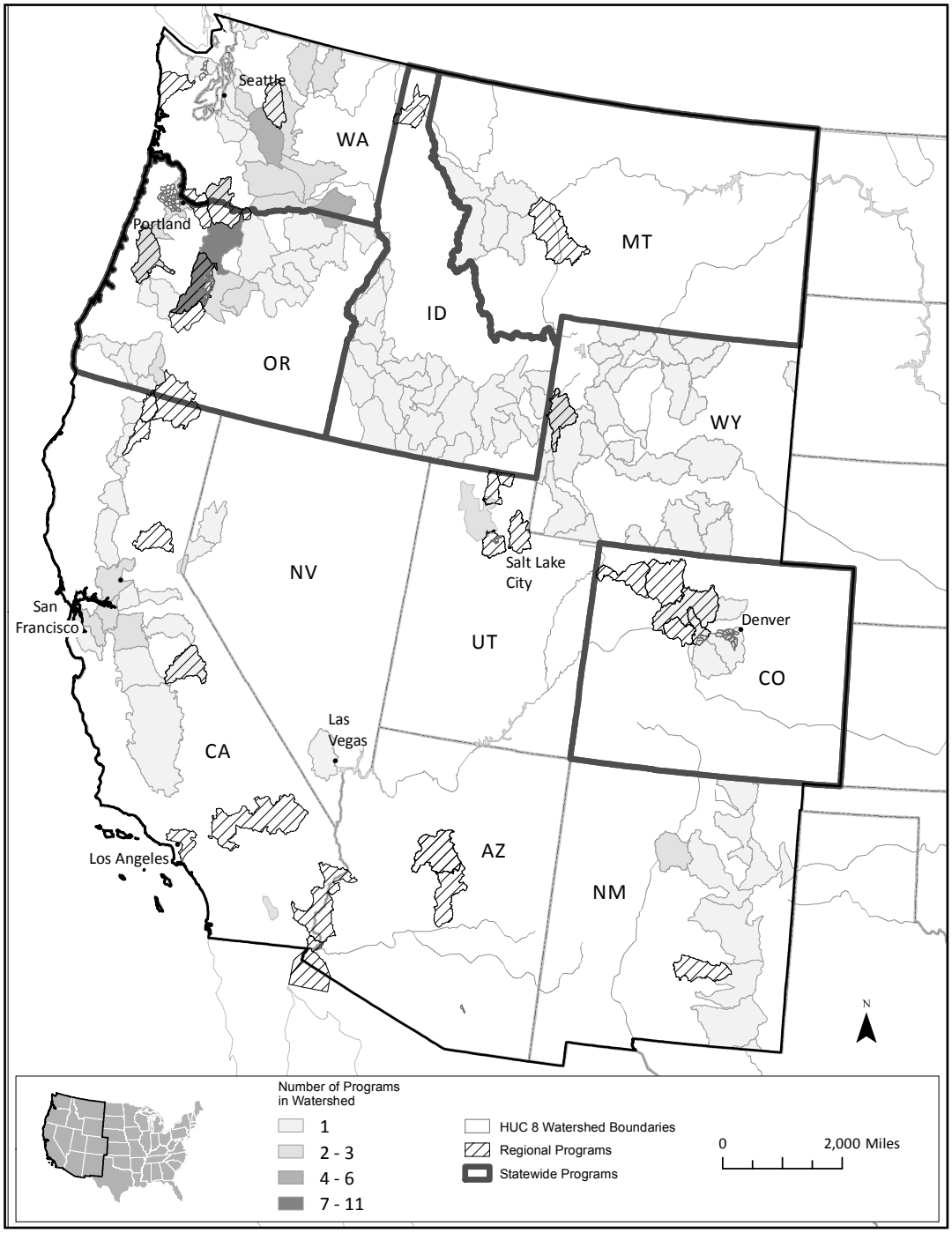

Figure 2.1. Map of western US showing the location, number and scale of PWS programs. The shading of polygon/watershed boundaries directly corresponds to the number of programs in the watershed area, as shown by the "Number of Programs in Watershed" Legend (darker the shading, the more overlapping programs that region contains).

2.3.2. PWS Cluster Analysis by Institutional Factors

I found that clustering the following variables yielded program clusters that had mainly typical (*eta* = 0.243-0.311) to substantial (*eta* = 0.371-0.833) relationships (Vaske, 2008), and created a useful typology for understanding the types of PWS programs in the region:

1. *Buyers*: Actors paying for watershed conservation by sector type: federal government, state, county, utility, NGO, and private;
2. *Management actions:* Management interventions used to achieve desired environmental outcomes, including:
    - *Water rights transactions:* transactions included both temporary or permanent transfers of water rights back to a state for environmental benefits of increased instream flow.
    - *Restoration, Protection:* included land management actions aimed at restoring or protecting certain ecological characteristics of the land.
    - *Afforestation:* planting trees where none existed previously
    - *Stormwater management:* changing road maintenance and other practices to address water runoff directionality and pollutants
    - *Agricultural management:* changing land management practices on agricultural lands to address mainly water quality concerns (e.g. nonpoint source water pollution)
    - *Operational management:* changes in built infrastructure, such as technological upgrades to wastewater facilities
    - *Fire suppression:* Conducting forest management practices such as tree thinning, or prescribed burning to reduce the risk and potential severity of future wildfires.

This categorization employs the Actors and Roles, Actions, and Participation parts of my institutional analysis framework (Table 2.1), which links to organizational capacity, institutional design, and scale. Analyzing these variables resulted in four separate clusters based on management actions to address water issues of concern and buyer attribute variables (varying in size from $n = 5$ to $n = 17$). This categorization provides an enhanced understanding of two foundational dimensions of PWS: who is paying for the ecosystem service benefit (buyers), and which management actions are used to achieve those benefits. I also found that the four clusters naturally divided into two larger groups based on main water related concerns: water quality and water quantity. I refer to the clusters as: (1) Water Rights (41% of programs)*;* (2) Water Rights and Land Management (24%); (3) Restoration and Protection (22%); and (4) Operational Management (12%) (Fig. 2.2, Table 2.2). Water Quality programs (Water Rights and Water Rights and Land management) were primarily clustered in the Pacific Northwest, with the highest concentration in Oregon and Washington. Restoration and Protection Program occurred across seven different states (one per state, and 3 in Oregon), while Operational Management programs occurred only in the arid states of Nevada and Colorado (Table 2.2).

Water Quantity	
Water Rights ***n* = 17**	**Water Rights & Land Management** ***n* = 10**
Driven by state or Endangered Species Act regulations, these programs focus on temporary and permanent transfers of water rights for instream flows and groundwater augmentation. States are the primary buyer (water rights holder) and administrator type. Sellers are mainly private individuals willing to sell/lease water rights.	Similar to *Water Rights* but with added components of riparian restoration and improved land management practices on private lands to address water quality and some quantity-related issues. Buyers include NGOs with grant funds and private businesses meeting mitigation requirements.

Water Quality	
Restoration & Protection ***n* = 9**	**Operational Management** ***n* = 5**
Driven by general water quality concerns, with single water provider buyers, and diverse public and private land manager sellers. Focused on protecting drinking water supplies by limiting development with conservation easements or land acquisition, or minimizing ecological risks (e.g., wildfire) with forest health efforts.	Driven by federal and state water quality regulations, with similar actors participating as buyers and sellers. Key activities include improving operational and stormwater management, and using trading permits. Mainly private businesses and/or counties impacting specific water bodies (e.g., a reservoir).

Figure 2.2. Descriptions of different PWS program types resulting from cluster analysis: Water Rights (41%)*;* Water Rights and Land Management (24%); Restoration and Protection (22%); and Operational Management (12%).

Table 2.2. Institutional program characteristics grouped by cluster: Water Rights (41% of programs)*;* Water Rights and Land Management (24%); Restoration and Protection (22%); and Operational Management (12%).

	Water Quantity		Water Quality	
Institutional Factors	**Water Rights (*n* = 17)**	**Water Rights & Land Management (*n* = 10)**	**Restoration & Protection (*n* = 9)**	**Operational Management (*n* = 5)**
External Context				
State	CA, NM, WY (*n* = 1) CO, ID, MT (*n* = 2), OR & WA (*n*= 4)	AZ, MT, region (*n* = 1) WA (*n* = 2), OR (*n* = 5)	CA, CO, NM, NV, UT, WA (*n* = 1) OR (*n* = 3)	NV(*n* = 2) CO (*n* = 3)
Land Ownership	Private = 94% Public = 24%	Private = 100% Public = 40%	Private = 67% Public = 44%	Private = 100% Public = 40%
Scale	Regional = 71% State = 18% Local = 12%	Regional = 80% Local = 20%	Local = 78% Regional = 22%	Regional = 60% Local = 40%
Main Water Concerns	Flow restoration = 100% Groundwater recharge = 12%	Flow restoration = 80% Groundwater recharge = 30% General Water Quality = 20%	General Water Quality = 44% Flow restoration = 44% Temperature = 44%	Phosphorous = 80% Ammonia = 40% Specific Quality Issue = 20%
Program Structure				
Actors and Roles				
Buyer	*Single buyers = 65%* State = 71% NGO = 29% Federal agency = 18%	*Multiple buyers = 60%* Private business = 70% NGO = 50%	*Single buyers = 89%* Utility = 100%	*Multiple buyers = 100%* Private business = 100% County = 80%
Seller	*Multiple sellers = 100%:* Water rights holders = 82%	*Multiple sellers = 90%:* NGO = 60% Water rights holders = 30%	*Multiple sellers = 78%:* General landowners = 56% Federal agencies = 46% Municipalities/utilities = 22%	*Multiple sellers = 100%:* County = 60% Private business = 40%
Administrator Type	State = 50% NGO = 35% Federal = 12%	NGO = 60% Non-water utility = 20% State,/county, academic=10% each	City municipality = 67% NGO = 22% State = 11%	State Administrator = 60% County Administrator = 20% Private business = 20%
Intermediary	Intermediary present = 47%	Intermediary present = 50%	Intermediary present = 67%	Intermediary present = 40%
Participation				
Management Actions	Water rights = 100%	Water rights = 70% Protection, Restoration = 50% Reforestation = 40%	Restoration, Protection = 67-44% Water rights = 33% Fire suppression = 22%	Operational Management = 80% Stormwater = 60%
Buyer Participation	Voluntary = 50% Compliance-driven = 50%	Compliance-driven = 50% Combo. = 20% Voluntary =30%	Compliance-driven = 67% Voluntary = 33%	Compliance & combo. = 100%
Seller Participation	Voluntary = 94% Compliance-driven = 6%	Voluntary = 80% Compliance-driven = 20%	Voluntary = 100%	Compliance & combo. = 100%
Financial Incentives & Deterrents				
Payment Basis	Outcome = 100%	Practice = 50% Outcome = 50%	Outcome = 56% Practice= 33%	Outcome = 80%
Payment Timing	Beginning = 76%	Beginning = 80%	Beginning =44% Ongoing = 44%	Conditional = 80%
Contracts	Used contracts = 24%	Used contracts = 20%	Used contracts = 56%	Used contracts = 0%
Outcomes				
Monitoring	Conducted monitoring = 100%	Conducted monitoring = 80%	Conducted monitoring = 100%	Conducted monitoring = 100%
Biodiversity	Biodiversity co-benefit = 94%	Biodiversity co-benefit = 30%	Biodiversity co-benefit = 44%	Biodiversity co-benefit = 0%

2.3.3. External Context of Clusters

The program clusters varied in scale, with *Water Rights* being the largest scale with regional and all state-level programs, and *Restoration & Protection* containing the highest proportion of local scale programs. *Water Rights* and *Restoration & Protection* contained the highest number of states (n = 8 and 7, respectively), while *Operational Management* only included two states. All clusters contained both public and privately owned lands; *Water Rights* and *Water Rights & Land Management* had the highest percentages of private land, and *Restoration & Protection* contained the most public land. Instream flow restoration was the primary focus for both *Water Rights* and *Water Rights & Land Management*, while *Restoration & Protection* and *Operational Management* contained programs mainly focused on general and specific water quality indicators (e.g., phosphorous, nitrogen, temperature, ammonia as indicators reported by survey respondents).

2.3.4. Cluster Actors and Roles

Water Rights and *Restoration & Protection* contained primarily single buyers (e.g., state agencies and water providers, respectively), while *Water Rights & Land Management* and *Operational Management* contained primarily multiple buyers (e.g. private businesses). *Water Rights* contained mainly state buyers, as well as all identified federal agency buyers and some NGO buyers. *Water Rights & Land Management* contained primarily private business and NGO buyers. *Restoration & Protection* contained primarily water provider buyers (e.g., municipal drinking water providers, water utilities, water districts and other entities delivering water). *Operational Management* included county and private business buyers.

Across all four clusters, seller participation was primarily in the form of multiple sellers per program, with water rights holders as the majority seller for *Water Rights*, and present in

both *Water Rights & Land Management* and *Restoration & Protection* clusters. *Water Rights & Land Management* also contained NGO sellers as the main type, and *Restoration & Protection* contained a mix of general landowners, federal agencies and water providers as sellers. Matching its buyer types, *Operational Management* contained counties and private businesses as sellers.

Program administrators varied across the clusters, including state agencies (*Water Rights* and *Operational Management),* water providers (*Restoration & Protection*), and counties (*Operational Management*). All clusters except *Operational Management* contained NGOs as program administrators, with the highest concentration in *Water Rights & Land Management*. *Water Rights* contained the only programs to identify federal agencies as administrators.

Intermediaries were present in some programs across all clusters. Intermediaries were defined as organizations or other entities playing supporting roles in a program, such as technical assistance, management actions, verifying or registering credits, or assisting in delivering the compensation mechanism. The largest presence of intermediaries was in *Restoration & Protection,* and lowest in *Operational Management*. The presence of intermediaries was highest in programs involving individual landowners as sellers. Most intermediaries were listed as regional or local non-profit organizations (NGOs), such as watershed groups and partnerships.

2.3.5. Cluster Participation

Programs across all clusters reported regulatory drivers as key motivators for buyers to participate. In many cases, multiple drivers were identified as linked to the program, or programs were an option for how to achieve regulatory compliance. The primary drivers were: federal water quality regulations within the Clean Water Act, including Total Maximum Daily Load, National Pollutant Discharge Elimination System (Section 402), and Water Quality Standards

and Implementation Plans (Section 303); the Safe Drinking Water Act; and the Endangered Species Act with requirements addressing in-stream flows, temperature, and habitat.

Operational Management contained only compliance-driven buyers and sellers: all programs reported regulatory drivers or a combination of both regulatory and voluntary drivers, primarily around water quality regulations within the Clean Water Act and state-specific nutrient standards. *Restoration & Protection* included primarily compliance-driven buyers, citing water quality requirements from the Safe Drinking Water Act and Clean Water Act as key motivating regulations. *Water Rights* contained the highest levels of voluntary participation for both buyers and sellers (50% and 94% respectively), with compliance-driven buyers mainly motivated by water quantity concerns for threatened or endangered species through the Endangered Species Act, state-specific in-stream flow and/or groundwater requirements, and interstate water compacts. The remaining voluntary buyers still cited related water quantity concerns as a non-regulatory driver for their participation. *Water Rights & Land Management* identified similar Endangered Species Act and in-stream flow drivers, as well as hydroelectric relicensing agreements (e.g., funds for projects to improve or enhance riparian resources, habitat and connectivity potentially affected by continued plant operation).

All clusters except *Operational Management* contained primarily voluntary participation by sellers, with the largest proportion in *Restoration & Protection*, which contained programs citing the fewest regulatory drivers, and program motivations centered around source water protection and risk aversion. *Water Rights* and *Water Rights & Land Management* contained programs with a combination of regulatory (related to the Clean Water Act) and voluntary (related to improved watershed stewardship or risk aversion) drivers for sellers whose participation was not completely voluntary.

Both voluntary and regulatory programs cited mitigation requirements as drivers. These included programs mainly in *Water Rights* and *Water Rights & Land Management*, in which buyers were required to participate in some form of mitigation (i.e. aquatic species habitat to offset dam disruptions on the river) but voluntarily chose to invest in (or create) a PWS approach to watershed health instead of engaging in more traditional regulatory compliance measures (e.g., groundwater mitigation permits, hydropower mitigation funds). This was also the case for other voluntary programs facing impending changes like more stringent water quality regulations, in which buyers were choosing to engage in the PWS program as a form of pre-compliance, or as an alternative to more conventional mitigation or in-lieu fee-programs in the future. Other programs with voluntary buyer participation cited catastrophic wildfire and subsequent damages (e.g., flooding, sedimentation, reduced reservoir storage) as key motivating factors, especially for drinking water providers in the *Restoration & Protection* cluster. Similarly, voluntary drivers also included concerns from downstream users and environmental NGOs about water availability and access, water quality, and other motivations for improving watershed stewardship (all clusters except *Operational Management*).

2.3.6. Cluster Actions

Programs in all clusters except *Operational Management* identified water rights transactions, including acquisition of temporary leases and permanent water rights transfers, as a key approach to address the program's water quality or quantity concerns. *Water Rights* included such transactions as the only management action; *Water Rights & Land Management* identified water rights transactions in combination with protection, restoration, and reforestation actions; and *Restoration & Protection* primarily identified restoration and protection management actions, with a portion of programs (33%) employing water rights transactions, often in

combination with other management actions. *Operational Management* contained distinctly different management actions, including technological upgrades or changes, permit trading and all programs using stormwater management actions. *Restoration & Protection* also contained all programs identifying wildfire suppression as a management action.

2.3.7. Cluster Financial Incentives & Deterrents

Overall, programs reported the use of similar financial mechanisms. Payments were reported across all four clusters as mainly outcomes-based, meaning that payments were made conditional upon a program seller achieving the intended outcome. These intended outcomes were primarily reported as successful completion of transfers of water leases, water rights, or land ownership (e.g., a water rights seller was compensated upon successful transfer of a water right). Payments for these actions occurred at the time of the transfer. *Water Rights & Land Management* and *Restoration & Protection* also included payments for practices that were on-going throughout a project, such as annual payments for land management actions (e.g., riparian restoration, forest thinning). *Operational Management* payments for outcomes were conditional upon completing the outcome, typically a reduction in nutrients or point source permit trading.

Contracts were used in programs across all clusters except *Operational Management*. *Restoration & Protection* programs used contracts the most, mainly for multi-year land management projects (including the setting of objectives and annual work plans and payment schedules) or conservation easements. *Water Rights* contracts were typically for short-term water leases, while *Water Rights & Land Management* contracts were combinations of water leases and land management contracts.

2.3.8. Cluster Outcomes

Programs reported a high level of monitoring with all conducting activities for the *Water Rights*, *Restoration & Protection*, and *Operational Management* clusters, and 80% of programs for *Water Rights & Land Management*. Monitoring was reported in a variety of ways including: contract compliance (e.g., acres treated and/or dollars spent), acres reforested, miles of streams restored, cubic feet per second of water flow increase, tons of specific nutrients removed, and water temperature reductions. *Water Rights* and *Water Rights & Land Management* mainly reported monitoring quantifying flow increases, number of rights leased or retired, and habitat restoration-related metrics. *Operational Management* programs most frequently reported specific nutrient or sediment reductions, such as tons of nitrogen or phosphorous reduced. *Restoration & Protection* reported conservation easement and acquisition specifics (e.g., acres protected) and forested watershed management actions such as acres thinned, reforested, or restored.

Programs in all clusters except *Operational Management* reported biodiversity co-benefits, with the highest concentration in the *Water Rights* cluster. Co-benefits were defined as any additional benefits the program targets besides primarily water-related concerns. None of the clusters reported social or economic co-benefits as an explicit part of their program.

2.4. Discussion

I analyzed the institutional dimensions of active PWS programs in the western US, which facilitated comparison across programs subject to common regional and diverse local conditions, to inform PWS (and PES more broadly) research and practice. My results demonstrate how institutional analysis allows comparison and contrasting of program components to distill key lessons, as described below, about factors such as institutional interplay, organizational capacity, geography and ecological conditions, and institutional performance and outcomes.

My results also provide institutional baseline data for the population of PWS programs in the US West, a necessary precursor to track changes over time. As PWS programs continue to expand rapidly in the study region and globally, having institutional baseline information is valuable for tracking individual program developments, for comparing across programs to identify trends and shifts in institutional approaches, and for connecting PWS structures and performance to contextual factors (e.g., regulatory structures, changes in natural resource conditions).

2.4.1 Institutional Interplay

Institutional analysis allows researchers to understand which types of PES institutions are being developed and how they interplay with (account for and affect) existing institutions in a region (Corbera et al., 2009). My results support the assertion that pre-existing policies and institutions are a key influence in shaping the structure of a PWS program (Corbera et al., 2009). People and institutions respond to the incentives provided by an approach such as IWS.

While shifts are occurring away from government actors as the sole decision makers within environmental governance broadly (Armitage et al., 2012), my results show government presence is still prevalent, particularly in federal and state regulations and policies, and as direct program participants (Muradian et al., 2013; Scarlett & Boyd, 2011). Institutional interplay can occur between institutions operating at different (vertical) or the same (horizontal) levels of social organization (Corbera et al., 2009; Young, 2002). In most of the compliance-motivated programs in my study, I observed vertical institutional interplay occurring, between federal policies at the national level, and state policies including those pertaining to water rights. In some cases, horizontal interplay was evident, in programs that identified multiple federal

regulations (such as the Endangered Species Act and Clean Water Act), or state-specific legislation both for instream flows as a legally recognized beneficial water use and new water permit restrictions.

Although 80% of the PWS programs in the western US identified voluntary seller participation and 39% identified voluntary buyer participation, federal and state regulations remain primary drivers for programs in the region (Table 2.2). Key regulations included the federal Endangered Species Act and Clean Water Act, and state-specific water quality and quantity requirements. States are key participants in programs using water rights transfers (66% of programs, mainly *Water Rights* and *Water Rights & Land Management),* since western US states hold water rights and are therefore charged with regulating and managing permanent transfers or temporary leases made for improving instream flows (Landry, 1998; Loehman & Charney, 2011).

My finding that regulation-driven PWS programs still contain voluntary components demonstrates how PWS can provide alternative approaches to meeting existing government regulations through leveraging new funds and partnerships (Sattler & Matzdorf, 2013; Scarlett & Boyd, 2011; Schomers, Sattler, & Matzdorf, 2015). Several program respondents noted they could have engaged in a different (often more direct or traditional) approach to comply with regulatory requirements, but instead chose to engage (and in many cases, fund) other mechanisms to reach their regulatory targets, while also seeking to provide additional social and ecological benefits.

2.4.2. Organizational Capacity

The dimensions of institutional interplay speak directly to organizational capacity, or the capacity of actors involved in a program and subsequent effects on program performance

(Corbera et al., 2009). Even though existing institutions and regulatory drivers are relatively long-standing for key participants in the western US programs, the ways in which organizations are collaborating to address water resource challenges represent partial departures from previous approaches.

Actors are addressing resource and capacity challenges using different financing mechanisms, such as private or mitigation funds, and cost-sharing agreements to collaborate with organizations in other sectors, in order to address water concerns across land types and actor groups (Sattler & Matzdorf, 2013). For example, water providers in the most arid regions of the western US face an increasing number and severity of catastrophic wildfires, directly impacting surface water conditions, water treatment costs, and water infrastructure capacity for downstream communities (Gartner, Mulligan, Schmidt, & Gunn, 2013; Scarlett & Boyd, 2011; Talberth et al., 2012). Public land management agencies such as the US Forest Service are also tasked with finding ways to reduce catastrophic wildfires in their forested watersheds in a changing climate with increasingly limited funding (Scarlett & Boyd, 2011). In cases such as these, PWS can serve as a mechanism for institutionally linking downstream water user needs with upstream land stewards who are in a position to enhance ecosystem-service supply. In many cases, this is seen as facilitating the creation of programs that leverage more resources and work across multiple land ownership types, which would be difficult for an individual buyer or seller to accomplish alone (Gartner et al., 2013). Such water quality concerns and high levels of water provider participation are characteristics present in source water protection programs beyond my study region in response to episodic threats such as catastrophic wildfire and subsequent flooding, as

well as slower-moving drivers such as land use intensification, both within the US (Bennett et al., 2014; Gartner et al., 2013) and in Latin America (Bennett et al., 2013; Goldman-Benner et al., 2012).

Similarly, in regions with instream water flow concerns, PWS can facilitate augmentation of sellers' income, provide an alternative to historically-engrained "use it or lose it" western US water law, and benefit both states and conservation groups interested in improved instream flows for aquatic species and environmental health. These collaborations demonstrate organizations identifying shared concerns and leveraging resources to achieve common goals. This use of water markets as mechanisms to retire water rights instream to address water quantity concerns is being employed both across the US and Australia (Bennett et al., 2013).

Organizational capacity also includes actors recognizing their capacities and constraints. In several of the water quantity programs, respondents reported that the state did not have the capacity or connections to manage water rights transactions, particularly in providing individual outreach and connection with water rights holders. In several cases, states connected with regional-scale NGOs that had already established connections with water rights holders, and therefore better capacity to conduct outreach and enrolment. This highlights the critical role of NGOs across a majority of program types, supported by my finding that NGO presence was the only actor sector found across all actor types (14 program administrators, 10 buyers, 3 sellers, 5 intermediaries) and all clusters except *Operational Management*. This suggests that NGOs had an ability to facilitate programs and connections in a more nimble manner than entities at different scales or in different sectors. In some cases, NGOs were seen as an aggregator: receiving funds from ecosystem services buyers to portion out to individual landowners for restoration practices on their land. The individual landowners would not have been able to

connect to the larger grants on their own, so the NGO was able to serve as an intermediary (and aggregator) between the actors, and in many cases, also administer funds. Intermediary presence was also higher across programs that involved private landowners. Intermediary functions such as these can be key for facilitating PWS transactions (Huber-Stearns, Goldstein, & Duke, 2013; Schomers et al., 2015).

2.4.3. Role of Local Context and Geography

My results demonstrate the influence of local context, particularly the important role of geographic context in shaping program administrative components, such as land ownership, actor types, and management actions. In PWS programs in the western US, the presence of individual private landowners as compared to public land participants in programs is a geographic match for relative proportions of public versus private land ownership in the region. In particular, there are higher percentages of private land in Northwestern states relative to more publically owned land in the intermountain portions of the region (Nie, 2008). Ecological concerns are not constrained like management actions by administrative or politically defined boundaries on the landscape (Landres, Knight, Pickett, & Cadenasso, 1998) which explains why program-identified water-related concerns are more evenly spread across the landscape than the management actions used to address them. Certain management actions (e.g., instream flow restoration, water rights transactions) are better employed on private land with individual sellers (water rights holders) than on federally managed land (often not water rights holders).

I also suggest that beyond land ownership, the incentives being offered in programs are geared towards and attractive to private landowners. The other major land owner in the western US is the federal government, particularly the US Forest Service and Bureau of Land Management. These agencies' bureaucratic processes and land management mandates can be

more challenging to engage in PWS programs, particularly when compared to landowners working on conservation actions through relationships with NGOs. This trend, however, appears to be changing, as recent research has identified an increasing number of programs involving partnerships with federal agencies to address risks on public lands (Bennett & Carroll, 2014; Gartner et al., 2013).

2.4.4. Institutional Performance

Institutional performance includes the measurement and monitoring of ecosystem services provision (Corbera et al., 2009), which programs reported to varying degrees. Institutional performance is also about linking measurements and outcomes to determine if an institution is achieving its goals (Corbera et al., 2009). The institutional analysis framework allowed me to not only gather information about program characteristics, but also to identify gaps, particularly the notable lack of information reported by respondents about measured and potential outcomes. Some programs define criteria for evaluating institutional performance in program rules and/or monitoring approaches, while other programs have vague or non-existent criteria, requiring the researcher to define it (Corbera et al., 2009). The degree to which programs contain such criteria was not well identified by this survey, and would warrant more in-depth examination of programs. How programs are built is key to outcomes, but oftentimes, collecting quantifiable and analyzable data about how program outcomes relate to performance is challenging. This link between such data and informing institutional performance is a critical part of understanding how programs are functioning over time, and to what degree they successfully address ecological (and social and institutional) concerns.

I received limited information on such program outcomes from survey respondents. The majority of programs reported that monitoring was occurring, although details were limited on

how and what was being monitored. The responses for several ecological and outcome measurement variables were not used in analysis due to these relatively limited responses and lack of comparability across programs. Respondents reported that information was limited due to privacy concerns, as well as a lack of recorded, quantifiable data for measuring program outcomes. Additionally, the responses about outcomes varied in measurement units (e.g., dollars invested, acres restored, pounds of nutrient removed), making these data inappropriate for cross-program comparison.

The majority of surveyed programs identified biodiversity co-benefits (additional to their primary water concerns) mainly related to instream flow increases improving aquatic (and other wildlife) habitat; however, the survey did not obtain detailed information on how these co-benefits are identified, tracked and managed. Although environmental, social and economic co-benefits are often part of the rationale for choosing ecosystem-based strategies like PWS (Wunder, Engel, & Pagiola, 2008), the practical matter is that relatively little is known about measured outcomes, especially co-benefits (Brouwer et al., 2011; Lockie, 2013). PWS is still relatively in its infancy, which means that monitoring of program outcomes is still not mainstream or far enough along for ecological processes that take multiple years to change (Bennett et al., 2013; Brouwer et al., 2011).

This lack of information on outcomes for water goals and co-benefits points to the need for empirical research relating institutional design to performance (Corbera et al., 2009; Muñoz Escobar et al., 2013). Obtaining better information on how programs measure performance is necessary to improve understanding of the outcomes being achieved by PWS, and how these outcomes align with program goals and structures. Addressing this gap would provide research opportunities for longitudinal analysis of institutional and ecological changes and their relation to

program performance. This research could help inform the currently limited understanding of how different environmental management arrangements function and adapt over time, particularly as they move from design to program implementation (Cheng, Gerlak, Dale, & Mattor, 2015; Emerson & Gerlak, 2014; Imperial & Koontz, 2007), and fill a need for more longitudinal social science research (Stidham et al., 2014).

2.5. Conclusion

My analysis characterizes the institutional dimensions of the population of active PWS programs in the western US, in order to contribute to the growing body of theory and practice related to PWS as a mechanism to incentivize improved watershed and water resources stewardship. I based my analysis upon program survey results, quantitative analysis, and institutional and contextual understandings obtained from the literature. Beyond understanding and characterizing PWS in the western US, my use of an institutional lens has implications for understandings of institutional interplay, organizational capacity, geography and ecological conditions, and institutional performance and outcomes. My use of Ostrom and Corbera's institutional components allowed identification of a common set of variables applicable to the broad diversity of PWS across the region, which facilitated clustering of program types across the region. My research has implications for understanding of PWS as an institution and its implications for freshwater and natural resources management.

PWS is not a neutral institution; how it operates depends directly on the institutional context within which it is situated, which is supported by my results and a growing body of literature (Muñoz Escobar et al., 2013; Muradian & Rival, 2012; Sattler & Matzdorf, 2013; Vatn, 2010). PWS programs provide a set of mechanisms to address water quality and quantity

concerns, within existing policies, drivers, and actors. I argue that these institutional considerations should be more explicitly addressed within PWS (and PES) research and used to inform on-the-ground implementation.

There is increasing acknowledgement that cooperation across land ownership types is crucial (yet challenging), particularly when addressing conservation efforts across a matrix of ownership types, like in the western US (Bergmann & Bliss, 2004). My research demonstrates that such collaborative problem solving and atypical partnerships are increasing (Sattler & Matzdorf, 2013; Scarlett & Boyd, 2011). Understanding trends in natural resource management is relevant for researchers and practitioners participating in current conservation initiatives, understanding key factors that shape program structures, and more broadly understanding the "contested and power-laden context of conservation" (Armitage et al., 2012, p. 245). In this context, my analysis has identified considerations for researchers and practitioners in existing PWS initiatives, as well as shed light on how existing institutional conditions interplay with PWS (Corbera et al., 2009; Young, 2002).

While specific results of my research are influenced by conditions particular to the western US study region (e.g., program participants and roles in relation to public versus private land ownership patterns), broader insights should be transferable beyond the study region related to the importance of the dynamics between institutional factors for external context, program structure, and other institutional analytical domains in shaping how PWS is applied to water resources challenges globally.

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CHAPTER THREE:

THE EVOLVING ROLE OF GOVERNMENT IN THE ADAPTIVE GOVERNANCE OF FRESHWATER SOCIAL-ECOLOGICAL SYSTEMS IN THE WESTERN US

3.1. Introduction

Sustaining the quality and quantity of freshwater resources to meet environmental and societal needs is one of the most vexing governance challenges affecting the globe (Pahl-Wostl et al., 2010). The asymmetric distribution of water, growing social demands for both human uses and environmental protection, and changing climate change are intensifying water resource governance challenges (2008; Pahl-Wostl et al., 2010; Scholz & Stiftel, 2005). The western United States (US), an area with a history of water conflicts, is no exception, particularly as growth and development stress ecological systems (Fahlund et al., 2014; Gleick, 2002; Kenney, 2005a; Scholz & Stiftel, 2005).

Authority to set standards, enforce rules, and arbitrate the use of freshwater resources has historically rested with local, state and federal levels governments (Gerlak, 2006; Hardy & Koontz, 2009; Kenney, 2005b; Koontz & Newig, 2014; Sabatier, Focht, et al., 2005; Scholz & Stiftel, 2005). The fluid nature of the resource, and mismatch between political boundaries and water basins often results in water management implemented by multiple entities working across different scales and in various arenas, with policy responses often motivated by crisis (Gerlak, 2006; Kenney, 2005a). The historical evolution of water resource policy has essentially resulted in a system split between states managing water quantity issues and the federal government managing water quality issues (Association, 1989; Gerlak, 2006, 2008; Loehman & Charney, 2011).

The past three decades have seen a shift in the role of government within the United States, as an increasing awareness grows among water managers and users that government command and control policies are not sufficient to address the complexity of natural resource issues, such as freshwater concerns (Kettl, 2002; Kettl, 2000; Koontz & Newig, 2014; Koontz et al., 2004; Olsson et al., 2006; Sabatier, Weible, et al., 2005; Scholz & Stiftel, 2005). As water sustainability concerns grow, existing water governance systems and historically common engineering responses to such issues are proving environmentally and economically difficult or inadequate, resulting in a shift towards more economically efficient strategies for managing water needs (Debaere et al., 2014; Grafton et al., 2011; Zetland, 2011). Similarly, there is a growing recognition that policy makers and tools must adapt to fit new contexts for governing water resources in the face of increasing social and ecological complexities (Gallaher et al., 2013; Olsson et al., 2006).

Recent decades have seen government agencies combining regulatory or quasi-regulatory structures and rules with a variety of voluntary, collaborative market-type exchange mechanisms to support ecosystem services (Wayburn & Chiono, 2010). In this way, government actors and institutions can influence environmental management (Koontz & Newig, 2014) through the 'powerful hammers' of federal law and law enforcement, and by acting as facilitators of restoration and collaborative efforts (Gerlak, 2006, p. 247). Federal and state regulations around water issues have the potential to induce decentralized or bottom-up approaches, facilitating the participation of a broad range of stakeholders (Hudson & Weinthal, 2009).

This range of political, economic, social, and administrative processes in place that influence and respond to conditions in a system (Pahl-Wostl, 2009 from UNDP, 2000 definition), (e.g. water resource concerns) is defined as governance. While many public, private and

nonprofit actors are engaged in water resource concerns in the region, the role of government is a foundational component of governance of water resources in the western United States. Federal and state governmental policies comprise the institutional framework for how water resources in the western US are managed and specify the authorities under which government agencies may act.

How governance systems deal with complexity in a time of increasing ecological change is critical; however, existing literature on natural resource governance, performance and dynamics is still limited (Boyd & Folke, 2012a; Pahl-Wostl, 2009). These changes in the role of government in relation to water quality, quantity and source protection issues exhibit characteristics of the idea of adaptive governance, which has been identified as a critical response for governing increasingly complex social-ecological systems, especially in times of change (Folke, Hahn, Olsson, & Norberg, 2005; Olsson et al., 2006; Pahl-Wostl, 2009). Adaptive governance requires networks connecting individuals, organizations and others at multiple levels, balancing centralized and decentralized control (Folke et al., 2005; Olsson et al., 2006). Indeed, the paradigm of water management is shifting, due to new mechanisms like partnerships and collaborative efforts in water resources increasingly occurring on a more local level (Gerlak, 2008; Koontz et al., 2004; Leach & Pelkey, 2001; Sabatier, Focht, et al., 2005; Sabatier, Weible, et al., 2005; Wondolleck & Yaffee, 2000). As such, the increase in government actors and institutions engaging at the local, state and federal levels of environmental management highlight the need for an improved understanding of the roles these actors play (Koontz et al., 2004).

This shift in government roles is in line with movement, noted both nationally and globally, towards more incentive-based and problem-oriented investment mechanisms aimed at

addressing the provision and enhancement of ecosystem services (Bennett & Carroll, 2014; Gerlak, 2006). One such mechanism are Investments in Watershed Services (IWS), defined as "transactional (in cash or in-kind) agreements between or more parties that compensate a land manager for restoring, maintaining or enhancing the natural infrastructure that maintains clean water supplies" (Bennett & Carroll, 2014, p. xxii). These programs have increased in number over the past decade and typically focus on geographically defined responses to water issues (Bennett & Carroll, 2014). Such incentive-based approaches for water resource management have been noted as improving both ecosystem functioning and social factors within given watersheds (Kolinjivadi, Adamowski, & Kosoy, 2014). Although approaches such as IWS have been cited as alternative mechanisms for filling gaps in existing regulations for natural resource issues, addressing ecosystem service concerns is no longer about a choice between political decisions and free market approaches; rather, it is about a combination of options (Muradian & Rival, 2013; Sommerville, Jones, & Milner-Gulland, 2009). Understanding the role of government in the governance of ecosystem services is key to understanding the performance of different combinations of policy options (Muradian & Rival, 2013).

These mechanisms involve private landowners (Bohlen et al., 2009; Gartner et al., 2013; Goldstein et al., 2011; Majanen et al., 2011), and municipal water utilities and federal agencies (Bennett et al., 2014; Gartner et al., 2013; Lurie et al., 2013; Postel & Thompson, 2005; West, 2011). They also encompass water markets for increasing water flow in streams (Anderson et al., 2012; Debaere et al., 2014; Grafton et al., 2011; Landry, 1998; Loehman & Charney, 2011; Zellmer, 2008) and regulatory drivers (Craig, 2010; Gerlak, 2006; Gerlak & Heikkila, 2007; Hudson & Weinthal, 2009; Wayburn & Chiono, 2010). However, no one study has looked at the role of government across the combination of all these different mechanisms under the broad

umbrella terminology of IWS. While this variety of entities are key to IWS, this paper focuses on the role of government specifically, because: 1) previous research has identified this particular actor group as foundational to IWS across the study region (see Chapter 2); and 2) water resource management within the western United States is heavily influenced by government regulations at the local, state and federal levels.

This paper presents research on the changing role of government in IWS in the western US. While specifics differ, the region embodies global characteristics of water access, quality and availability (Gleick, 2002; Kenney, 2005b). These increasingly complex freshwater water resource concerns shape governance of water resources, including both government regulations and direct participation in such challenges. An improved understanding of how government actors regulate, facilitate or participate in IWS can shed light on the evolving roles of government in adaptive water governance and the future of IWS, and inform future research. To forward this understanding I asked the following research questions:

1. What are the different types of IWS programs that exist, and what is the role of government regulation and participation across the region overall?
    a. What differences are there in the role of federal, state and local government across these programs?
2. How is the government affecting IWS programs? Specifically; how does the role of government regulation and participation vary across water resource concern (in-stream flow vs. water quality vs. water source protection)?
    a. Do these roles vary by level of government (federal, state and local)?

3.2. Government Rules and Roles in Water Resource Management in the Western US

Government across scales is responsible for defining property rights as they relate to water, shaping actor roles and responsibilities across the region. This section provides an overview of the role of federal and state regulation in influence water resource management in the US West, specifically issues of water quality and quantity. This overview is key to understanding how and why IWS has developed in the study region.

3.2.1. Federal Regulation

The evolution of federal water regulatory authority in the western US is intertwined with the history of the region's settlement, growth, and development. Federal regulatory authority expanded with federal environmental legislation in the 1970's, most notably the Clean Water Act (CWA), which regulates water discharge and surface water quality (33 U.S.C. §1251, 1972), and the Safe Drinking Water Act (SDWA) which oversees drinking water quality and those water providers supplying drinking water (42 U.S.C. 300f–300j; Gerlak, 2006). Additionally, the Endangered Species Act (ESA) empowers the federal government to regulate human actions affecting threatened or endangered aquatic species listed under the law. Regulatory powers include designating critical habitat for protection (even on private lands), defining allowable and prohibited actions, and specifying standards for protecting and recovering listed species, such as water quality, quantity, temperature and velocity standards (16 U.S.C. § 1531; Parobek, 2003). Pursuant to the CWA and ESA, the federal government oversees regulation of water quantity, stream volume and flow rates, all of which link directly to water quality (CWA) and aquatic species habitat conditions (ESA) (Loehman & Charney, 2011). Volume and flow requirements and allocations for large river systems crossing state and national boundaries are regulated by legally binding compacts authorized by the US Congress (CWCB, 2015; Egan, 2013).

Additionally, despite the deference to state systems for water rights, federal intervention is allowed as part of Congress' powers under the Commerce Clause of the Constitution (Rasband, Saltzman & Squillace, 2004).

While federal regulatory authority defines a role for the federal government in water governance, this authority operates within a complex institutional environment that varies state-by-state. Due to the lack of an overarching legal-regulatory framework that governs all aspects of water allocations, water governance in the western US is characterized as being chaotic, overlapping, reactionary and fragmented (Craig, 2010; Gallaher et al., 2013; Gerlak, 2008; Scholz & Stiftel, 2005), with multiple agencies across scales overseeing various portions of water policy, and individual states creating separate legislation or legal systems to manage water quantity within their boundaries (Gerlak, 2006; Loehman & Charney, 2011). Only recently have federal law and regulation been viewed as motivating influences for both government and non-government actors to work collaboratively on shared water concerns (Gerlak & Heikkila, 2007). For example, decades-old federal regulation such as the ESA and CWA are increasingly triggered by declining water quality and/or quantity, which affects public, non-profit and private actors alike, typically in cases that regulation alone cannot resolve, without the help of other entities.

3.2.2. State Regulation

In the nineteenth century, water access and allocation emerged out of customary practices and common law handed down from territorial courts (Johnson & DuMars, 1989); the responsibility for developing the specific legal-regulatory framework for water rights allocations, was deferred to states by the federal government. Water access and allocation in the western US is based on the prior appropriation doctrine, which is essentially a 'first come, first served'

approach, customized by individual states (Landry, 1998; Loehman & Charney, 2011). The essence of prior appropriations is explained by Kenney (2005a):

> "The system awards the right to use and consume public waters in the West to individual users such as farmers and cities based on a seniority system where the first users of a resource establish perpetual rights to continue that use year after year, with new users entitled only to the water left over after the first user takes their usual entitlement." (p. xv).

Prior appropriations was first instituted in the 1850's by miners needing to divert water out of rivers and streams (Johnson & DuMars, 1989). Miners who declared to be first in time on a water body claimed the first rights to divert and use; only after the first miner had his/her water needs satisfied could the next miner in time divert and use. Farmers and municipalities had to adopt this system as they developed water use systems. Each western US state evolved with its own prior appropriation legal and administration system. The federal government recognized prior appropriations law and state authority with the Mining Act of 1866 and Desert Land Act of 1877 (Johnson & DuMars, 1989). Water rights are adjudicated under the regulatory oversight of state agencies and water courts.

Addressing 21st century water resource challenges using 19th century water governance systems has obvious challenges (Gallaher et al., 2013). Until recently, prior appropriation doctrine typically has not considered water left in a flowing water body ('instream flow') as an accepted use of water rights; water rights are only recognized when a user diverts and applies the water for a legally-recognized 'beneficial' purposes (Anderson et al., 2012). This system induces persistent water diversion, leaving inadequate water flow in rivers and streams for aquatic species and maintaining water quality (Landry, 1998). Prior appropriation has resulted in several challenges, including the historic disincentive to conserve water, and a lack of water sharing

capabilities. For the purposes of this paper, this section focuses specifically on instream flow, as it is a common component of IWS programs in the region.

The environmental benefits of instream water flow have become increasingly recognized; however, this awareness has largely come about after much available water was already allocated to out-of-stream water right uses (Landry, 1998). Individual state legislatures have responded to the increased federal regulatory pressures and societal demands for instream flow by creating legal mechanisms for such rights transfers through creating water policies establishing instream flow rights as "beneficial use" beginning in the 1960's and 1970's (Anderson et al., 2012; Landry, 1998). States have also used a combination of tools, such as bureaucratic fiat, to establish minimum stream flows, reserve unappropriated remaining water from appropriation, introduce restrictions on new water rights, and empower government agencies to acquire rights for instream flow (Anderson et al., 2012; Anderson & Snyder, 1997; Grafton et al., 2011; Landry, 1998).

In addition to state government policy and institutional changes, water markets have been established for decades as ways to transfer water between users; water markets are particularly useful in regions where most of the available water was previously appropriated (Debaere et al., 2014; Grafton et al., 2011; Landry, 1998). This mechanism for maintaining and enhancing instream flow is popular because it entails voluntary, cooperative, market-type exchanges between those interested in selling and buying water rights. Voluntary mechanisms are less confrontational than a regulatory program, and can return flow to streams in less time and with fewer complications than having to navigate federal regulations (e.g., water quality and endangered species acts) and legal debates (Debaere et al., 2014; Loehman & Charney, 2011). However, their use in inducing water rights holders to voluntarily return rights to instream flow

is more recent and, therefore, warrants further empirical investigation concerning their structure, functioning, and performance (Anderson et al., 2012; Grafton et al., 2011).

These historic roles of federal and state government in shaping water resource management in the western United States is foundational to water governance in the region today. Conservation mechanisms such as IWS fit within existing social, political and ecological contexts, which, in this case, means IWS approaches must adhere to existing water resource management such as federal regulations and states' prior appropriation. This exploration of the role of government in IWS is necessary in order to provide a more comprehensive picture of how government roles and responsibilities are changing within IWS.

3.3 Methods

3.3.1. Study Region

My study region included the eleven states of the western US including Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. These eleven westernmost states are ecologically, politically and culturally distinct from other portions of the US. These states contain a large geographic region, geographically varied availability of water resources, increasing urban and suburban populations, economic growth, unpredictable and changing precipitation patterns and critically important headwaters of major river systems (Debaere et al., 2014; Perry, Tzoumis, & Emmert, 2014; Theobald et al.; West, 2011).

The region encompasses approximately 3.04 million hectares (33% of the US), is home to over 73.5 million people (23% of US population), and contains the highest concentration of federal land ownership in the contiguous 48 states, (47% of the land area in the region) (Gorte et al., 2012; Mackun & Wilson, 2011). Competing demands on water for growing populations

(especially cities), agriculture and environmental needs are rising (Anderson et al., 2012; Fahlund et al., 2014), which is particularly complex due to variable precipitation patterns across a generally arid and water limited region (Fahlund et al., 2014; Theobald et al., 2013). Similarly, urban and rural communities are facing drought-induced risks such as water shortages and wildfires (Warziniack & Thompson, 2013; West, 2011).

Parallels can be drawn between water issues in the western US, and other parts of the world dealing with similar issues of increasing populations, arid-and semi-arid climates, agricultural demands, inefficient domestic water use, and conflicts between urban, agricultural and environmental water uses with "government planning agencies that have not yet figured out how they will have to change to meet a changing world" (Gleick, 2002, p. 1; Fahlund et al., 2014; Kenney, 2005a). This region also contains one of the highest concentrations of IWS programs in the world (Bennett & Carroll, 2014).

3.3.2. Study Design

In order to identify and capture descriptive information regarding the role of government in different IWS mechanisms, I partnered with Forest Trends' Ecosystem Marketplace (http://www.ecosystemmarketplace.com/) to design and implement the third bi-annual survey of investments in watershed services around the globe (Bennett & Carroll, 2014; Bennett et al., 2013; 2010). To constrain which program were included in the inventory, I employed Ecosystem Marketplace's definition, which defines IWS as, "transactional (in cash or in-kind) agreements between or more parties that compensate a land manager for restoring, maintaining to enhancing the natural infrastructure that maintains clean water supplies" (Bennett & Carroll, 2014, p. xxii). This survey did not include water markets for agricultural or urban water right transactions, only water rights transactions for environmental flow purposes; these are defined as, "buying or

leasing water rights in existing water market, which are not used but instead set aside to ensure a minimum level of flows and protect wildlife and habitats" (Bennett & Carroll, 2014, p. 5).

I administered an online survey from March through May 2014 to all identified programs in order to conduct a census by obtaining information about the entire population, instead of a surveying a selected sample. The population was initially characterized by the 2012 Ecosystem Marketplace survey (Bennett et al., 2013). To administer the survey, an email was sent to the main contact identified, or program administrator, requesting completion of an online survey. Follow-up phone calls were used to confirm survey data, and/or to connect with those who had not filled out the survey in order to administer the survey over the phone.

Within the western US, 76% of identified program administrators overseeing active or developing watershed investment programs in 2013 completed the survey either online or over the phone. Of the remaining identified programs, 87% were completed through: 1) desk research (use of publically accessible program documents and websites to complete survey answers); 2) other relevant program documents (e.g. annual reports, grant reporting) provided by actors involved in the program development or operation. The two remaining identified programs were noted as nonresponses, but due to inactivity on websites, reports and other trackers, they appeared to be inactive during the survey time period.

Survey questions were organized around five sections: 1) program profile, 2) overview of activities, 3) program finance, 4) funding mechanism, and 5) implementation. For some survey questions, respondents were able to select more than one response if applicable (e.g. land types involved in program, primary water-related challenges, types and roles of program participants), which means that not all categories were mutually exclusive, and reported percentages may total more than 100% for different variables. The components of the survey are listed in Table 3.1.

Table 3.1. 2014 State of Watershed Investments Survey Topics

2014 State of Watershed Investment Survey[1,2]		
Topics/Questions	**Data**	
Program Profile		
Program status	Active Demonstration/pilot stage	Planning/design stage Inactive (no transactions for more than 3 years)
Land ownership	National/Federal State/Provincial County Municipal	Business Civil/Non-profit Private (i.e. household, landowner) Collective ownership
Scale of program	Local/Municipal Multiple localities/municipalities County Multiple counties	State/Provincial Multi-state/province National International
Brief description of program	*Short answer including program history, objectives, the environmental problems it seeks to address, and outcomes to date.*	
Overview of Activities		
Total and annual amounts spent on watershed protection activities	Dollars spent in 2013, 2012 2011, and over program lifetime	
Total land area in active management	Number or hectares or acres	
Identify program's primary water-related challenges:	Drinking water protection Stormwater management	Wastewater management Other types of watershed risk (list)
Rate the importance of the following specific water-related challenges:	Restoring flows Groundwater recharge Nitrogen loading Sediment loading Phosphorous loading Fecal coliform	Heavy metals Temperature Dissolved oxygen Wetland conservation Flood risk mitigation Minimizing fire risks
Documented water quality or quantity improvements	List improvements, e.g. tons of Nitrogen reduced, cubic feet per second of increased instream flow	
Program Finance		
List Program Administrator name	*Administrator is entity that oversees the investment/transaction mechanism.*	
For each investor, list name	*Investors are communities, companies, non-profits, government bodies, or others who pay for watershed protection actions.*	
Each investor's profit status	Public Public-private partnership For profit (e.g. private business)	Not for profit (e.g. nongovernmental organization) Households/individuals
Percent of total funding provided by each investor Future funding committed by each investor	*Percent and dollar amounts committed over years*	
Does each investor voluntarily fund watershed protection? Or does some law or regulation drive investments?	Voluntary In anticipation of a future law or regulation An option to meet compliance	Required by law or regulation List the relevant law(s) and/or regulation(s)
Strategic motivations: rank up to five motives driving each investor's support for watershed protection.	Regulatory compliance Water availability or Water quality risks Climate change risk Weather-related disaster risk (flooding or storm damages) Wildfire risk Health-related goals: safe drinking water access Energy or Food security risk	Cost abatement or Revenue opportunity Protection of existing/planned infrastructure Reputation/brand management Local livelihoods/local economic development Social issues: Poverty, gender, tenure security, or other Lack of good governance of resource Biodiversity protection Other (please explain)

List each supplier name	*Suppliers are people, households, organizations, or others that are paid (in cash or otherwise) for actions that restore or protect watershed resources or functions*	
Each supplier's profit status	Public Public-private partnership For profit (e.g. private business)	Not for profit (e.g. nongovernmental organization) Households/individuals
Supplier's participation in watershed protection is:	Voluntary Actions required by policy/regulation	Policy/regulatory incentives for participation but actions not mandatory List the relevant law(s) and/or regulation(s)
List each intermediary name	*Intermediaries are those organizations supporting programs with roles like technical assistance or monitoring*.	
Intermediary profit status	Public Public-private partnership For profit (e.g. private business)	Not for profit (e.g. nongovernmental organization) Academic institution
What role(s) does each intermediary play?	Administration Advocacy Compliance/ reporting Information/ outreach/ communications	Monitoring Program design Technical/ scientific support Verification Marketing
Funding Mechanism		
How were initial scoping/design phases of the program funded?	Government budget, grant, or loan Bond issue Private capital Micro-credit/Micro-loan	Multilateral development institution loan/credit or grant/funding Funding from program investor(s) or program supplier(s) Non-profit/foundation funding
How is compensation to suppliers determined?	Practice-based, i.e. $25 per hectare of land under management Outcome-based, i.e. $25 per ton of reduced sediment load Land use rights contract, i.e. a conservation easement, land use restriction, etc. Sale of land Water use rights sale or Water use rights lease	
What form does investment/compensation to suppliers take?	Cash Technical assistance/training Inputs, for example seeds or tools	Tenure security Loans/access to credit Other non-cash support (please explain).
Funds transaction process between investor(s) and seller(s)	Directly between investor(s) and seller(s) Through an intermediary group or third party	Through a market exchange or clearinghouse *Please list the name and/or profit type of intermediary or exchange*
Implementation		
Does the program measure the value of its outcomes (like reduced pollution) in economic terms?	Yes No	No but we plan to
Does the program conduct feasibility analysis and/or program goals other than water supply or quality	Yes No	No but we plan to
Watershed management activities undertaken by program.	Afforestation Reforestation Sustainable forest management Ecological restoration (non-forest) Protection of existing landscape Sustainable agricultural practices Reduction of urban/man-made impacts (i.e. limiting factory discharge)	Urban green infrastructure Dedication of water use right to instream flow augmentation Education/outreach activities targeting local users Other (please explain)
Pre-project land use/land cover type	Agriculture: Combined feeding, Cropland, Orchard/vineyard Agriculture: Permanent pasture, or Other Coastal	Grassland/shrubland Marine Savanna Tundra Urban/Built environment

	Desert Forest: Coniferous, Deciduous, Mixed deciduous-coniferous, or Degraded/clear-cut Forest: Tropical	Wetland: Forested or Non-forested
What kinds of program outcomes are monitored?	Water quality Water quantity Other biophysical outcomes (wildlife, carbon, etc.)	Economic outcomes Social impacts: e.g., poverty alleviation, gender equity, or health outcomes.
How frequently does monitoring happen	More than once a month More than once a year	About once a year Less than once a year
When did monitoring begin	Year	
What metrics are used to measure each monitoring outcome?	*Short answer*	
Who is responsible for monitoring each outcome?	*List organization name*	
Most difficult challenges for the program	Lack of buyers/investors or lack of suppliers Raising initial capital/funding Managing funds Challenges connecting investors and suppliers Lack of lands/management options for watershed management Lack of scientific expertise about watershed or scientific data on program outcomes Lack of technical expertise for management	Regulatory uncertainty for compliance programs Perceived lack of direct benefits to constituents Lack of local stakeholder support Lack of useful standards/tools for design Lack of participation/conflicts with planning Lack of policy-makers/decision-maker support Legal/regulatory barriers to funding work
What changes would help program success?	*Short answer*	

1 See Bennett & Carroll, 2014

2 Unless listed otherwise, responses were multiple choice and/or check boxes

Government was defined in the survey and in my subsequent results as public entities delineated by scale, including:

1. **Federal government:** government agencies and policies operating at the national level.
2. **State government:** government agencies or policies operating at the state level.
3. **Local government:** government agencies or policies operating at the local level. This includes counties, municipalities, and cities, as well as other public water providers, state-created water conservation districts, or nonprofit public entities.

Actors in the survey were defined as:

- **Investors:** Communities, companies, non-profits, government bodies, or others who pay for watershed protection actions.
- **Suppliers:** People, households, organizations, or others that are paid for actions that restore or protect watershed resources or functions
- **Program Administrators:** the entities that oversees the investment/transaction mechanisms. (See Table 3.1)

In reporting Results, some explanation of point and nonpoint source trading is needed for the reader. Point source trading involves purchasing portions of discharge permits for certain nutrient(s) from other facilities that are below their permit regulation amount, thus not exceeding total concentration limits for the water body. Nonpoint source trading involves purchasing nutrient reductions from sources without permit regulations, such as septic system performance improvements and/or other best management practices that are calculated to reduce phosphorous in the water body.

Upon reviewing the results of the survey, I found that some programs were inactive (n= 3, defined as no transactions after 2011), still in development (n = 5, no transactions had occurred yet, and all participants were not yet determined), or in demonstration or pilot stage (n= 7, conducting initial pilot transactions with willing sellers and investors). For the findings reported in this section, only programs classified as active (defined as having transactions in 2011, 2012 and/or 2013) were included, since many of the variables for in-development or demonstration programs were undetermined or not yet finalized.

3.3.3. Analysis

Analysis of survey data focused specifically on how the roles of government at the local, state and federal levels have changed as IWS mechanisms have expanded to complement and supplement legal-regulatory frameworks. Data was organized by the specific biophysical issue of concern, including: 1) water quality; 2) water quantity; 3) water source protection.

I used survey data in two ways. First, I used overall information from the survey to generate descriptive statistics (e.g. frequencies) characterizing the range of variation of IWS programs across the region. Categories include program location, main program foci, and actor roles broadly. Second, I used descriptive statistics such as cross tabulations to examine the relationship between government roles in programs and other program characteristics, with a focus on understanding how the differences in water resource concerns shaped community attributes and rules, and how different IWS programs were located within these groupings. Three types of government variables were examined: 1) actor roles (government investors, suppliers, program administrators and intermediaries); 2) investor and supplier motivations for participation (and relevant laws or regulations driving participation); and 3) landownership (government-owned lands enrolled in programs) (See Table 1).

Survey data were input and organized in the quantitative analysis software SPSS (Version 22). This involved coding survey responses into numeric variables, one per survey attribute (e.g. yes/no (1/0) responses for dichotomous variables, and a range of numbers for categorical variables). I used SPSS to create new variables from my data that grouped programs by primary water resource concern (instream flow, water quality, sourcewater protection), with some programs identifying with more than one concern. I also converted short answer responses to coded data where necessary. For example, I used information provided by survey respondents

such as the names of organization(s) responsible for program administration, monitoring or other tasks, to create new variables for actor roles (e.g. Program Administrator, Intermediary), sorted by organization type (e.g. government, private, nonprofit). I also created new variables in order to organize the amount and type of government involvement by program. This included for example, dichotomous variables on the presence/absence of local, state and/or federal actors (attributes of water user community), and the presence/absence of government regulations or policies driving actor participation (rules in use). Since this study was a census of IWS in the western US, I did not require the use of inferential statistics to make generalizations about a broader population. My creation of new variables allowed me to describe the dataset overall then explore government presence and roles across scale to understand changes over time, and responses to different water resource concerns.

3.4. Results

3.4.1. IWS Overview: Government Influence and Distribution

Forty-eight total active IWS programs were identified across all eleven states in the study region, with the highest number of programs in Oregon (n=11), Washington (n=10) and Colorado (n=9) (Figure 3.2).

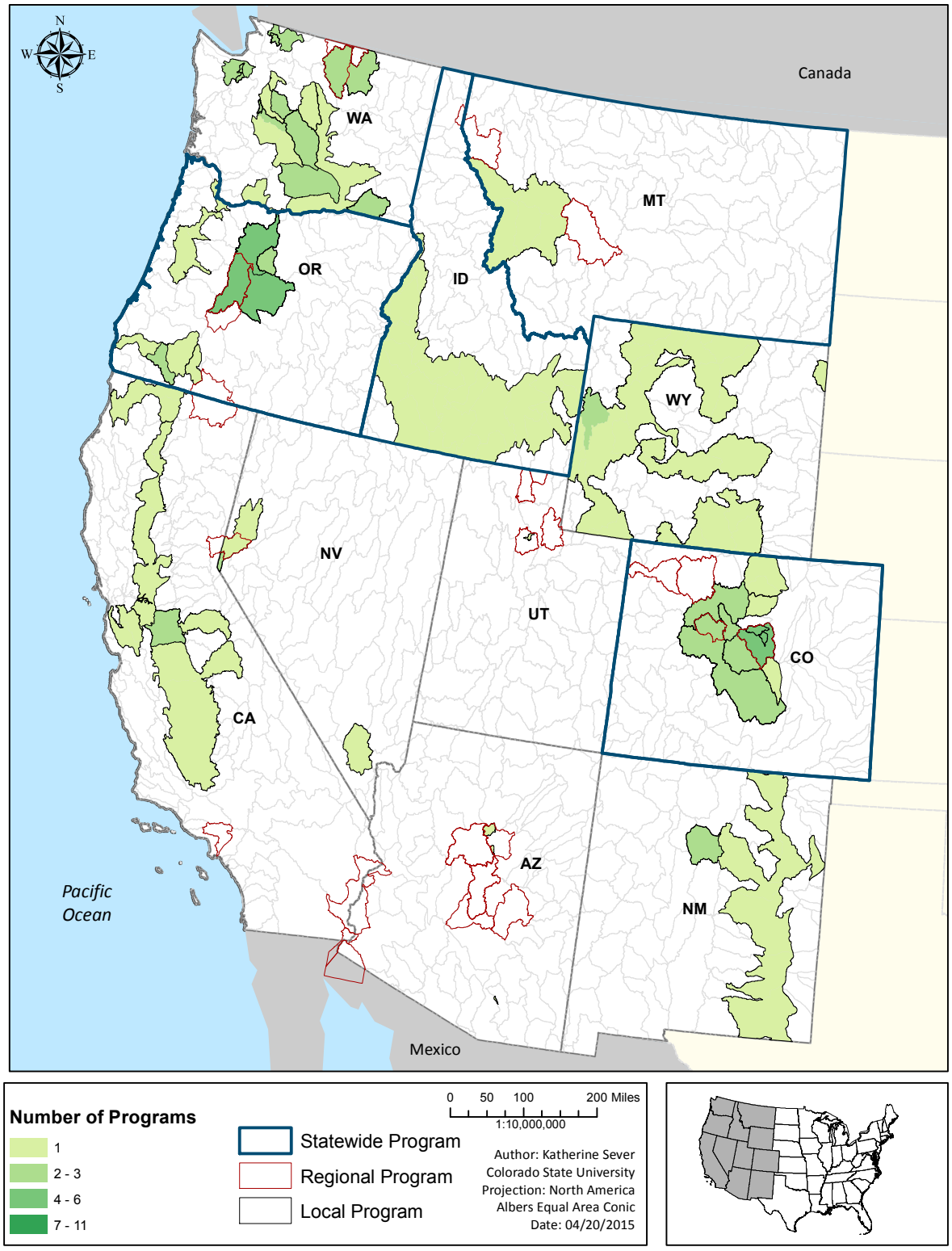

Figure 3.1: Map of western US highlighting all watersheds included in the 48-program inventory. Shading of watersheds indicates where multiple programs overlap in certain

watersheds. The darker the shading, the more programs the watershed contains (see the "Number of Programs" portion of the legend for specific program number ranges).

All of the programs included some form of government direct participation or influence, including at least one of the following: 1) local, state or federal policies as motivations for program inception, 2) local, state or federal government participation as a supplier, investor, program administrator or intermediary, and/or 3) the presence of local, state or federal government-managed land (Table 3.2).

Table 3.2. Government regulations and roles in influencing IWS

Government Presence in IWS Overall	Percent of Total Programs N = 48
Government presence overall[1]	**98%**
Government regulations motivate program participation[2]	**46%**
Government regulations driving program investors	46%
Government regulations driving program suppliers	17%
Government as Program Actors[3]	**92%**
Government as Investor	77%
Government Supplier	50%
Government Program Administrator	81%
Government Supporting Roles	
Government Intermediary	31%
Government conducting monitoring	58%

1 Includes combination of government as program actors and government regulations driving investor or supplier participation

2 For both suppliers and investors combined

3 Includes Government as investor, supplier, and/or program administrator

Ninety-eight percent of programs identified government regulations motivating actor participation and/or government participation as actors in their program. When asked about types of actor participation, 46% of programs noted that a government regulation or policy was motivating investor participation. Thirty-six percent of these same programs with regulation-motivated investors also reported similar regulations driving supplier participation. Fifty percent of programs reported voluntary participation for both investors and suppliers. However,

programs with voluntary participation still included government influence through a combination of: direct participation by government actor(s) (74%), inclusion of government land (65%), and/or voluntary participation in programs linked to mainly state instream flow and groundwater regulations (48%). Sixty-five percent of programs identified federal government influencing their program. By contrast, fewer programs identified the presence of local or state influence (57% local, 48% state).

When asked to identify primary actors involved in program development and/or performance, 92% of respondents noted government agencies as Investors, Suppliers, and/or Program Administrators, compared with 79% of responses identifying private landowners and/or businesses and 56% of respondents identifying nonprofit organizations (NGOs) in those roles. Seventy-seven percent of the programs contained at least one government investor, and 50% contained at least one government supplier. The majority of programs (81%) contained a Program Administrator from a government agency, and 31% contained some form of government as an intermediary. An intermediary was defined as organizations supporting programs with roles (e.g. technical assistance or monitoring), which in this case, included conducting supporting tasks like administration, compliance reporting, and outreach. Fifty-eight percent of programs also credited a government actor with conducting program monitoring of water quality, quantity and/or other biophysical impacts.

Fifty-eight percent of all IWS programs encompassed some form of government landownership; fifty-two percent of programs involved municipal or county government lands and 46 percent of programs involved federal lands, such as those managed by the US Forest Service. By contrast, state owned lands were involved in fewer programs (28%).

3.4.2. Types of IWS Programs by Water Concern and Government Role

When asked about their primary program issues, respondents mainly identified concerns related to water quality (46%), flow restoration or water quantity (56%), groundwater recharge (48%), and protecting drinking water sources (33%). Programs also noted other water concerns related to water quality which included primarily phosphorous, sediment and nitrogen (19%); and storm and/or wastewater (10%) runoff. To further explore the role of government as a regulator and active participant in IWS, I examined roles relative to three types of water resource concern specified by respondents:

1) *Water quality* for programs focused on maintaining or meeting specific water quality conditions (n=10);

2) *Water flow* for programs focused primarily on increasing instream flow and/or groundwater recharge (n=28)

3) Water *source protection* for programs focusing primarily on protecting drinking water sources from land use and ecological change such as development or wildfire (n=12).

Two IWS programs encompassed two water-related concerns, and were therefore listed twice between water quality and water flow, resulting in the three groups totaling 50 for the IWS population of 48 programs. IWS program growth in response to these main water resource concerns has changed over the years, with the earliest programs motivated by water quality, then water flow in the 1970's, and in the past decade, water source protection (Figure 3.2). The following sections explain these changes to water resource concerns over time, explaining the role of government in each of the three types of IWS relative to identified water concerns.

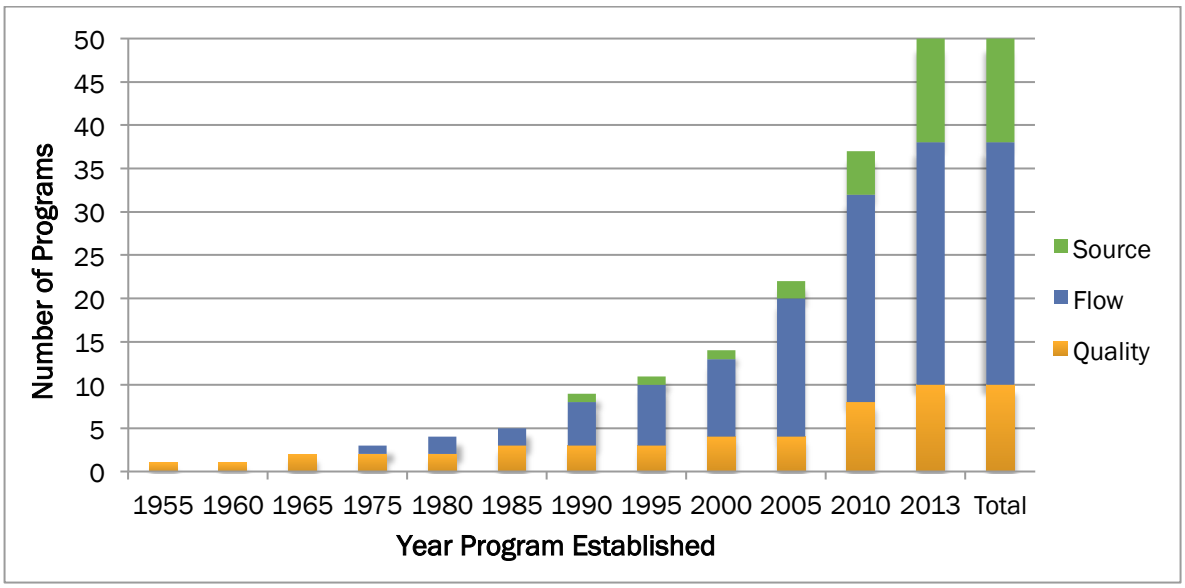

Figure 3.2. IWS programs' main water-resource concerns listed by the year each program was established (from 1954-2013)

Across the water concern groups, government presence is highest in *Water Quality (Quality)* and *Source Protection (Protection)* (100%), and only slightly lower for *Water Flow (Flow)* (96%) (Table 3.3). Government regulations were noted by respondents as being important in shaping *Quality* and *Flow* programs (90% and 45%, respectively), but were absent in *Protection* programs. Government was noted as a program actor for all Protection and Quality programs (100% each), and in 86% of Flow programs. Government Program Administrators were also present across programs, especially in Quality and Protection programs (80% and 75% respectively), in contrast to 57% of Flow programs. Quality programs were identified in four states (CO, NV, OR, WA), and one regional (multi-state program). Flow programs were present in nine states (all western states except NV and UT), and one regional program. Source Protection programs were identified in seven states, with the highest concentration in Colorado (n=5). The following sections present these three main groups in order of regulatory influence

(90%-0) and the emergence of each water issue in the IWS timeline, starting with Quality, then Flow and ending with Protection.

Table 3.3. Government Influence Variables in IWS by biophysical water concern

Government Influence Variables in IWS[1]	**Main Program Biophysical Concerns**		
	Quality *N = 10*	**Flow** *N = 28*	**Protection** *N = 12*
Government presence overall, (% of N =48)	**100%**	**96%**	**100%**
Government regulations influence participation	**90%**	**45%**	**-**
Government regulations influence investors	**100%**	**45%**	**-**
Federal	*80%*	*24%*	*-*
State	*20%*	*25%*	*-*
Government regulations influence suppliers	**50%**	**11%**	**-**
Federal	*40%*	*-*	*-*
State	*10%*	*11%*	*-*
Government as Main Program Actors	**100%**	**86%**	**100%**
Government as Investor	**100%**	**61%**	**100%**
Federal	*20%*	*32%*	*75%*
State	*10%*	*46%*	*8%*
Local	*80%*	*11%*	*83%*
Government Supplier	**70%**	**28%**	**92%**
Federal	*20%*	*18%*	*92%*
State	*10%*	*14%*	*-*
Local	*60%*	*7%*	*17%*
Government Program Administrator	**80%**	**57%**	**75%**
Federal	*20%*	*18%*	*33%*
State	*20%*	*21%*	*17%*
Local	*40%*	*18%*	*25%*
Government as Supporting Actors			
Government Intermediary	**50%**	**21%**	**33%**
Government conducts monitoring	**40%**	**50%**	**96%**
Federal	*-*	*11%*	*66%*
State	*10%*	*32%*	*8%*
Local	*40%*	*28%*	*42%*

1 Each percent is calculated as the percentage of that column n. For example, all percentages in the water flow column are calculated from n = 28. Two programs have multiple main water concerns, which is why the groups total 50 for the 48 total programs

IWS Program Type I: Water Quality

IWS-type programs focusing on water quality were established as early as the 1950's, with federal water quality regulations motivating 100% of investor participation and 50% of supplier participation in water quality programs. Notable federal regulations included the Clean Water Act's (54%) National Pollutant Discharge Elimination System and Total Maximum Daily Load and Impaired Waters Rule, and the Surface Water Treatment Rule (18%). Federal regulations have long been the basis of IWS-type programs; in the 1960's, local governments in particular actively invested in watershed protection and restoration programs to meet filtration avoidance criteria and avoid costs associated with building or expanding additional drinking water treatment facilities. From 1980-1996, state-specific watershed protection control regulations (e.g. drinking water reservoir standards) spawned point and non point source water quality trading programs for key water bodies (e.g. reservoirs) to improve water quality. For example, local government water treatment and discharge facilities (e.g. wastewater treatment) in some cases conducted such trading as an option to comply with annual waste load permit regulations for nutrients (e.g. phosphorous).

Sixty percent of the water quality-based IWS programs in the survey formed between 2005 and 2011. Survey respondents from these more recent programs noted that IWS was an option to meet intensifying water quality concerns, and/or to address issues in freshwater sources where poor water quality had triggered existing water quality regulations. This is supported by water quality reporting from this timeframe, such as a 2004 National Water Quality Inventory report to Congress (prepared pursuant to section 305(b) of the Clean Water Act) that noted: "In 2004, states reported that about 44% of assessed stream miles, 64% of assessed lake acres, and 30% of assessed bay and estuarine square miles were not clean enough to support uses such as

fishing and swimming" (EPA, 2009, pp. ES-1). Although this report only includes a portion of the nation's water sources (16% of rivers and streams, 39% of lakes and reservoirs), states focus their limited monitoring resources on waterbodies suspected as being impaired (EPA, 2009). Survey respondent comments and this report demonstrate how, despite over 30 years of regulatory standards and enforcement, water quality was not improving, resulting in government and non-government actors searching for new approaches to complement regulations.

While wastewater utilities and county agencies continue to be primary investors in water quality programs, survey data show that since 2005, federal land management agencies such as the US Forest Service have begun asserting their role as a supplier and an investor in clean water in the region (n=2). This role shift occurred during the same time period of the "Watershed Condition Framework" development, which was created in response to a 2006 White House Office of Management and Budget review critiquing the US Forest Service's lack of a national program for prioritizing watersheds for restoration and improvement (USFS, 2011b). The framework assesses watershed conditions with ecological, hydrological, and geomorphic functions and processes indicators in order to identify priority restoration areas that Forest Service management activities (either terrestrial or aquatic) can influence to improve watershed conditions (USFS, 2011b).

Another role conducted by government for water quality programs involves program monitoring. Half of Quality program monitoring is conducted by nongovernmental entities (e.g. water trusts, private companies), while the remaining half of programs note that government actors such as state departments and local water providers conduct program monitoring (mainly water quality).

IWS Type II: Water Flow

IWS focused on water flow began in the 1970's, when state-level legislation to designate instream flow as a beneficial use began to appear. Of the eleven water flow programs formed between 1973 and 2003, eight encouraged the temporary leasing and/or transfers of water rights from users to state government agencies for instream flow purposes. Fifty-five percent of these early programs cited regulations driving program creation, including the Endangered Species Act (n=1), US Congressional law mandating improved instream conditions for critical fish and wildfire habitat (n =1) and state-specific instream requirements (n=2).

Flow programs expanded between 2004-2013, motivated in large part by the Endangered Species Act (n=5), Federal Energy Regulatory Commission hydropower permit requirements (n=2) (e.g. hydropower renewal permits contingent on funding mitigation work for dam impacts to streams and aquatic habitat), and interstate water compacts (n=1). Flow programs also noted state regulations as motivating factors, including state-specific groundwater regulations (n=3), and state-mandated instream flow requirements (n=2).

State government agencies are the primary actors in Flow programs, serving as an investor, supplier and administrator. Both state agencies and the governing boards overseeing these agencies' policies and administration are involved. Agency types include those relating directly to water resource management as well as those pertaining to environmental protection, ecology, commerce, transportation, and fish and wildlife. In addition to providing water rights holders options to sell or lease their water rights back to the state, Flow programs included similar options for users to mitigate and/or offset groundwater use.

Although 55% of Flow programs do not cite specific government regulations requiring investor or supplier participation, many of them noted in the survey that instream flow concerns

are motivated by increasing needs to restore critically dewatered portions of streams, and to address threatened and endangered aquatic species habitat concerns. These concerns have increased over time, as Flow programs from 2004-2013 demonstrate by changes in program type, actors, and regional focus. While the 1973-2003 time period consisted of mainly state-mandated in-stream flow programs for overall state water concerns (73%), 65% of Flow programs created between 2004-2013 were additional programs in states with pre-existing state Flow programs.

In addition to state government agencies, the period between 2004-2013 saw the inclusion and growth of nongovernmental organizations, such as water trusts and/or water banks to facilitate water rights transfers and work with landowners directly, or to focus on high priority watersheds or water body segments. As nongovernmental organization participation as administrators or facilitator increased in the 2000's, state government roles focused mainly on investing and holding water rights. Federal government agencies have also increased their participation in IWS-type instream flow programs to meet federal regulatory requirements to conserve aquatic species, including agencies such as the Natural Resource Conservation Service and Bureau of Reclamation. Half of flow programs reported that government entities, especially state (32%) and local (28%) government conducted program monitoring, for water flow as well as biophysical impacts relating to aquatic habitat. This included state agencies (e.g. Department of Ecology), county government, and federal agencies (e.g., US Fish and Wildlife, Bureau of Reclamation).

IWS Type III: Water Source Protection

Water source protection represents the most recent area of growth for IWS-type programs in the dataset. Of the twelve Protection programs, ten have developed since 2006. These

programs did not report any regulations motivating participation; rather, all reported increased concerns about drinking water source protection (100%), water availability (92%), and catastrophic wildfire effects (92%). Programs cited wildfires from 1996-2013 and post-wildfire impacts such as flooding as driving their creation. Protection programs have the highest levels of government participation as an investor and supplier overall (100% and 92%, respectively), and contain the highest levels of federal government participation as supplier, investor, and program administrator (92%, 75% and 33%) across all three IWS program types. Protection programs also contain the highest percentage of local government involvement as an investor (83%). Protection programs involve actions (e.g. tree thinning, patrolling) aimed at improving or protecting forested watershed health to address concerns related to wildfire and/or land development that affect drinking water sources.

In most cases, federal land management agencies act as suppliers and investors by providing resources and/or cost-sharing for risk reduction activities, such as hazardous fuel reduction and riparian area restoration and stream-side stabilization. Municipal water providers typically act as investors in such activities. Ninety-two percent of the Protection programs involved federally managed lands, especially those lands managed by US Forest Service, National Park Service, and/or Bureau of Reclamation from which local level government (e.g. water providers, municipalities and cities) draw upon for agricultural, drinking, and industrial water. Three of these programs also used land acquisitions, conservation easements and forest treatments to protect key privately-owned areas in their watersheds. Ninety-six percent of Protection programs reported monitoring conducted by government entities, especially federal (66%) and local (42%), which mainly included federal agencies (e.g. the US Forest Service)

reporting on biophysical impacts (e.g. acres of forest treated), and local water providers monitoring protection measures and/or water quality impacts.

3.5. Discussion

This study set out to investigate the IWS landscape in the western US and how government roles, rules, and actions intersect with IWS as an evolving governance arrangement. The influence and roles of local, state, and federal governments in all 48 identified IWS in the western US have changed over time in response to different water resource concerns, moving from solely regulator to a main participant in IWS. The results of this research show IWS as a mechanism for new and creative ways to governing water resources in the western US, with federal, state and local government regulatory policies and agency participation expanding from traditional regulatory roles to more voluntary, incentive-based approaches. This work provides new insights concerning the adaptive governance of complex social-ecological systems and highlights needs and opportunities for future research in IWS-type programs in particular and environmental governance in general.

Two caveats are warranted. The first relates to the limited ability to understand the causal connections between contextual factors and program outcomes. My dataset comprises a census of the IWS population of the US West. As such, the large scale at which I conducted my study allowed me to understand the overall influence and changing roles of government across water resource management concerns. However, my ability to understand certain specific details is limited. For example, my research does not include specific variables for measuring an individual program's entire suite of enabling conditions or performance outcomes. Instead, the survey elicited information about general regulatory or ecological drivers, and project outputs reported by only one respondent per IWS program – the program administrator. To gain further

insight on how specific policy, socio-economic, and biophysical contextual factors relate to program performance and government rules or roles, survey responses from – and in-depth interviews with – a representative sample of actors participating in each IWS program would provide more specific information. For some topic areas, case study-based research has already been conducted to dive more deeply into specific contextual factors and interactions between factors, such as for water markets for instream flow (see (Anderson et al., 2012; Debaere et al., 2014; Grafton et al., 2011; Landry, 1998; Loehman & Charney, 2011; Zellmer, 2008) and relevant regulatory motivations (Craig, 2010; Gerlak, 2006; Gerlak & Heikkila, 2007; Hudson & Weinthal, 2009; Wayburn & Chiono, 2010).

The second caveat relates to problems associated with developing a longitudinal dataset for a rapidly evolving arena of environmental governance. The dataset used in my analysis was derived from the third data collection effort on investments in watershed services, following a 2010 and 2012 survey (Bennett & Carroll, 2014; Bennett et al., 2013; Stanton et al., 2010). All three surveys vary in survey questions and response rate. Since the survey questions are not parallel constructs, some attributes have more measures than others. Therefore, comparing data results temporally can be difficult. These issues are simply artifacts of trying to understand the relatively new and still rapidly changing arena of payments for ecosystem services that has really just emerged since the early 2000's. As these programs begin stabilizing in structure, functioning, and performance, I anticipate that my data will serve as a baseline dataset and will provide a reliable basis for conducting longitudinal studies on IWS. Despite these limitations, the results of my study do shed insights on government in IWS, as well as the adaptive governance of freshwater resources more broadly.

3.5.1. Government actors are essential to freshwater governance in the western US

The results of this research clearly show government as a foundational component of major freshwater governance in the western US as implementer and enforcer of federal law and regulation, and in more recent roles facilitating restoration and collaborative efforts (Gerlak, 2006). This research provides unique contributions to existing research by using IWS in the western US to demonstrate changes in government roles, showing how although government command-and-control regulation is not sufficient to address the complexity of current freshwater resource concerns (Kettl, 2002; Kettl, 2000; Koontz & Newig, 2014; Koontz et al., 2004; Olsson et al., 2006; Sabatier, Weible, et al., 2005; Scholz & Stiftel, 2005), government regulatory structures and/or participation still form the basis of many new collaborative environmental management approaches (Koontz & Newig, 2014; Scarlett & Boyd, 2011; Wayburn & Chiono, 2010). Government as a bureaucracy is still an important component of public administration, not just to set and enforce rules and regulations, but also as an instrument to link broad public policy values to on-the-ground actions (Olsen, 2005). In many cases, government bureaucracies maintain control, ownership, and/or decision-making authority over natural resources (Kettl, 2015; Wondolleck & Yaffee, 2000), especially in the context of freshwater resources in the western US (Gerlak, 2006; Nie, 2008). Water quality and quantity issues cannot be solved by collective nongovernmental action alone; government regulations and participation are needed to propel a majority of programs. Improving understanding of where and how government influence precipitates programs presents a richer picture of the future for water issues in the western US.

3.5.2. Government regulatory frameworks motivate IWS

My results demonstrate the key role of regulation in IWS, with the majority of respondents involved in Quality and Flow IWS reporting that government regulations were key influence in driving participation. By the same token, respondents noted that existing efforts were not sufficient to meet regulations; IWS arrangements emerged to fill gaps where existing rules were insufficiently addressing the resource concern. Federal and state government regulations still govern water quality efforts in the region, especially those overseen by agencies such as the Environmental Protection Agency (Clean Water Act, Safe Drinking Water Act), US Fish and Wildlife (Endangered Species Act), and state agencies. State regulations mandating minimum water flow are key to a majority of IWS in the region, and vary from state to state, depending on the degree to which the regulations enable or inhibit transfers of water rights to instream flow, and/or augmentation of groundwater use. In some parts of the west, legal frameworks have been slower to acknowledge the legitimate value of instream augmentation, and the transaction costs and permitting can make the processes burdensome (Bennett & Carroll, 2014; Yates, 2014).

My research also shows how some states are building further on their established regulatory structures for instream flow by allocating water rights transfers responsibilities to nongovernmental organizations as mechanisms to improve instream flow, particularly in specific de-watered rivers and streams (Loehman & Charney, 2011). For example, policies determined by the states of Oregon and Washington have allowed for water rights transfers through a variety of programs and organizations, largely in response to ESA drivers. This might suggest that these states have been able to facilitate more transactions than their western counterparts, but I did not collect sufficient data on these variables to allow for appropriate comparison. These differences

across states highlight how state policies can either facilitate or inhibit water rights transactions for instream augmentation, directly affecting the potential applicability and effectiveness of an IWS approach.

In sum, this research demonstrates how regulatory approaches combine with incentive-based and cooperative mechanisms to address water resource concerns (Scarlett & Boyd, 2011; Wayburn & Chiono, 2010). This can be observed in the Flow programs, where government regulations dating back nearly 40 years provided a foundation for the creation of new and expanded programs in more recent years. Collaborative partnerships typically lack regulatory authority to command changes (Koontz & Newig, 2014), which means there is an opportunity for government policies to bring stakeholders together for quantity and flow concerns. For example, some programs noted how intensifying water resource concerns actually triggered pre-existing regulations, such as instream flow requirements or endangered species concerns in years of drier weather and/or increased water demand. This shows how even decades-old regulations can still motivate present day IWS creation, and how adaptive governance can occur both as bottom-up and top-down in response to such intensifying natural resource complexities (Olsson et al., 2006).

3.5.3. Expanding roles of government

In a time of increasing social-ecological complexity, local, state and federal governments are expanding their historically engrained roles of creating and enforcing regulatory standards to include more direct participation in voluntary, collaborative and incentive-based approaches. In the case of the source water protection programs, this is especially true, as these programs formed in response to disruption of watershed functioning from large wildfires in the early 2000's and subsequent increased awareness of watershed vulnerability to wildfires; indeed, such

voluntary collaborations between stakeholders are on the rise (Bennett & Carroll, 2014; Porras et al., 2008). This recent escalation in government participation in IWS programs seems logical given that federal agencies such as the US Forest Service are one of the largest landholders in the western US, and 50% of western freshwater originates on National Forest land (Weidner & Todd, 2011). Although forest treatments can cushion threats to watersheds (e.g. wildfire), and create benefits not captured by current markets, funding shortfalls often limit such management actions on land in the west (Mueller et al., 2013). However, evidence is growing that federal agencies are increasingly engaging in such programs, particularly in the arid west, by devoting staff and financial resources to reducing wildfire risk in recognition of social and ecological vulnerabilities (Bennett et al., 2014; Bennett & Carroll, 2014; West, 2015). These partnerships allow all levels of government to leverage funds, work across land jurisdictions, and co- create common goals and shared priorities (Gartner et al., 2013), all of which are increasingly recognized as viable ways to leverage funds in a time of financial and resource scarcity (Selin & Chavez, 1995).

This increasing prominence of collaborative environmental management on public lands (Koontz et al., 2004) will be important to track over time, as such programs gain more years of experience and project outcomes. For example, source water protection programs involving federal agencies are formalized and structured according to Memorandums of Understanding with five-year lifespans; renewals are subject to federal agency funding and priorities. Programs such as IWS have the potential to redirect agency priorities to where funding and partnerships exist, with the potential risk of restructuring their agency mandates. Similarly, as social-ecological complexities intensify, government agencies across authority levels may be forced into a position of increased regulation, which could conflict with their direct participant role.

How government will navigate these potential pitfalls and complexities as key regulators and participants in IWS must be tracked longitudinally, in order to better understand long what government changes (especially in the past decade) imply for the shape of freshwater governance.

These changes in the role of government in IWS in the region are not about the government shifting from one position to another; rather, these changes demonstrate how the government is expanding its roles and responsibilities, moving beyond historic command and control roles to support and facilitate programs. This demonstrates how the government policies and agencies are adapting to fit new contexts for sustainably governing water resources in the face of increasing social and ecological complexities (Gallaher et al., 2013). However, it is important to note that these adaptations are reactionary rather than anticipatory (Gerlak, 2006); many of the source water protection programs were formed after catastrophic wildfires affected the region, after post-fire sedimentation and increased runoff caused severe damage to drinking water supplies and water providers' infrastructure (Warziniack & Thompson, 2013; Weidner & Todd, 2011). Proactive adaptive governance to reduce the vulnerability of watersheds to potential catastrophic losses would require greater investment in change detection, learning, and continuous monitoring of current fuel reduction treatment impacts, in order to implement more effective monitoring and link ecological outcomes to IWS intentions (Naeem et al., 2015). As the complexities of water resource management continue to increase, such collaborative governance approaches will likely become increasingly common, as such issues defy the ability of any one authority to address on their own, even with regulations in place (Kettl, 2015).

3.5.4. Reactionary, pragmatic and incremental government

My research shows government not only as reactionary, but also as pragmatic, and

incremental in freshwater resource governance. Government uses existing policies as a foundation for new actions, making changes incrementally, rather than wholesale transformation (Kettl, 2015). Similarly, government is pragmatic, focusing on specific water concerns, improving stakeholder engagement and program activities to transcend fragmented water policy (Gerlak, 2006, 2008). My findings also suggest that government is learning, engaging in an, "…exploratory, stepwise search process where actors experiment with innovation until they meet constraints and new boundaries" (Pahl-Wostl, 2009, p. 358) in order to understand how to react to new and different challenges. However, the time lag between learning and changes to institutional structures of government can be substantial and not result in sufficiently rapid responses in the face of abrupt change such as ecological disasters.

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CHAPTER FOUR:

FROM CATALYZING EVENT TO GOVERNANCE CHANGE: EXAMINING THE EMERGENCE OF FOREST WATERSHED PROTECTION PARTNERSHIPS IN COLORADO, USA

4.1. Introduction

In the past two decades wildfires in Colorado have gained increasing state, national, and international attention. For instance, there were over 4,000 wildfires reported in 2012 in Colorado, resulting in the destruction of 648 structures, more than 384,000 acres burned, and the death of six people (*Shortchanging our forests*, 2013). National trends in 2012 were similar, with 67,700 fires burning over 9.3 million acres (Center, 2015). Often, the official reports of fire impacts do not provide a full picture of the social, ecological and environmental damages over the years to come (*Shortchanging our forests*, 2013). For instance, major effects from fires in Colorado occur post-fire, when rain events cascade over burned areas, resulting in increased sediment in water bodies (Larsen et al., 2009). When sediment fills water storage reservoirs, the effects on drinking water infrastructure in forested watersheds can be severe (Gartner et al., 2013). These natural resource concerns are compounded as growth and development stress ecological systems further and demands for water resources increase (Scholz & Stiftel, 2005).

In response to the vulnerabilities of social and ecological systems to wildfires, decision makers have been faced with the challenge of designing policies, principles, and organizations to be effective in governing watershed protection and water resources (Busenberg, 2004; Steelman & DuMond, 2009). In Colorado between 2010-2014, new water governance partnerships emerged that involved federal agencies—primarily the U.S. Forest Service—and large, municipal water providers to address watershed risks; these partnerships are known as Watershed

Protection Partnerships (WPPs; (USFS, 2014e). Over the last several years, the number of these partnerships and the amount of funds they have leveraged both have increased, amplifying Forest Service capacity for restoration work; as a result, the agency is placing an increased emphasis on such partnerships and factoring in larger increases in partner contributions in their budget justifications and performance targets (USFS, 2014a). For the participating water providers, these partnerships are also a relatively new way to leverage resources and opportunities for land management beyond their boundaries. Although Forest Service partnerships with water providers have existed for decades (e.g., Salt Lake City, Portland Water Bureau), partnerships focused specifically on addressing catastrophic risks like wildfire have emerged more recently, primarily in the arid west (e.g., Santa Fe, New Mexico in 2009 and Flagstaff, Arizona in 2012) (Bennett & Carroll, 2014; Falk McCarthy, 2014; West, 2011, 2015). Costs for reducing such watershed risks, like forest restoration work, can be high; however recent economic analyses have found that restoring forests is more cost-effective than paying the costs associated with a severe wildfire (Mueller et al., 2013; see also Wu et al., 2011; Snider, Wood & Daugherty 2003; Berry, 2010; Gartner et al., 2013). These WPPs can also demonstrate that downstream water users, such as water providers (irrigators and urban population centers) value the watershed services they receive from upstream forested watersheds (Mueller et al., 2013; Gartner, 2013).

Developments such as the WPPs are representative of incremental institutional innovations, a form of natural resource governance change that occurs outside of more infrequent or episodic legislative or administrative policy changes (Steelman, 2010). Governance refers to the range of political, economic, social, and administrative processes in place to influence and respond to conditions in a system (Pahl-Wostl, 2009). To understand governance, I must consider the relevant institutions, or the "systems of rules, decision-making procedures, and

programs that give rise to social practices, assign roles to the participants in these practices, and guide interactions among the occupants of the relevant roles" (Gupta et al., 2010; IDGEC, 1999, p. 12). Policy, in the form of legislative statutes or administrative rules, is only one component of governance and refers to anything governments choose to do or not do (Dye, 2002). WPPs represent governance change in the form of institutional innovation, with new roles and responsibilities for government and non-governmental entities working to reduce wildfire risk to forested watersheds.

Literature from multiple disciplines explores why and how governance change occurs (Armitage et al., 2012; Berkes, 2010; Biermann & Pattberg, 2012; Boyd & Folke, 2012a; Kettl, 2015; Olsson et al., 2006; Scholz & Stiftel, 2005; Tompkins & Hurlston, 2012; Young, 2013; Young, King, & Schroeder, 2008). In the case of the WPPs, it appeared that governance change was prompted by major fire and flooding events that focused attention on the state of forested watersheds and their impact on water deliveries. In the political science literature, Multiple Streams Approach (MSA) is a framework that seeks to explain how policy change occurs and relies heavily on the importance of "focusing events," such as disasters, that lead to policy change, especially when "policy entrepreneurs" help to create "windows of opportunity" (Kingdon, 2003). In the social-ecological systems literature, scholars have noted that the combination of climate change and increased extreme weather events often make apparent the inadequacy of existing governance arrangements to address pressing natural resource challenges (Pahl-Wostl, 2009). How governance systems evolve in response to increasing ecological change is an important area of theory-building, but existing literature and empirical work in this arena is still limited (Boyd & Folke, 2012a; Pahl-Wostl, 2009).

To advance the understanding of governance innovation in the context of a complex and changing social-ecological system, I used the emergence of several Colorado WPPs as case studies. To do this, I utilized Kingdon's (2003) MSA as a "sensitizing concept" which meant it guided my inquiry and shaped my presentation of the data (Bowen, 2006). This allowed me to address my two research objectives, which were: 1) To understand the pathways and mechanisms that facilitated the creation of WPPs; and 2) To provide insights into how and why institutional innovation and change occurs in response to social-ecological challenges.

4.1.2. Case Study Context: Background on the Five Colorado Watershed Protection Partnerships

My research focused on five watershed protection partnerships (WPPs) in the state of Colorado, in the Western United States, a region in which 50% of freshwater originates in federally managed or "national" forests (Weidner & Todd, 2011). Many of the forested regions in the state are at high risk for wildfire (Warziniack & Thompson, 2013; Weidner & Todd, 2011), and/or changing rapidly due to insect-induced tree damage or mortality (Pugh & Small, 2012; Service, 2014; USFS, 2015). Colorado contains 5.26 million people, with most of the population concentrated in a relatively small portion of the state's 103,641 square miles of land (Mackun & Wilson, 2011). Eighty-three percent of the population lives along the Front Range of Colorado (DeGroen, 2012), which encompasses the area along the Interstate-25 corridor, between the cities of Fort Collins in the north and Pueblo in the south. This area also is home to the majority of the state's most recent destructive wildfires (Center, 2015). Colorado's forested lands contain a mosaic of landownership, with 67% of forested land in the state managed by federal agencies (primarily the Forest Service), and 30% privately managed by 186,000 different private landowners (CSFS, 2010). Citizens depend on surface water from snowmelt, which is stored in reservoirs. The health of the state's forested watersheds, which house the water sources

for the population, are critical to protecting water infrastructure, maintaining high water quality, and ensuring adequate supplies and storage (Garfin, Jardine, Merideth, Black, & LeRoy, 2013). Ecological threats such as wildfire and insect infestation directly affect water sources and systems by triggering rapid changes in forest characteristics that can impact hydrologic processes (Garfin et al., 2013; Pugh & Small, 2012).

Colorado now contains more voluntary WPPs addressing wildfire risk between the Forest Service and water providers than any other state in the United States (Bennett & Carroll, 2014). These WPPs started in 2010, and increased to include five of the largest municipal water providers along the state's Front Range by 2013 (2010, 2011, 2012 and two in 2013) (USFS, 2014c; 2014e; 2013a; 2013b; 2012; 2011; 2010). All the partnerships delineate their area of interest as the watersheds important for municipalities, and all of these watersheds include national forest land (see Figure 4.1).

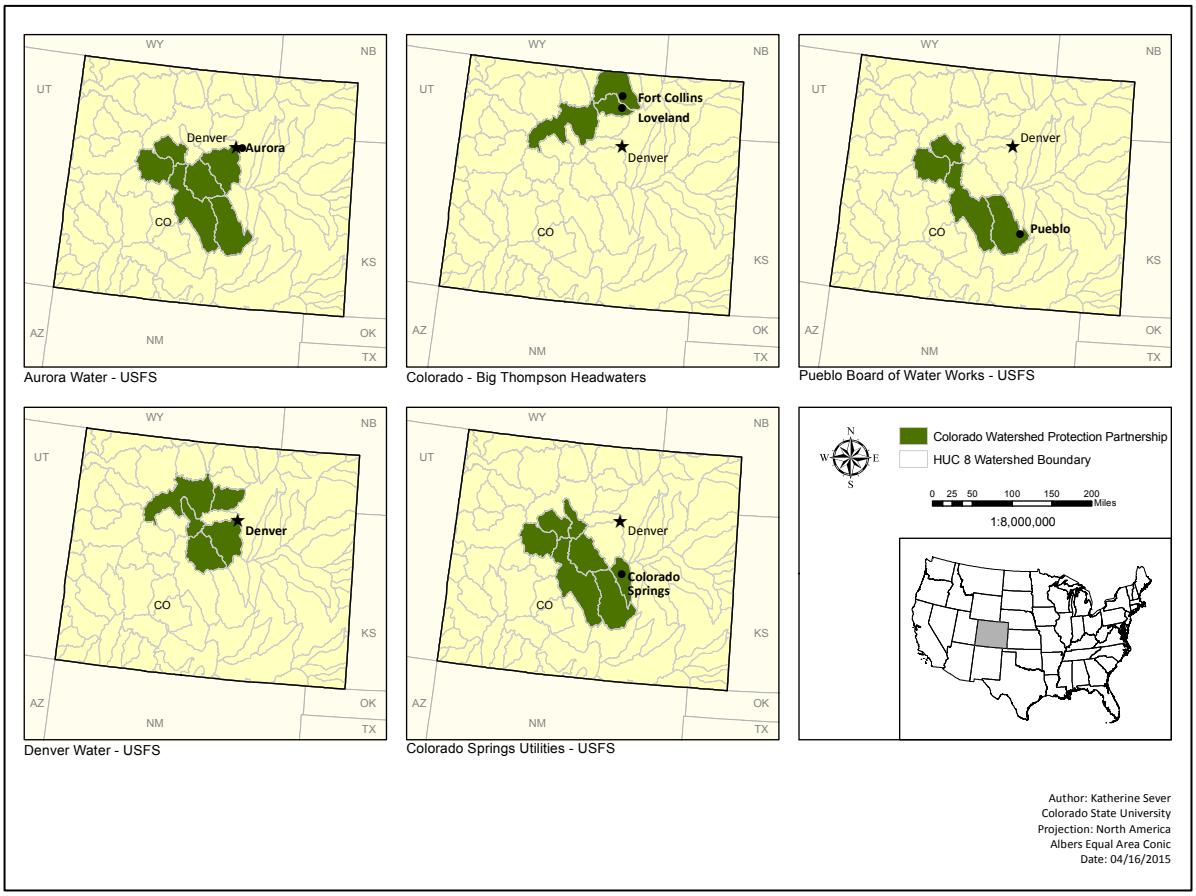

Figure 4.1: Map of case study locations within Colorado at the HUC-8 watershed scale

The Forest Service refers to the WPPs as "High Performance Partnerships," or resource-leveraging opportunities through voluntary public-private partnerships between the agency and other entities. According to the Forest Service, these partnerships are "creating strategic opportunities in water and watershed management," by increasing the size and scope of partnerships to promote watershed restoration and water quality improvement; the agency notes how this emphasizes the direct linkages between forests and water supplies (USFS, 2014b, p. iii).

All five WPPs include a Memorandum of Understanding (MOU) between the water provider and the Forest Service that serves to officially document both the partnership and a plan

for "mutually beneficial activities" (NFF & USFS, 2005, p. 31). In one WPP, the MOU includes additional partners: the Colorado State Forest Service, and Bureau of Reclamation in order to address watershed risks across the water provider's extensive infrastructure on National Forest, Bureau of Reclamation, and private lands (USFS, 2012). The MOUs are structured similarly across the WPPs, including language such as, "restoring forest and watershed health to protect….municipal water supplies and infrastructure" (USFS, 2010, 2011, 2012). These partnerships involve a water provider paying the Forest Service to conduct fuels reduction projects (i.e. projects that reduce small trees and downed woody material in order to decrease the intensity and spread of fire) in their watersheds, as well as projects to reduce potential post-fire sedimentation in their reservoirs (i.e. planting trees or other vegetation to stabilize soils and minimize runoff in post-fire rain events) (USFS, 2014e, 2014b). The Forest Service uses these investments to leverage their own work and available project funds, providing staff and administrative time and resources to conduct mutually beneficial projects.

4.1.3. Governance Change in Social-Ecological Systems

Existing theories for understanding current social-ecological changes and institutional innovation within governance often fall short of providing a complete understanding of such changes (Steelman, 2010). However, as evidence about unsustainable human-environment interactions increases, interest on how to transform social-ecological systems governance to a more sustainable path is also growing (Folke et al., 2011; Moore et al., 2014; Scheffer, 2010; Westley et al., 2013). Much of this literature has included an increased focus, by practitioners and scholars alike, on governance regimes that can better address change and uncertainty (Dietz, Ostrom, & Stern, 2003; Folke et al., 2005; Lebel, Anderies, Campbell, Folke, & Hatfield-Dodds, 2006; Olsson et al., 2006). Such adaptation and change in governance has been identified as a

critical response for governing increasingly complex social-ecological systems (Chaffin, Gosnell, & Cosens, 2014; Folke et al., 2005; Olsson et al., 2006; Pahl-Wostl, 2009). The concept of adaptive governance is prevalent across this literature, described as, "An emergent form of environmental governance that is increasingly called upon by scholars and practitioners to coordinate resource management regimes in the face of the complexity and uncertainty associated with rapid environmental change" (Chaffin et al., 2014). These new adaptive governance regimes require considerable changes from how human have traditionally governed such systems, based on policies grounded in synoptic planning, regulation, and top-down authority measures (i.e. "command-and-control") (Berkes, Colding, & Folke, 2003; Folke et al., 2005; Olsson et al., 2006). Although the literature calls for institutional innovation, and transitions towards more flexibility (Boyd & Folke, 2012), little is know empirically about how the mechanisms for such innovation come about (Moore et al., 2014).

4.1.4. Multiple Streams Approach.

Frameworks and theories on policy change may help to shed light on the process of governance change in the context of the WPPs. Policy analysis methods such as MSA are decades old, but they continue to develop in order to better understand the policymaking process and to meet decision makers' increasing need for relevant information during a time of intensified complexity (Fischer, Miller, & Sidney, 2007). I looked to Kingdon's (1984) MSA to help analyze the formation of the WPPs. MSA has been used in a variety of policy studies, most commonly to understand the U.S. federal legislative system (Birkland, 1997; Birkmann et al., 2008, 2014). Although much of the policy studies literature focuses on the national or state level, change can also occur at the regional or local level. I selected MSA to tell the story of the WPP formation and reflect on governance change, because I saw characteristics of MSA within my

collected data and therefore wanted to investigate systematically how this framework could help me to interpret these case studies.

MSA can be applied to the entire policy formation process, from agenda setting to decision making (Zahariadis, 1992). The process of agenda setting focuses on understanding how and why specific issues rise to the forefront and what solutions are attached to them (Kingdon, 2003). MSA explores why decision makers pay attention to certain issues on the agenda more than others and why a particular solution is adopted at the expense of others within a political process (Kingdon, 2003). Kingdon (2003) explains that issues and their associated solutions gain status when three "streams" converge (Birkland, 1998; 2003). The *problem stream* includes the components and conditions of a problem. The *policy stream* "contains the potential solutions to a problem" (Birkland, 2005, p. 180). The *political stream* includes national mood, the state of politics, and shifts in interest group pressure; this stream influences people's receptiveness to particular solutions at any given point in time (Cairney, 2012; Kingdon, 2003). These three streams typically operate independently of one another, are affected by different forces, and involve different actors (Kingdon, 2003).

Policy change occurs during "windows of opportunity" when the three streams come together as a result of a *focusing event* or the activities of a *policy entrepreneur* (Birkland, 2005; Kingdon, 2003). A focusing event changes how people understand a problem and moves the problem up the agenda (Birkland, 2004). Birkland defines a potential focusing event as one that is:

> [S]udden, relatively rare, [and] can be reasonably defined as harmful or revealing the possibility of potentially greater future harms, inflicts harm or suggests potential harms that are or could be concentrated on a definable geographical area or community of interest, and that is know to policy makers and the public virtually simultaneously (1997, p. 22).

Policy entrepreneurs are individuals or groups of individuals from a variety of governmental, research, and nongovernmental sectors that create, advocate for, or block policy change (Huitema, Lebel, & Meijerink, 2011; Kingdon, 2003). These entrepreneurs can be a variety of actors, including politicians, interest group leaders, decision-makers, and/or unofficial representatives of an issue. Their main role as a policy entrepreneur is to sell decision makers on their proposed policy responses, acting as "agents of change"(Carter & Jacobs, 2014, p. 125; Kingdon, 2003; Mintrom & Vergari, 1996). Policy entrepreneurs use focusing events or policy debates to their advantage, linking their pre-formed solutions or political strategies to a problem (Howlett, 1998). These individuals typically have solutions in hand, waiting for the right issue to emerge to which they can attach their solutions (Kingdon, 1984). In this way, policy entrepreneurs can couple previously separate streams; as Kingdon explains, "They hook solutions to problems, proposals to political momentum, and political events to policy problems" (2003, p. 182).

Windows of opportunity result from the convergence of the three streams, open infrequently, and can occur predictably (e.g. renewals or a budget cycle) or unpredictably (e.g. crisis) (Kingdon, 2003). The theory suggests that windows do not stay open long, typically for only a number of months, and can close for a variety of reasons, such as participants feeling as through the issue is addressed, the precipitating crisis passing, or personnel changing (Kingdon, 2003). Sometimes the appearance of a window can create a "spillover," which occurs when an open window leads to policy change that then establishes a principle that can influence future decision-making within similar policy arenas (Kingdon, 2003). In the end, these windows of opportunity can lead to a variety of outcomes. In effect, the result can be a range of outcomes, from no policy change whatsoever to substantive policy change or innovation (Birkland, 2004;

Kingdon, 2003). I use the literature on MSA policy processes as a sensitizing concept to guide my inquiry of the WPPs rather than propositions to test empirically.

4.2. Methods

4.2.1. Case Selection

This study used a qualitative case study approach, with a single WPP service as a case, focusing on the five WPPs in the state of Colorado, formed between 2010 and 2013. A case study refers to the study of a social phenomena or specific topic, which can be based on one or multiple cases, each of which involve one to many interacting actors (Yin, 2003). I use a multiple case study approach, studying five cases each with a number of interacting actors and organizations. Case study research provides an opportunity to research events in context and depth; its weakness may be limited generalizability and the possibility of selection bias (Yin, 2003). Recent quantitative survey-based research identified ten partnerships in the western United States between water providers, federal land management agencies and in some cases, other nongovernmental or local entities, aimed at watershed protection and/or risk reduction (see Huber-Stearns, et al., in review; Bennett & Carroll, 2014). Of these identified partnerships, seven are located in the arid west (Colorado, New Mexico, and Arizona) and focused specifically on addressing wildfire. I selected the five case studies in Colorado because, although each WPP is unique based on its exact geographic location, infrastructure, and water provider structure and personnel, comparisons and themes can be drawn from across these cases from the several factors they have in common. Specifically, these WPPs: operate in the same Forest Service region, often in overlapping national forests; share the primary purpose of reducing watershed risk from wildfire and insect infestation threats; and contain staff on both the land manager and water provider sides that are engaged in similar learning and action networks focused on

ecological threats to forested watersheds. I did not include as a case study the sixth and most recent WPP in Colorado, which was formalized in late 2014 after this research was completed (USFS, 2014d).

4.2.2 Data Collection

My case studies relied on 1) review of publically available documents from each WPP and 2) semi-structured interviewees with WPP participants. I identified interviewees using a purposeful sampling strategy, which involves selecting interviewees for study based on their role and involvement with the WPPs and likely ability to provide information on the topics in question (Patton, 2002). I included in my sample all the main contacts within each partnership from each participating organization. This typically included one lead contact from each organization that was tasked with being the main organization representative in the WPP. In cases where I interviewed more than one main person per organization, it was because the selected individuals represented distinctly different regions and/or scales within their organization. Some interviewees, particularly in the Forest Service worked on more than one partnership, due to water providers' overlapping source watersheds that crossed multiple national forests. Others were individuals who helped develop the WPPs but are no longer employed in their previous position. During these interviews with main contacts, I identified through snowball sampling additional potential interviewees directly related to the WPPs (Patton, 2002). I continued to add interviewees to my sample until I had contacted all pertinent, identified individuals and I began consistently receiving similar results from interviewees, approaching information saturation (Patton, 2002).

In total, I identified 32 potential interviews and removed two because of a lack of direct connection to the partnerships; the remaining four potential interviewees were either unable or

unwilling to participate in an interview. Therefore, I interviewed 26 individuals directly involved in the formation and/or ongoing operation of the partnerships, all noted as key contacts for their organization's role in the partnerships. The final interview sample included at least one contact from each organization involved in a partnership. This resulted in interviews with individuals representing thirteen different organizations: five water providers, four government agencies (3 federal, 1 state entity), two nongovernmental organizations, and two private entities (private consultant and a private landowner) (see Table 4.1 for details).

Table 4.1. Number of interviews by organization type

Organization	Number of Interviews[1]	
		Level:
Federal agency	**15**	Federal: 2
		Regional: 5
		National Forest: 4
		District: 4
State agency	**2**	
Water provider	**5**	
Private	**2**	
Nongovernmental organization	**2**	

1 Total interview n=26

I conducted semi-structured interviews, which involve an interview guide, but allow for flexibility to explore topics as they arise and for respondents to focus on aspects of the questions that are most relevant to them (Charmaz, 1991). My questions were designed to investigate the history and stories of the partnerships, major precipitating events or other social, ecological and/or political drivers that lead to creating partnerships, key people and organizations that initiated and facilitated the work, successes and challenges so far, opportunities for future developments, and any changes that occurred within partner organizations due to their WPP participation. Interviews were confidential, and based on interviewee preference, were either

recorded (n=19) or documented via detailed notes (n=7). I transcribed and analyzed data from each interview using the qualitative data analysis software NVivo 10 for Mac (QSR International, 2014).

4.2.3. Analytical Approach

My process tracing method (Tansey, 2007) allowed me to use interviews to uncovering and analyzing the events, people, processes, and decision points that led to the formation of WPPs. Process tracing is helpful for "exploring casual processes and analyzing complex decision-making" (p. 1), particularly when used in non-probability sampling approaches, such as I employed (Tansey, 2007). Process tracing offered me an empirical window into institutional innovation and change.

I used a modified ground theory approach to review data and code for themes via an open-coding methodology (Strauss & Corbin, 1990). I modified ground theory by approaching the interviews with a set of attributes to look for and questions to ask (my interview guide), instead of approaching the phenomena without any preconceived notion of what to examine. The MSA attributes of windows of opportunity, politics, policy and problem streams and entrepreneurs all guided my resulting case study data as sensitizing concepts (Bowen, 2006), as I did not hypothesize a priori about how these concepts influenced the WPP creation. Rather, I used the theory as a lens to guide and organize my collected data, in order to understand how different political, policy and ecological factors came together to form the partnerships. Specifically, I applied MSA to understand WPP formation as a process, but not to predict outcomes (Ostrom, 1999).

My original codes were closely related to the main interview questions asked, and I created new codes when new themes emerged from the data (Strauss & Corbin, 1990). This was

an iterative process focused on identifying concepts within the text to then link to theoretical models (Glaser & Strauss, 1967; Strauss & Corbin, 2008). I used both the coding process and summary reports of findings, which I organized by partnership and by organization type to analyze data. In reporting my results, I identify the interviewee only by their organization type (i.e. federal agency, water provider, nongovernmental organization) to preserve confidentiality.

4.3. Results

4.3.1. Focusing Events and their influence on the Problem Stream

Respondents suggested that fires were a significant focusing event that precipitated the formation of the WPPs. Although Colorado has a history of wildfires, the frequency, intensity and resulting damage from such wildfires has increased notably over the past two decades. Interviewees cited the unpredictability and potential for high damages from wildfires as major concerns facing the region, and noted that this shift towards more frequent and destructive fires began in 1996 and 2002 with the Buffalo Creek and Hayman fires in the South Platte watershed. This watershed is critical to Denver Water, the largest water provider in the state; supplying about half and moving 80% of their water via diversions from the Colorado River Basin across the Continental Divide. These two fires resulted in 1 million cubic yards (equivalent to forty years worth) of sediment deposition in Strontia Springs Reservoir. Interviewees explained that impacts of these fires, both in terms of ecological recovery on the forest and sedimentation impacts to water supply and storage, are still being addressed over a decade later.

Interviewees also cited the record-breaking, catastrophic wildfires of 2012 as re-igniting awareness of wildfire and its impacts in the state. The High Park Fire in Northern Colorado occurred in close proximity to Northern Water Conservancy District's Colorado-Big Thompson trans-mountain water diversion, which supplies over 800,000 people in the Front Range of

Colorado. Interviewees operating in the more southern portion of the state described the 2012 Waldo Canyon Fire in 2012 and the subsequent and even more destructive 2013 Black Forest Fire in the same area, their backyards as reinforcing the urgent need to address both post wildfire response and plan for fire risk reduction and prevention.

All interviewees noted at least one of these fires as a focusing event contributing to their participation in a WPP. All of the partners involved in the first two WPPs (established in 2010 and 2011) noted that the fires and sedimentation of Strontia Springs, which provides portions of both their water supplies, led to the formation of their WPPs. For instance, one water provider explained their motivation for joining a WPP after the 2002 events this way: "[I] understand fully that catastrophic wildfire will have a huge impact to our water system...[and] that it's better to do things up in the natural watershed than to treat water at a treatment plant with chemicals, because it is more costly." A federal agency employee explained this situation this way:

> These two fires were a wake-up call to Denver that they needed to be in the watershed business, not just the water storage and delivery business…This precipitating event, particularly the impacts on Strontia Springs served as a rallying cry for water providers throughout the Front Range with everyone wanting to "prevent another Strontia Springs.

Interviewees in the more recent (2012-2013) partnerships credited the 2012 and 2013 fires as additional motivation to create formal partnerships and begin addressing watershed health more systematically across land types. One water provider explained:

> The High Park Fire that occurred in 2012 was a pretty big eye opener as to the magnitude and the vulnerabilities that our project has for large scale wildfires…right after that fire that we realized that we need to do something a little more proactively to address some of the watershed and forest health issues that we have.

Another water provider noted that these 2012 and 2013 fires precipitated a six-fold increase in their forest management budget, thus increasing their capacity to partner and conduct more work in the forests.

4.3.2 Activity in the Policy Stream: Framing the problem and identifying a solution

Activity in the policy stream, according to interviews, involved collaborative learning and coordination among state and federal agencies, water providers, conservation organizations and other land managers concerning potential solutions to wildfire concerns. This involved developing a collective understanding of the risks to key watersheds, building networks between organizations to share knowledge, and overcoming policy gaps. Interviewees said the fires instigated in this community of stakeholders a renewed understanding of the need to collaborate and assess how they could work together to reduce wildfire and associated watershed risks. In response to the 2002 fire season, federal and state agencies, conservation organizations, and water providers formed the Front Range Fuels Treatment Partnership (FRFTP) to serve this purpose (FRFTP, 2014). The FRFTP funded an assessment report, conducted by a third party, which concluded that climate factors and forest conditions placed Front Range source watersheds at high risk from severe wildfires that threaten water supplies and the integrity of reservoirs (Le Master, Shao, & Donnay, 2007). This report comprised a first framing factor emerging from the report, as it provided the necessary credibility and legitimacy for pursuing an immediate, new course of action, specifically a justification that new approaches were needed. Interviewees involved in this process credited this report as the impetus for the Front Range Watershed Wildfire Protection Working Group (WWPG), formed to collaboratively develop and implement a strategy to protect critical Front Range watersheds from high-severity wildfires (http://www.jw-associates.org/wwpg.html). The work of the WWPG provided a standard

methodology for prioritizing and locating hazardous fuel treatment projects in municipal watersheds (Associates, 2009).

This collaborative work and assessment process allowed participants to frame the problem, which facilitated the identification and prioritization of potential management solutions and policy options. Areas of high risk, or "zones of concern," helped those in the WWPG understand where the biggest risks were located and potential management actions to address such concerns. A large portion of the zones of concern were located on national forest land that housed water sources and/or infrastructure (e.g. water pipes, reservoirs, treatment plants) for major water providers, thus initiating conversations about how to accomplish work on various land jurisdictions, particularly federally managed lands, to address collective concerns about wildfire and insect infestation impacts to forests and water supplies. As interviewees noted, most areas of highest risk to water providers' systems were outside of their direct control, which made partnering with federal agencies critical. A key focus and challenge, according to interviewees, was to create such policies that were more proactive about costs to water infrastructure and less reactive to the effects of fire and sediment flow.

The idea of avoided costs comprised a second framing factor emerging from the interviewees, who noted that the costs of conducting forest treatments to reduce wildfire risk would likely be less than the costs of dealing with post-fire source water and infrastructure damage. Both federal agency and water provider interviewees frequently cited the $26 million Denver spent on water quality, reclamation, and restoration treatments in the South Platte Watershed and sediment dredging to restore functionality in Strontia Springs Reservoir since the fires. Interviewees explained this framing of "preventing another Strontia Springs" as a way for

water providers to convince their board and decision-making bodies that investment in reducing watershed risks would be cheaper than dealing with fire suppression and post-fire response.

The policy solution of partnerships, according to interviews, was essential to address shared interests around watershed risks by collaborating and leveraging resources to work across land jurisdictions. It was the outgrowth of these collaborative learning partnerships, the third framing factor of shared risk, and the need for cross-jurisdictional coordination and action that led to the formation of the WPPs. For example, a federal agency employee said, "[T]ogether we are all better off if we talk and share information, data, money, help leverage non-federal funding." Water provider employees explained this leveraging of resources to address shared risks as a way to financially motivate the Forest Service to conduct more fuels and sedimentation treatments in high priority areas, treating more acres faster with the influx of additional funds. This solution of WPPs was both a reactive and proactive approach, containing plans for addressing post-fire restoration and potential sedimentation concerns, as well as treating acres with the highest levels of potential wildfire risk and/or infrastructure damage.

4.3.3. The Role of Policy Entrepreneurs: Changing the Politics Stream to further open the Window of Opportunity

Armed with this policy solution of water provider-federal agency partnerships to increase forested watershed treatments, the challenge in the politics stream was to create a political environment supportive of the identified policy solution. This was the role of policy entrepreneurs in these case studies: to make the identified policy solutions a reality. Policy entrepreneurs emerged in the form of key leadership from a federal agency, the federal government, and a major water provider in the state. A number of interviewees noted that key individuals worked to advocate for policy solutions across scales, to create national-level

political support, reallocate funds within the Forest Service region to support the early WPPs, and in one case, to act as a willing water provider to invest in a partnership with a federal agency. Interviewees involved in the processes identified specific federal agency leaders at the national and regional level, and one major water provider as key to the formation of the WPPs. Interviewees also noted that these individuals built local and regional support by traveling around the state and the Western United States more broadly, attending water meetings, and talking to water providers about the need to partner to address watershed issues on public lands.

A regional-level federal agency interviewee explained the role of one of these key individuals at the national level this way:

> We had a political appointee who was very interested in this issue and this was his personal mission. He was the one who set the idea in motion and asked the agency, "Please make this happen with [a water provider]." That was the moment of political opportunity, but also the subsequent work [he did] with the utilities. Because without that pressure, because it was already so different and new to be dealing with [a water provider], if we hadn't had political pressure within the agency to continue developing partnerships, that wouldn't have happened. The vision that he lined out was simply for us to form an agreement. Once we did that, then the next goal was to see if we could get all of the major utilities on the Front Range working with us in similar partnerships. He personally helped to make phone calls to each utility program CEO or manager to say, 'We would like you to entertain this idea.'

This political appointee had a specific interest in Colorado, due to his personal and professional connections in the state. Interviewees noted how this appointee worked with his established contacts to pursue WPP formation, both with regional federal agency contacts and water providers. The role of another key individual, at the regional level, was described this way:

> [The political appointee] garnered support from the state, showed up at water conferences across the western U.S., and worked with and tailored messages to water providers for avoided costs, power companies for protecting transmission lines in the forest, the Bureau of Reclamation for infrastructure and energy production security, and National Forests to "secure favorable conditions of water flows" per the Organic Administration Act of 1897.

Interviewees across organizations noted that the WPPs would require organizational changes for federal agencies and water providers. Interviewees noted how transitions for the partnerships took time and effort to develop within their respective organizations. Interviewees from water providers explained this as having to convince governing convincing boards and executive decision-makers to invest in partnerships, effectively directing management on lands other than their own. In particular, creating the first WPP involved required significant work for the one policy entrepreneur within the water provider, due to both the approach being so different than anything the water provider had done before, and the large amount of the partnership investment. Interviewees explained that this type of partnership was new, and without any successful examples to point to, getting decision makers on board for a somewhat experimental approach was challenging. Agency interviewees described how funding for specific management practices redirected staff tasks and priorities, adding additional workloads on limited staff already working at capacity. Federal partners were not used to conducting projects funded by and co-developed with water providers; in some cases, these partnerships would change the location, timing and/or type of land management actions conducted in national forests. Federal partners, especially the Forest Service, also had to increase staff and administrative capacity to coordinate partnerships, both at the regional level, and within some field-level administrative units. The creation of a supportive political environment at the national level and directives to make such changes at the regional level, both instigated by the actions of policy entrepreneurs, motivated these transitions within the agency.

Notably, these changes did not require formal policy change, but, rather, a change in the institutional arrangement between the Forest Service and partners. Water providers also had to reorient their way of doing business (e.g., administrative processes, staff time), by investing

money in lands that were not under their ownership and control. Interviewees employed by water providers noted that their boards or decision-making bodies directly asked them to prioritize these partnership or reallocation funding towards the WPPs. Water provider interviewees also noted the political pressure they felt from the national level to formalize a partnership with the Forest Service; they attributed this to the activities of policy entrepreneurs at the national and regional level, who contacted them directly to advocate for the WPP policy solution. Similarly, interviewees also credited individuals from the water providers engaged in the earliest WPPs as encouraging other water providers to follow suit, which they did in the WPPs that formed in later years, such as the 2012 and 2013 WPPs. Participants in these WPPs said people engaged in the earlier WPPs encouraged them to utilize this model, both directly and by demonstrating the benefits of engaging in such partnerships through their WPP models.

These changes, including a reorganization of priorities, changes to decision-making procedures, and new roles and responsibilities for involved parties, required time for adjustment, learning, overcoming resistance within organizations, and relationship-building prior to the formalization of WPPs. Interviewees noted the amount of time required for building support for partnerships, both between and within organizations' administrative processes and bureaucratic structures, and across scales. One interviewee at the Forest Service district level explained it this way,

> There's always a political build up before [partnerships] surface, so my sense is that these partners are engaging in a much higher level probably than even the regional forester before it trickles down and becomes my next emergency to get done. It is important for folks to take time to develop a common understanding, [because] everyone speaks their own language.

Interviewees, particularly within agencies at the Forest or District scale, noted an additional complexity of these partnerships was their development at the national and regional levels, which

then had to trickle down to more local levels in charge of interpreting what these visions could look like in terms of feasible actions on the ground. These same interviewees and others at the Regional level noted that changes to address these issues across agency levels were already underway, including improved coordination in developing partnership agreements and annual work plans.

The role of policy entrepreneurs in my case studies appeared to be in promoting the WPPs as a policy solution and making it politically feasible. This occurred once collaborations (e.g. the WWPG) had formed and the involved parties had identified a viable policy solution. In summary, these individuals were able to use the framing and proposed solution created by stakeholders engaged in collaborative learning to build sufficient political support across scales and make the WPPs a viable reality.

4.4. Discussion

I explored the pathways and mechanisms that facilitated the creation of Watershed Protection Partnerships, specifically examining the influence of key events and actors. MSA informed my analysis by highlighting the importance of focusing events in creating opportunities to align the political, problem and policy streams; allowing me to understand later fires and WPPs as accompanying events and spillovers; and drawing my attention to the actions of policy entrepreneurs. The process described herein represents a new mode of governing a social-ecological system, expanding beyond traditional command-and-control approaches through enacting changes in rules, processes and actor roles at the local and regional scales (Folke et al., 2005; Kettl, 2015; Olsson et al., 2006). This new mode of governance includes a focus on incentives, and potential cost avoidance in the form of future wildfires affecting water supply systems. The details of how governance systems change is critical; however, existing literature

on these areas is still limited (Boyd & Folke, 2012a; Pahl-Wostl, 2009). Therefore, I discuss the implications of my findings for updating MSA to fit today's complex governance context and to contribute to the currently limited bridging of theories from political science and the social-ecological systems literature (Hatfield-Dodds, Nelson, & Cook, 2007).

4.4.1. Explaining WPP formation

As MSA predicts, the focusing events of fires were important for bringing attention to the governance problem of addressing wildlife risk in municipal watersheds and for highlighting the need for a new policy solution that was cost-effective in the face of potential wildfire damage. Stakeholders found the solution through coalition formation and collaborative learning to frame the problem and find ways to address watershed risks across administrative boundaries and leverage funding. WPPs also were an economically appealing and politically acceptable solution that could be conducted without legislative change, which likely would have been more difficult and time-consuming to accomplish.

As MSA explains, greater awareness of a problem often occurs with second crises, because original focusing events may be considered anomalous (Kingdon, 2003). My data suggest the 2012-2013 fires led to a "spillover," which occurs when policy solutions identified in response to earlier crises are then adopted repeatedly (Kingdon, 2003). Once a new policy principle is created, decision-making in that arena is never the same, and it "becomes as difficult to reverse the new direction as it was to change the old" (Kingdon, 2003, p.191). This played out in my case studies, with the almost immediate formation of more WPPs in response to the 2012-2013 fires, largely attributable to the original focusing event that established the principle of partnerships to address risk.

Policy entrepreneurs in my case studies were critical for attaching policy solutions to the identified problems and building political support for those solutions. Local coalitions identified a new and feasible solution, which gave policy entrepreneurs at the regional and national scales a strategy to pursue in order to affect change within the realm of watershed governance; other researchers have found policy entrepreneurs to play a similarly important role in water resources issues (Font & Subirats, 2010; Huitema et al., 2011; Huitema & Meijerink, 2010). Policy entrepreneurs worked as "agents of change," selling decision makers on the proposed policy responses of WPPs (Carter & Jacobs, 2014, p. 125; Kingdon, 2003; Mintrom & Vergari, 1996; Steelman, 2010) and using the wildfire problem and cost avoidance strategy to create political support (Howlett, 1998; Huitema et al., 2011; Kingdon, 2003). The roles of these individuals and their networks were critical to the WPP formation.

4.4.2. Adjusting MSA: From policy change to governance innovation

There were several aspects of my case studies that did not conform with my sensitizing concept of MSA. As I have noted, the WPPs involve a recombination of existing ideas to forge novel solutions and partnerships. This includes new decision-making procedures, roles and shared responsibilities for actors both inside and outside of the federal government. All of these changes constitute governance innovation. Therefore, based on my empirical work I suggest adjustments to MSA for consideration in the context of complex, social-ecological governance challenges.

Although windows of opportunity may be brief in the context of national legislative agendas per Kingdon (2003), my work suggests windows can stay open much longer when local actors are learning and working collaboratively to identify and implement solutions, as actors did after the 2002 fire in my case. I found, as other researchers have noted, that the MSA streams

provided useful analytical categories, but the window of opportunity component might be better applied as a metaphor for "capturing the sense of opportunity that must exist in order for policies to be enacted" than as a specific window with clearly defined openings and closings (Stout & Stevens, 2000, p. 353).

Furthermore, unlike what MSA describes, policy entrepreneurs in this context were not "waiting in the wings" to attach their preformed solutions to the right problem and/or politics stream. They navigated frictions within and between organizations to develop partnerships, overcoming internal resistance, uncertainty, and capacity concerns, and pulling the streams together to take advantage of the window of opportunity for transition presented by the wildfires. These types of decision-making processes are often more complicated that MSA indicates; the structure and culture of organizations (e.g. individual member involvement and direction) can affect policy entrepreneurs' willingness to link solutions to problems (Boscarino, 2009). The policy entrepreneurs were critical in my cases to developing relationships, building capacity between organizations, making the economic case for the potential benefits of wildfire risk reduction, and working across various levels of governance, characteristics that previous research has noted as important in the context of watershed governance (Boyd & Folke, 2012; Koontz & Newig, 2014). The unpredictability of disasters means that decision makers are increasingly confronted with governance challenges to which they do not necessarily have a pre-formed response, or an appropriate solution floating in the "policy primeval soup" (Kingdon, 2003). Therefore, in the context of current environmental governance, the role of policy entrepreneurs may be more one of holding open windows of opportunity as they create the political support at multiple scales necessary to facilitate local and collaboratively identified governance innovations.

The focusing events of 1996 and 2002 were an opportunity that did not facilitate a merging of streams, but, rather, created shared awareness of a social-ecological issue and space for stakeholders to collectively identify potential effective and efficient ways forward, and for policy entrepreneurs to eventually pull the streams together. Unlike perhaps other policy problems, where the policy intervention to a social problem is clear or bounded, the unpredictability and uncertainty in complex social-ecological systems makes defining any single solution a challenge. Society increasingly is confronting such problems in the 21st century-those that require an immediate solution to a complex or new problem, but are beyond any one agency's responsibility or leverage to solve alone (Kettl, 2015). As Kettl (2015) explains, government agencies are increasingly unable to solve, control or manage such problems on their own, and sometimes can only contribute to framing a response. Furthermore, the cross-jurisdictional nature of ecological issues such as fires and floods (Landres et al., 1998) makes multi-jurisdictional involvement critical for addressing such concerns. In this case, there was clearly a political pressure to "do something, anything" to address wildfire risks to water supplies, tackling both federal agency land management and water provider source protection concerns. However, the solution was not immediately evident to partners; rather, the focusing events highlighted the need to seek innovative and potentially economically efficient solutions.

These changes in how key individuals and organizations prepare a system for change, recognize windows of political, ecological, social and economic opportunity, and develop strategies to meet increasing social-ecological complexity are becoming both necessary and more common, according to the environmental governance scholarship (e.g. Armitage, 2012; Berkes, 2010; Chaffin et al., 2014; Moore et al., 2014; Olsson et al., 2006). As human societies confront increasingly complex, uncertain and changing environmental problems (Crona & Parker, 2012;

Ludwig, 2001; Rockstrom et al., 2009), they will need time and space to develop an improved understanding of how to address such novel problems (Boyd & Folke, 2012a). My work, based on empirical observations in current governance contexts, can contribute to this broader conversation regarding governance changes in social-ecological systems (Boyd & Folke, 2012a; Folke et al., 2005; Olsson et al., 2006). Traditional management approaches are likely to be inadequate (Gallaher et al., 2013; Kettl, 2015; Wayburn & Chiono, 2010) as they were in my research. Additionally, my work suggests that MSA should explicitly consider the space and time needed for learning, coalition formation, and other innovations; it also must account for the time and effort of policy entrepreneurs working across governance scales to bridge the politics and policy streams.

4.4.3. Fitting adaptive governance and public policy within today's social-ecological context

Theories explaining policy change and relationships between variables in governance arenas should adjust to the changing scope and complexity of issues facing society (Koontz, Gupta, Mudliar, & Ranjan, 2015; Ostrom, 2005). Traditional theories of public administration, founded on hierarchy and authority, can fall short of offering adequate solutions for many of the complex problems we currently face (Kettl, 2015). Public policy as a discipline is constantly evolving, in order to better understand the complexities and roles of institutions, actors, and information in order to improve policy theory (Anderies & Janssen, 2013; Eissler, Russell, & Jones, 2014). The current trend is to expand traditional policy studies research (Eissler et al., 2014; Kettl, 2015) to link dynamic social-ecological and policy contexts with improved theories to better inform the policy process (Anderies & Janssen, 2013). For instance, recent expansion in agenda-setting work has led to greater research on novel institutions and contexts, focusing less on studying top-down federal government policies, and moving more towards examining

bottom-up state processes (Eissler et al., 2014). Incorporating considerations of social-ecological systems into public policy has the potential to aid public policy in addressing uncertainty and change, improving awareness of policy vulnerabilities and robustness, and making public policy theories relevant in the context of not just policy change, but also broader changes in environmental governance (Anderies & Janssen, 2013).

Given that global environmental change is occurring faster than any other point in history (Boyd & Folke, 2012a), I therefore suggest future research more explicitly consider how adaptation in governance can be bridged with public policy literature. The concept of adaptive governance can provide a complementary lens through which to analyze a broader suite of factors potentially affecting policy solutions (Hatfield-Dodds et al., 2007). Such integration of concepts could add value to work increasingly occurring at the nexus of adaptive governance, policy, and economics, and facilitate increased exchange between scholars of different disciplines. Idea sharing and learning in more interdisciplinary environments could reduce the extent to which scholars "talk past each other" (Cairney, 2013, p. 8; Poteete, Janssen, & Ostrom, 2010). Additional empirical research, like the case studies presented herein, will serve to build understanding of how adaptive governance approaches develop and what novel factors and circumstances should be incorporated into existing policy theory to understand our new complex social-ecological world.

4.5. Conclusion

Such cases of sudden, catastrophic events affording the opportunity for institutional change are not typical; in most cases, built systems are in places that allow people to live in and manage highly vulnerable conditions, such as hurricane or drought-prone areas. In other cases, institutions have already prohibited or placed a high cost on living in such vulnerable conditions

(e.g. floodplains). For water managers, the ability to collect sufficient revenue to pay for not only managing and maintaining their built infrastructure and capital spending, but to also invest in natural infrastructure can be a daunting task (Zetland, 2012). These types of catastrophic events can demonstrate the importance of managing for water resources more broadly, and carefully considering existing and potential risk management and performance adjustment approaches needed for long-term water supplies in vulnerable ecological conditions (Gartner et al., 2013; Zetland, 2012). This framing of a long-term investment in natural infrastructure might help water providers and land managers alike move from reactive crisis management to more proactive long-term planning for securing water supplies in a time of intensifying natural resource changes.

In my discussion, I posited that it takes the actions of policy entrepreneurs to align the political and policy streams through their leveraging power in order to craft policy solutions to vulnerability and resilience issues of social-ecological systems. However, these actions might only be temporary, in the face of long-standing institutions. Institutional innovations in governance such as the WPP creation can either establish practices and principles that will endure over time, or exist as temporary innovations (Steelman, 2010). The relative newness of the partnerships means that the innovation's permanence is unknown; sufficient information about the effectiveness of the partnerships will take years to collect. Additionally, the five-year limit on formal partnership agreements with federal agencies might prove a hurdle to water providers planning long-term. How watershed protection partners navigate these transitions and assess program effectiveness will directly influence the durability of this new trajectory for addressing wildfire risk in forested watersheds.

An unanswered question is if new arrangements such as WPPs will actually alter society's vulnerability, fostering the appropriate work and level of funding to avoid potential

future ecological risks. Similarly, understanding what implications such innovations hold for federal agency mandates, funding, and directives over the long-term is something only future longitudinal research could answer. Knowledge and learning have key roles to play in fostering adaptive institutions and equipping actors to better respond to environmental feedback (Koontz et al., 2015). Additionally, ecological triggers for change, such as catastrophic wildfire, can provide new opportunities for actors to affect change (Moore et al., 2014; Riddell, Tjörnbo, & Westley, 2012). Such changes are reflective of research showing how disaster can create a space in which potentially major social, environmental, and political changes can occur (Birkland, 2004, 1997; Birkmann et al., 2008; IRP, 2007; UNISDR, 2007; Wisner, Blaikie, Cannon, & Davis, 2004).

Although the story of Colorado WPP formation is subject to the specific political, ecological and social context of the time, I draw parallels between characteristics of these cases and other parts of the arid western United States, particularly New Mexico, and Arizona, where similar WPPs on federally managed lands were also developed following major wildfires, in order to address risk and invest in risk avoidance strategies (Bennett & Carroll, 2014; Falk McCarthy, 2014; Gartner et al., 2013). These programs involve new partnerships that leverage funding to improve forest health in the face of changing climatic conditions (Falk McCarthy, 2014), demonstrating both a rise of governance innovations and opportunities for further longitudinal research.

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CHAPTER FIVE: CONCLUSION

IWS AS A NEW ARENA OF ENVIRONMENTAL GOVERNANCE IN THE WESTERN US

The overarching focus of my dissertation is an examination of evolving governance of freshwater social-ecological systems in the western US. I investigated: 1) what this arena looks like and how it is unfolding across the region; 2) factors influencing its recent and significant growth; and 3) how this form of governance differs from traditional water resource governance in the region. Here I provide answers to these research questions, showing how my three selected analytical lenses were helpful in conducting an institutional analysis of IWS, exploring the changing roles of government regulations and actors, and illustrating how political, economic, policy and ecological motivations led to the recent growth in voluntary IWS. I also discuss insights gained during my analytical study, and considerations for future longitudinal research. This research provides new insights for future water resource management within the region and more broadly, informs understanding of IWS as a governance arena in complex social-ecological systems.

5.1. An Institutional Analysis of the IWS Landscape in the Western US

I analyzed the institutional dimensions of 41 active IWS programs in the western US in 2012, which facilitated comparison across programs to inform IWS (and PES more broadly) research and practice. Cluster analysis identified four main groupings around buyer types and management actions. My results highlight the important interactions between overarching regional factors (e.g., federal policies, water rights) and diverse local conditions (e.g., land ownership, resource challenges) in shaping the institutional structure of individual PWS programs. A key gap remains collecting robust information on PWS performance. As such, this

work provides a baseline for future longitudinal institutional analysis to link program structure and performance to inform PWS research and practice.

IWS is not a neutral institution; how it operates depends directly on the institutional context within which it is situated, which is supported by our results and a growing body of literature (Muñoz Escobar et al., 2013; Muradian & Rival, 2012; Sattler & Matzdorf, 2013; Vatn, 2010). Although shifts are occurring away from government actors as the most important decision makers within environmental governance broadly (Armitage et al., 2012), government presence in IWS is still prevalent, particularly in federal and state regulations and policies, and as direct program participants (Muradian et al., 2013; Scarlett & Boyd, 2011). In some cases, IWS can provide alternative approaches to meeting existing government regulations through leveraging new financing mechanisms and collaboration across sectors (Sattler & Matzdorf, 2013; Scarlett & Boyd, 2011; Schomers et al., 2015). Geographic context is key to shaping program administrative components, including land ownership, actor types, and management actions. The presence of individual private landowners as compared to public land participants in programs is a geographic match for relative proportions of public versus private land ownership in the region.

5.2. The Changing Role of Government in IWS

My analysis of government influence within the 48 identified IWS in the western US in 2014 found some form of government presence in all programs: across scale, in both voluntary and regulatory participation contexts, and across water quantity, quality and source water protection concerns. This includes federal regulations driving early water quality management efforts, state legislation (and to some degree participation) addressing water quantity concerns,

local government tackling specific water quality and source water protection concerns, and finally, federal agencies partnering in local efforts to reduce watershed risks.

The changes illustrated in the role of government in IWS in the region are not about the government shifting from one position to another, rather, these changes demonstrate how the government is expanding its roles and responsibilities, moving beyond historic command and control roles to support and facilitate programs. This is largely attributable to an increasing recognition that issues such as water quality, quantity and protection go beyond the ability of any on actor or solution to address alone (Kettl, 2015; Scholz & Stiftel, 2005). In some cases, IWS arrangements emerged to fill gaps where existing rules were insufficiently addressing the resource concern. Local, state and federal governments are increasingly participating directly in voluntary, collaborative and incentive-based approaches. This is particularly true in individual state's efforts to build on their established regulatory structures for instream flow by allocating water rights transfers responsibilities to nongovernmental organizations, and federal and local government's participation in source water protection. My research shows government not only as reactionary, but also as pragmatic, and incremental. This is demonstrated by their use of existing policies as a foundation for new actions instead of wholesale transformation, and in improving stakeholder engagement and program activities to transcend fragmented water policy (Gerlak, 2006, 2008).

5.3. Voluntary IWS in Response to Catastrophic Ecological Events

I explored the pathways and mechanisms that facilitated the creation of the most recent expansion of IWS: voluntary programs such as the Watershed Protection Partnerships. Application of the Multiple Streams Approach as sensitizing concepts informed our analysis by showing how the focusing events of fires created opportunities to align the political, problem and

policy streams that led to coalition formation and collaborative learning to frame the problem and determine potential solutions to address watershed risks across administrative boundaries. This framing included a focus on the urgency and unpredictability of wildfire, and the cost-avoidance of investing in risk aversion strategies. Policy entrepreneurs were critical for developing relationships, building capacity between organizations, and working across various levels of governance, all important characteristics in watershed governance (Boyd & Folke, 2012; Koontz & Newig, 2014). Unlike what MSA predicts, I found that fires as focusing events were an opportunity that did not facilitate a merging of streams, but, rather, created shared awareness of a social-ecological issue and space for stakeholders to collectively identify potential ways forward, and for policy entrepreneurs to eventually pull the streams together with innovative solutions. The unpredictability of disasters means that decision makers are increasingly confronted with governance challenges to which they do not have a pre-formed response (Kingdon, 2003). These types of risks are creating new challenges for decision-makers in how they address such uncertainty given multiple priorities and limited budgets. In the case of these partnerships, many interviewees mentioned that this strategy was the alternative to doing nothing, and waiting for the next fire to occur. The expected value the partners saw was in the possibility that their investment in forest treatments would reduce risk of threats to drinking water systems in the future. A key challenge exists for the ability of decision makers to continue to invest in such approaches that have the potential to reduce risk. This often must be done without more accurate quantification of what the investors (in this case, the water providers) are actually getting from the investment (e.g. level of hazard reduction, amount of sediment loading reduced).

The WPPs involve a recombination of existing ideas to forge novel solutions and partnerships, with new decision-making procedures, roles and shared responsibilities for actors both inside and outside of the federal government. These changes in how key individuals and organizations prepare a system for change, recognize windows of opportunity, and develop strategies to meet increasing social-ecological complexity are becoming both necessary and more common, according to the environmental governance scholarship (Armitage et al., 2012; Berkes, 2010; Chaffin et al., 2014; Moore et al., 2014; Olsson et al., 2006). These empirical observations in current governance contexts can contribute to the broader conversation regarding governance changes in social-ecological systems (Boyd & Folke, 2012a; Folke et al., 2005; Olsson et al., 2006), and hold considerations for how theories explaining policy change and relationships between variables in governance arenas should adjust to the changing scope and complexity of issues facing society (Koontz et al., 2015; Ostrom, 2005).

5.4. Research Considerations

Collectively, this research answers my overarching dissertation question about this new arena of environmental governance that is occurring within our study site, and also provides new insights within the region and more broadly across the US and globally. This approach facilitated characterization of the IWS population of the region, in order to then explore the influence of government as a regulator and program actors, as well as to understand how voluntary programs were created during windows of political and ecological opportunity. This helps inform understanding of how this approach differs from traditional management of freshwater resources in a region that is a microcosm of the complex socio-ecological challenges at play globally.

It is important to note, that as in any research approach, my original research objectives changed over time, in response to the reality of conducting an analytical study on a new and

constantly evolving field of conservation management. IWS, and more broadly, Payments for Ecosystem Services concepts are not as established as older conservation approaches, such as collaborative management, or regulation. The issues I describe here and in previous chapters are simply artifacts of trying to understand the relatively new and still rapidly changing arena of payments for ecosystem services that has only become more prominent since the early 2000s. As such, a few considerations are warranted.

First, at its core, IWS is about addressing specific ecosystem services concerns, which results in problem and place-based responses, built in absence of any overarching framework or blueprint. From an analytical standpoint, this can create challenges for comparability between programs. The diversity of programs span actor groups, water concerns, land ownerships and monitoring approaches, so when conducting regional analysis such as surveys, program groupings must be broad enough to include a variety of approaches, but also bounded enough to draw meaningful distinctions between programs. I found that grouping programs by water resource concerns, and/or characteristics about program investors and management actions allowed me to identify significant distinctions between the broad landscape of programs.

The second consideration involves developing a longitudinal dataset (such as the surveys) for such a rapidly evolving arena of environmental governance. The survey datasets used in my analysis were derived from the second and third data collection effort on investments in watershed services (Bennett & Carroll, 2014; Bennett et al., 2013; Stanton et al., 2010). All three surveys vary in survey questions and response rate. Since the survey questions are not parallel constructs, some attributes have more measures than others. Therefore, comparing data results temporally can be difficult. As these programs begin stabilizing in structure, functioning, and

performance, I anticipate that the data will serve as a baseline data and will provide a reliable basis for conducting longitudinal studies on IWS.

Third, how programs are built is key to outcomes and understanding how program actions align with goals and measures of success. But oftentimes, collecting quantifiable and analyzable data about how program outcomes relate to performance is challenging. This is due in some degree to limited responses on outcome variables, but mainly lack of comparability across programs. A related challenge is if quantification of program performance factors in baseline conditions pre-treatment or investment. If a baseline is not established prior to measuring program performance, the results will be an inaccurate reflection of the changes that occurred as a result of the program creation and investment. This is an important consideration for accurately assessing the ecological, economic and social impacts of a program, due to IWS intervention.

This research did not include specific variables for measuring an individual program's entire suite of enabling conditions or performance outcomes. Instead, the surveys elicited information about general regulatory or ecological drivers, and project outputs reported by only one respondent per IWS program – the program administrator. Programs reported monitoring and outcome data as varied measurement units (e.g., dollars invested, acres restored, pounds of nutrient removed), making these data inappropriate for cross-program comparison. PWS is still relatively in its infancy, so monitoring of program outcomes is still not mainstream or far enough along for ecological processes that take multiple years to change (Bennett et al., 2013; Brouwer et al., 2011). Obtaining better information on how programs measure performance is necessary to improve understanding of the outcomes being achieved by PWS, and how these outcomes align with program goals and structures. Addressing this gap would provide research opportunities for longitudinal analysis of institutional and ecological changes and their relation to program

performance. This research could help inform the currently limited understanding of how different environmental management arrangements function and adapt over time, particularly as they move from design to program implementation (Cheng et al., 2015; Emerson & Gerlak, 2014; Imperial & Koontz, 2007), and fill a need for more longitudinal social science research (Stidham et al., 2014).

The large scale at which I conducted my two survey-based studies creates limited ability to understand the causal connections between contextual factors and program outcomes. To gain further insight on how specific policy, socio-economic, and biophysical contextual factors relate to program performance and government rules or roles, survey responses from – and in-depth interviews with – a representative sample of actors participating in each IWS program would provide more specific information. I addressed this issue in my third study, exploring five programs that fit a specific type of IWS-the most recent growth in voluntary programs. This in-depth exploration allowed me to gain multiple perspectives on the selected cases, including insights from all program actors, from those investing, managing lands, and supporting the program(s). Although the story of Colorado WPP formation is subject to the specific political, ecological and social context of the time, I can draw parallels between characteristics of these cases and other parts of the arid western United States, particularly New Mexico, and Arizona, where similar WPPs on federally managed lands were also developed following major wildfires (Bennett & Carroll, 2014; Falk McCarthy, 2014; Gartner et al., 2013). This allows detailed insight into a very new (last 5 years) approach to ecological risks, and the most voluntary type of IWS. Similar research would need to be conducted for other IWS program types, in order to gain the type of detailed data I obtained from my study.

My mixed methods approach for both large scale, and in-depth studies allowed me to characterize the IWS landscape broadly, and also provide insights into the most recent area of IWS growth. Despite the aforementioned limitations, the results of my study do shed insights on actors, motivations, design and operation of IWS in the region, as well as the adaptive governance of freshwater resources more broadly. My research provides a baseline of a new conservation mechanism-IWS-which can provide a reliable basis for conducting longitudinal studies on IWS. Additionally, it is clear that institutional change has occurred in the region, as rules, actor roles and relationships have changed. Without survey data tracking these programs since 2010, such changes would be more difficult to identify. Tracking such changes over time will allow researchers to understand long-term impacts from IWS programs, including: 1) the embeddedness of new roles for governmental and nongovernmental actors; 2) transformations occurring within governance approaches; 3) how such institutional arrangements are resulting in ecological uplift, or measurable improvement; and 4) the degree to which these new approaches are permanent, incrementally affecting institutional responses to increasing water concerns.

5.5. The Future Potential of IWS

These three separate research approaches, and resulting data also bring to light questions about in what context(s) IWS can operate most effectively. First, IWS has the potential to be a mechanism for moving from reactionary, crisis-driven approaches to more proactive water resource management. While ecological crisis such as wildfires, and/or dewatering of endangered aquatic species' habitat have a place in driving forward changes in conservation, these types of events alone will be insufficient to address the mounting challenges our society faces. There is a need to move from incremental change in response to uncertainty and risk towards more proactive planning that clearly communicates potential costs and benefits of

different water resource management strategies. The ability to identify and critically consider the social, ecological, and economic costs and benefits of different long-term management strategies for water resources is foundational to proactive management of our natural resources. IWS can provide this in many cases, identifying beneficiaries and providers, and the suite of related ecosystem services they receive from certain water resources. Collective action responses to such needs will likely prove far more effective than individual rational approaches. IWS, when used in appropriate context, can be a vehicle for implementing collective action responses to water quality and quantity issues. These responses can motivate stakeholders to consider the collective good, and common pool resource management, which is essential to a resource that is unequally distributed across the landscape, and defined by a series of ecological, social, political, and rights-related considerations.

Another important consideration about how and when IWS can be used most effectively, from an efficiency standpoint. IWS is an increasingly popular conservation mechanism, both domestically and internationally. However, a question that remains is if IWS is being implemented in the manner in which it was originally intended. More specifically, are programs paying for the right things? For example, are programs that pay landowners not to pollute their waterways through a series of incentives the most efficient way to address the concerns, or would regulation be more direct and all-encompassing? Is it socially and morally acceptable to pay the polluters, as is the case in IWS where nonpoint source sources are paid to reduce their pollution? Are those investing in such approaches making their payments conditional on the most effective unit (e.g. measured degree of wildfire risk reduction versus number of acres where forest treatments were applied)? These types of critical questions, while beyond the scope of this research, are essential to consider in seeing where IWS heads in the future. The points I make in

this research regarding the need for improved performance metrics, and clearer assignment of costs and benefits of IWS and the context(s) in which it can best operate are reflective of these key questions that emerge when considering the future of IWS. The potential of IWS is clear, but it should be balanced alongside improving science on program benefits and efficiency, and ecological and institutional context appropriateness.

5.6. Conclusions

Well beyond the western US, arid and semi arid regions across the globe are facing issues of increasing social and ecological competition for freshwater resources, to which this research can provide insight. First, I improve understanding of IWS as an institution, and demonstrate the importance of the dynamics between institutional factors for external context, program structure, and other institutional analytical domains in shaping how PWS is applied to water resources challenges globally. Second, I use IWS to demonstrate that government regulations and recent changes in government roles and participation can be key to drive programs and that water quality and quantity issues cannot be solved by collective nongovernmental action alone. Third, I show how theory identifying linkages and explaining relationships between variables in the policy process should adjust to the changing scope and complexity of issues facing society to explicitly consider the space and time needed for governance adaptations to social-ecological issues.

A large part of this discovery of a new form of governance is my key finding that governance structures still need government. All three of my data sets show that the role of government in integral in the governance of ecosystem services (Muradian & Rival, 2013). Within the western US, the architecture and infrastructure of government policies and presence still drives even new, often voluntary mechanisms like those offered by IWS. This new arena of

environmental governance includes new, more nimble forms of government; from water regulations allowing new mechanisms to meet requirements, to states forming a variety of in-stream flow programs with nongovernmental partners, to federal agencies voluntary engaging in source water protection with local government. There are of course, still internal challenges facing government entities (conflicting mandates, budget stagnation or decline, inequitable allocation of access to and benefits from resources, power imbalances), and the complex history of water governance in the western US means there will always be struggles between governmental and nongovernmental actors. However, my research strongly demonstrates how government is coming to the freshwater resource table, willing and flexible enough to engage in a variety of roles, particularly in response to ecological change.

This influence of government in western water issues also has implications for nongovernmental partners. IWS shows new roles for nongovernmental actors, including NGOs, private businesses and even individual landowners. These new arrangements involve changes in participants and their roles (e.g. Berkes, 2010; Armitage, 2012), forging new solutions, partnerships between seemingly unlikely partners, and organizational changes (e.g., new staff positions and responsibilities). My research also shows how public and private organizations have champions, entrepreneurs, shepherds, innovative thinkers and collaborators driving change forward within and between levels of government and organizations, and taking advantage of windows of opportunity, such as increasing ecological disasters (fires and floods).

IWS are a new arena of environmental governance that, while context specific, have notable implications for future conservation and research of freshwater resources in a time of increasing socio-ecological complexity. The picture I paint from this research shows how the political, economic, social, and administrative processes changed in order to respond to

increasing water quality and quantity concerns, leading to institutional innovation and governance changes beyond policy. IWS in the region demonstrate balancing centralized and decentralized organizational control, openness to learning and acceptance of change as inevitable (Boyd & Folke, 2012; Lebel et al., 2006; Moore et al., 2014; Olsson et al., 2006). Environmental governance literature shows increasing movement towards more adaptive governance approaches in response to increasing vulnerability of social-ecological systems and the inadequacy of traditional management approaches for addressing this vulnerability (Boyd & Folke, 2012a; Kettl, 2015; Olsson et al., 2006), which our research demonstrates, as new solutions (in the form of IWS) were created to address new issues not sufficiently addressed by existing management approaches.

In sum, my dissertation findings characterize the new arena of environmental governance within the region, and hold implications for how IWS and relevant scholars organize scientific inquiry and understanding in light of changing social and ecological conditions around freshwater management. This new arena of environmental governance is embedded in a time of increasing social-ecological complexity. The approach is adaptive, place and problem-based, learning and collaboration-focused, and accepting of new mechanisms to address uncertainty. Importantly, this new arena also contains nimble and adaptive government regulations and actors across scale, making government a key part of the adaptive governance of freshwater resources in the west. My work also creates a baseline of IWS in the region, and identifies areas for future research as IWS matures over time. A challenge and area for future research exists in linking existing work on governance adaptation to social-ecological complexity and policy research. Both theory and research should account for such governance adaptation in order to further

inform academic understanding of governance, IWS and the western US, and to better face future freshwater resource social-ecological challenges.

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