A Multi-Scalar Socio-Policy Analysis of Resource Reallocation and Water Security in Twenty-First Century Utah, USA

Clint P. Carney
Utah State University

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A MULTI-SCALAR SOCIO-POLICY ANALYSIS OF RESOURCE REALLOCATION AND WATER SECURITY IN TWENTY-FIRST CENTURY UTAH, USA

by

Clint P. Carney

A dissertation submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

in

Environment and Society

Approved:

Joanna Endter-Wada, Ph.D. Niel Allen, Ph.D.
Major Professor Committee Member

Karin Kettenring, Ph.D. Jack Schmidt, Ph.D.
Committee Member Committee Member

Lisa Welsh, Ph.D. D. Richard Cutler, Ph.D.
Committee Member Interim Vice Provost
of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2022
ABSTRACT

A Multi-Scalar Socio-Policy Analysis of Resource Reallocation and Water Security in Twenty-first Century Utah, USA

by

Clint P. Carney, Doctor of Philosophy

Utah State University, 2022

Major Professor: Dr. Joanna Endter-Wada
Department: Environment and Society

The western United States is confronting multiple scarcity-driven water insecurities in the 21st Century. Use of marketing mechanisms to reallocate existing supplies is often promoted as a less costly and more environmentally conscious approach to address water scarcity than traditional supply augmentation measures. Yet, water marketing has faced numerous socio-economic and institutional obstacles. To overcome these challenges, water banks have institutionalized the marketing process in recent decades. However, generating interest in water banks among stakeholders accustomed to specific water allocation arrangements largely defined by prior appropriation water law can prove difficult without understanding the geographical context and organizational structures of their current use patterns.

This dissertation uses social and policy science research methods to examine the challenges of implementing new water reallocation schemes in Utah, with particular emphasis on Cache Valley and the Bear River Basin. The research framed key interview questions pertaining to the impacts of water banks within the water security paradigm to
illustrate their utility at different scales and potential tradeoffs among water use sectors. It also relied on secondary data analysis of policy-related literature regarding water reallocation in the western United States, as well as participant observation of deliberations over water banking legislation in Utah.

This research found that water banks have evolved over time as adaptive policies through context specific institutional designs that balance competing approaches to water reallocation and integrate market features with prior appropriation law. We further show that in systems with highly interconnected uses like the Bear River Basin, the impacts of water bank transfers on the water security of disparate interests and ecosystems are likely to vary by scale. Finally, we illustrate how existing institutions have shaped water use behaviors among northern Utah stakeholders, and how those institutions might intersect with new reallocation schemes is a key issue in the expansion of water banks. This dissertation contributes to the academic literature and public policy discussions on market-based reallocation through a socially informed and contextually focused examination of the obstacles to institutional reform via water banks. Such insights are vital for policies that rely on the participation of key stakeholders to succeed.

(207 pages)
A Multi-Scalar Socio-Policy Analysis of Resource Reallocation and Water Security in Twenty-first Century Utah, USA

Clint P. Carney

As drought and a warming climate continue to impact the western United States, balancing the water needs of cities, agriculture, and natural systems is becoming increasingly more complex. One approach commonly promoted to address water supply issues is the transfer of water between users via markets. However, markets for water face multiple obstacles that can often be costly for participants due to constraints inherent in western U.S. water law. Coinciding with issues of cost, water markets must overcome disinterest among water rights holders in releasing their water rights for uses even if temporarily. Moreover, water transfers bring to light the potential impacts to security in access to water for other needs when water is moved between locations and uses.

This research examined key challenges to the establishment and use of market-based transfer arrangements known as water banks. Existing water banks in other states were first analyzed to assess how they have added flexibility to existing water law in order to address specific or broad impacts of water scarcity. Northern Utah’s Bear River Basin then served as a case setting to examine the complexities of establishing water banks through the perspectives of individual water users and others involved in water management. Data were collected through interviews, focus groups, observations of legislative workgroups, and analysis of existing literature.
This research found that the benefits of transfers through water banks are potentially dependent on the scale of interest that the transaction is assessed at and how the consumption of water is managed. Moreover, this work found that the prevailing behaviors and attitudes regarding water transfers are in part rooted in how existing water laws and organizations have controlled allocation and use of the resource. Understanding these social factors is critical to the policy designs of market-based approaches to sharing water that rely on participation of water rights holders to contribute towards rebalancing water supplies and meeting policy objectives at all scales of interest.
ACKNOWLEDGMENTS

I want to first thank my major professor Dr. Joanna Endter-Wada for providing me the opportunity to pursue this dissertation as a forty-something non-traditional student. I also want to express gratitude to my dissertation committee for their support – Dr. Karin Kettenring, Dr. Lisa Welsh, Dr. Niel Allen, and Dr. Jack Schmidt, who introduced me to the world of the Colorado River.

I also want to acknowledge others at USU for their encouragement and assistance – Dr. Layne Coppock, Dr. Chris Lant, Dr. Peter Howe, and Dr. Johan DuToit, as well as Rebecca Hirst in the ENVS office for helping me navigate graduate school procedures and paperwork. Also, I want to recognize friends who I have made during my time at USU, including my 2016 cohort members as well as Adrian Welsh, Ryan Tarver, Andy Witt, Aubin Douglas, and (fellow Cyclone) Dr. Korry Hintze for providing me timely laughs. I’m also indebted to each of the interviewees that I learned so much from during my research project, most notably Remington Buyer with the Idaho Department of Natural Resources and Kelsey Collins with the Washington Department of Ecology.

Several entities contributed to funding my dissertation program and research. Primary financial support and data used in this dissertation came from the project “Water Banking in Cache County,” Dr. Joanna Endter-Wada (PI), Dr. Niel Allen and Dr. Lisa Welsh (co-PIs), which was jointly funded by the USU Extension Water Initiative, the Cache Water District, and the Utah Divisions of Water Resources and Water Rights. For additional fellowship support from USU, I want to thank the Quinney College of Natural Resources for a Quinney Dissertation Fellowship and the iUTAH project. I want to recognize the USU Graduate School and the ENVS Department for supplemental
financial support and travel funding. External to USU, I want to especially thank Friends of the Great Salt Lake and the Babbitt Center for Land and Water Policy for respective scholarship and fellowship awards.

None of this would have been possible without the enduring support from my wife Sara, the love of my life, as well as the joy that our son Wynston brings us every day. Their endless patience with my time away and the sacrifices made as I pursued this degree helped drive me every day in this journey. I also want to recognize my late parents Jane and Paul, for instilling in me the value of education and showing me the wonders of the American West in my youth. Lastly, our furry four-legged family member Melvin has been the best reading companion one could ask for.

Finally, I also want to briefly share for any future readers of this dissertation the extraordinary events that unfolded in the United States over the time of my degree program. These years witnessed two impeachments of the same president, an attempted coup of the federal government, unceasing gun violence, countless acts of racial injustice, and the global Covid-19 pandemic that caused so much suffering and societal turmoil. These years also saw headline-making natural calamities unfold - from flooding, derechos, and hurricanes in the east to persistent drought and wildfires in the west. And the Colorado River’s first ever shortage was declared in 2021 for the Lower Basin states. As a student of public policy, the constant barrage of news provided ample real-time content that complemented (and sometimes interrupted) my focus on the fundamentals of public policy.

Clint P. Carney
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CHAPTER I

INTRODUCTION

Overview

Societies worldwide are confronted by multiple water security threats in the 21st Century. Instances of absolute water scarcity now frequently coincide with chronic water management challenges in industrialized and developing nations alike. The western United States (U.S.) is no exception to this trend despite immense 20th Century investments in water infrastructure and institutions at the federal, state, and local levels. Alterations in the hydrologic cycle and persistent drought, driven largely by climate change, have impacted livelihoods and ecosystems in every western state for over two decades (Borunda, 2021). Some of the most extreme manifestations of these changes were witnessed in the summer of 2021 from the Pacific Northwest to the Colorado River Basin (Cappucci and Samenow, 2021; Wilson and James, 2021). Coinciding with prolonged drought and shifts in hydroclimatic conditions beyond their normal bounds of variability (“non-stationary hydrology”), the southwestern states are experiencing aridification, which is defined as the long-term warming and drying trend since the late 20th Century (Milly et al., 2008; Overpeck and Udall, 2020). This term characterizes the observed trend in higher temperatures driving runoff declines in river systems such as the Colorado River Basin, where even normal or above average snowpack in recent years have yielded unexpectedly lower rates of spring runoff due to soil and plant uptake and sublimation (Woodhouse et al., 2018; Milly and Dunne, 2020).

As the realities of water scarcity unfold in tandem with economic growth in the western U.S., managers and stakeholders face scenarios requiring innovative policies and
greater societal cooperation. Moreover, allaying the region’s water insecurities will require a renewed commitment to technological and institutional investments to manage water scarcity and variability. Historically, the transfer of water within and between agriculture, municipal/industrial, and environmental uses has been practiced in response to the region’s temporal and spatial variability in water supplies (Brewer et al., 2008). Yet, scholars have suggested that reallocation, particularly through water markets, remains an underutilized approach to mitigating water scarcity in the western U.S. (Culp et al., 2014). Water market expansion has been promoted in recent decades as a lower cost alternative to water development to meet current and projected needs (Iseman et al., 2012). Despite their anticipated benefits, water markets face notable obstacles, including transaction costs, conveyance constraints, competing interests, participatory reluctance, and perceptions of social inequity resulting from further commodification of water (Marston and Cai, 2016; Leonard et al., 2019).

In response to these institutional complexities, water banks have been implemented in several western states to facilitate the coordination of market-based water rights transfers. The institutional diversity of water banks reflects the various hydrologic contexts and water insecurities across the western U.S. All water banks, however, must function within the tenets of prior appropriation law, the fundamental legal doctrine that has guided water allocation in the western states since the late 19th Century. In the state of Utah, the 2020 legislature passed a water banking bill sanctioning the statewide implementation of pilot water banks (Utah Legislature, 2020). The bill’s eligibility requirements to establish water banks maintain that applicants hold valid water rights and meet specific administrative criteria prior to approval by Utah’s Board of Water
Resources. Framers of Utah’s legislation saw water banking as a policy tool to help stem the trend of urbanization based on the “buy and dry” of agricultural land that has depressed local agricultural economies in other western states in recent decades. Moreover, they envisioned water banks providing access to water rights for the state’s threatened aquatic habitats, including the Great Salt Lake. Despite these well-intended objectives, expansion of water transfers under existing allocation law without examining the potential social and hydro-physical tradeoffs of such policies could potentiate outcomes that are inconsistent with the overarching objectives of Utah’s water banking statute.

While a wealth of research has examined the economic facets of water reallocation, focus on the social complexities (“human dimensions”) in market-based water transfers in the U.S. West remains limited. As illustrated in the existing literature, social and institutional design factors such as access, equity, transparency, and pricing can each contribute to determining the long-term success of reallocation policies in mitigating water insecurity (Tisdell and Ward, 2003; Giannoccaro et al., 2013; Bjornlund et al., 2014). Such is the case in emerging water banking initiatives or where existing entities have experienced limited activity or interest. As competition for increasingly scarce and variable water supplies in the western U.S. grows, further insight into the human dimensions of water reallocation will be essential to inform policy reform measures that meet individual needs and collective priorities.

Dissertation Objectives

The overall goal of this dissertation is to provide a deeper understanding of how water reallocation through water banking influences water security in the western U.S. at
multiple scalar dimensions through the perspectives of people who will be relied on the most to generate water bank activity. The policy design and eventual passage of Utah’s water banking bill provides a unique sequence of events from which to assess the human dimensions of water reallocation. The timing and location of these developments have provided an opportunity to fulfill the following research objectives through a qualitative, mixed methods approach:

1) to assess how water banks in the western U.S. have served as adaptive policy responses to disparate water insecurities;

2) to examine the scalar-based tradeoffs in water security with the potential establishment of water banks in a complex hydro-social setting; and

3) to illustrate through the perspectives of stakeholders with diverse connections to water use and governance the social and institutional obstacles inherent to water reallocation in a contextualized yet representative watershed setting of the western U.S.

The significance of this dissertation lies in its approach to understanding the complexities of water reallocation in a time and location where traditional uses and emerging needs vie for increasingly scarce and variable water supplies. A unique attribute of market-based water reallocation schemes such as water banks is that voluntary stakeholder participation is required for the policy to function and meet various objectives. Hence, understanding behavioral and social dynamics of the water user community is critical to informing water banking policy implementation. Unlike research on water markets through an economics lens, this dissertation addressed the question of water reallocation’s influence on water security through social and policy related research. This approach relies on insights from northern Utah stakeholders to provide a
contextualized understanding of the diverse connections and needs that water users have with the resource and the institutions that govern water’s allocation. As water users in the western U.S. continue to face fluctuating conditions in water supplies that trend toward less overall availability, cultivating greater cooperation in managing and sharing existing resources will be essential to mitigate absolute water scarcity. Hence, it is imperative to understand the human dimensions of water reallocation, particularly with those stakeholders who possess the most senior water rights and other interests who still seek greater access to water. The findings of this dissertation are intended to contribute to both the ongoing water security dialogue in the literature as well as to inform policy designs and reform measures necessary for the establishment or enhancement of water banks in the western U.S.

**Dissertation Structure**

This dissertation is presented in a multiple-paper format that includes an introductory chapter, three research chapters, and a concluding chapter that summarizes research findings. Chapters II, III, and IV have been prepared for publishing in specific academic journals. The research chapters are co-authored with investigators from the “Water Banking in Cache County” research project team. Chapter III has already been published (Carney et al., 2021). The primary qualitative data used in this research was acquired between July 2018 and April 2019 by members of the research team and involved semi-structured interviews, focus groups, and participant observation of legislative working group sessions. Secondary data acquisition occurred in various phases from 2018 through 2021.
The research chapters are sequenced from broader to more specific inquiries related to this dissertation’s overall research theme of understanding the scalar-based water security implications of reallocation through water banks. Chapter II examines the role of water banks as policy responses to water insecurity in the western U.S. historically and includes case analyses of four specific water banks developed in varying hydrologic and water insecurity contexts. This assessment was intended to illustrate through a framework of questions how water banks originated in the region and the specific water insecurities they were intended as a response to. This qualitative research utilized diverse sources of secondary data found in various types of literature and was verified with key experts within the water bank entities investigated. This article focuses on the transformative rules and administrative designs that allowed water banks to respond to various water insecurity issues in ways that existing policies were incapable of or limited in fulfilling. Moreover, this research illustrates how water banks have integrated market principles with prior appropriation, how various water banks have or have not adapted to emerging needs, and the progress of western U.S. water banks in attaining specific policy objectives.

Chapter III examines the human dimensions of water reallocation and water security through the northern Utah context. Specifically, this chapter relies on key-informant interviews and focus groups with a diverse set of stakeholders to understand the multi-scalar tradeoffs of water banking from the perspective of those most intimately connected to the region’s water resources. To set up this assessment, the article first examines the definition of water security through the views of stakeholders who either 1) directly use local water resources for economic gain, 2) seek access to use the resource
for non-consumptive purposes, or 3) manage the resource at specific levels of governance. The article uses stakeholder insights to examine how water banking could impact users’ water security at different hydro-physical scales as well as the water security tradeoffs that could unfold at different watershed scales with inter- and intra-sectoral water rights transfers through water banks.

Chapter IV also relies on the northern Utah context to examine the relationship between existing water institutions and the behaviors and perspectives of individuals regarding water use and reallocation and how this relationship can influence the implementation of water banks. The chapter uses the northern Utah context to illustrate the challenges of introducing new water reallocation policies in regions steeped in long-established modes of allocation and water use. This article intends to demonstrate that in addition to economic facets of reallocation (i.e., transaction costs), key human dimensions (i.e., behaviors, perceptions, fears, needs) must be considered in developing new institutional designs for water transfers. The sources of these human dimensions are further explored through the path dependency lens to illustrate how existing institutions as well as individual choices have contributed to molding the perspectives and behaviors that could influence water users’ interest in and capacity to participate in water banking. While focused on an area in the western U.S., findings from this chapter provide generalizable concepts for other regions seeking to establish or catalyze activity in existing water banks or other reallocation schemes that involve decisions at the individual level needed to satisfy broader, collective-defined policy objectives.

The conclusions of this dissertation are summarized in Chapter 5. Note that since chapters II, III, and IV represent individual research articles, each one contains separate
background and methodological sections (including relevant literature) germane to the theme of each individual article.

**Literature Cited**


https://doi.org/10.1002/wat2.1159


https://doi.org/10.1073/pnas.2006323117

Utah Legislature, 2020a. Senate Bill 26. (Available online:

CHAPTER II
WATER BANKING AS AN ADAPTIVE RESPONSE TO WATER INSECURITY IN THE WESTERN UNITED STATES

Abstract
Water banks have served as institutional policy responses to water insecurity in the western United States for over four decades. We examined through content analysis how institutional reform has allowed water banks to fulfill collectively defined objectives in diverse hydrologic contexts. Findings revealed that water banks have over time attained sustained levels of activity independent of their institutional origins. Adaptive features of water banks were the result of key rule modifications that integrated historically rigid allocation law with market features. Moreover, mature water banks have required considerable timespans and ongoing institutional investments before they contribute towards meeting specific policy objectives.

Introduction
The establishment of water banks has served as a policy response to various water insecurities in the western United States for over four decades. Competition for water and the hydrologic realities of climate change have further necessitated reallocation arrangements within and between uses in the region’s over-allocated watersheds (Anderson and Woosley, 2005; Culp et al., 2014; Overpeck and Udall, 2020; Wheeler et al., 2021). “Water bank” is a generic term used to describe various institutional arrangements that repurpose water rights for needs different than their original approved

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use (whereas water *banking* refers to participating in a water bank transaction or the physical act of storing water). Common water bank designs in the western United States (U.S. West) integrate administrative and economic incentives to encourage temporary transfers of surface water, groundwater, or storage water between users (MacDonnell et al., 1994; Ghosh et al., 2014).

Water banks have been promoted as institutional circumventions to the economic and administrative obstacles encountered in private water market transactions (MacDonnell, 1994; Clifford et al., 2004; Podolak and Doyle, 2014). Short-term and permanent water transfers in the U.S. West through formal and informal water markets have increased in number over recent decades (Brewer et al., 2007; Iseman et al., 2012). Despite the existence of mature water markets in some states (Carey and Sunding, 2001; Howe and Goemans, 2003; Hanak et al., 2019), multiple impediments to their expansion have been described in the literature. Transaction costs are often suggested as the primary barrier to transfer activity (Frederick, 2001; Garrick et al., 2013; Hanemann and Young, 2020), yet, other hindrances include equity issues, third party effects, stakeholder perceptions, and legal constraints on inter-state transactions (Chong and Sunding, 2006; Easter and Huang, 2014; Leonard et al., 2019). Moreover, pursuit of land and water right purchases by outside interests in water scarce areas has drawn increased scrutiny of market influences on water allocation in recent years, including in the upper Colorado River Basin (Kuta, 2020; Howe, 2021).

Negotiated water right transfers between parties are pursued in the U.S. West to satisfy disparate public and private needs alike (Garrick et al., 2009; Iseman et al., 2012; Aylward et al., 2020). Water banks, however, are publicly sanctioned entities that
coordinate market-based transfers to meet collectively defined policy objectives (MacDonnell et al., 1994; Brennan, 2017). By design, water banks provide centralized institutional structure to the use of water transfers in mitigating the repercussions of water scarcity. Hence, a key institutional feature of water banks is their capacity to adaptively respond to diverse water insecurities while functioning within existing modes of water governance.

Since MacDonnell et al.’s (1994) comprehensive analysis of water banks, a limited number of peer-reviewed articles (Megdal et al., 2014, Montilla-Lopez et al., 2016) and other professional reports (Clifford et al., 2004; O’Donnell and Colby, 2010; Cronin and Fowler, 2012; Haller, 2018; Eberling et al., 2019) have assessed the state of the practice in the U.S. West. However, the literature is abridged regarding the adaptative implementations of water banks in response to the region’s chronic and emerging water insecurities. We present research on the institutional reforms that have occurred via the establishment of water banks in the U.S. West. We conduct a systematic review (Grant and Booth, 2009) of how policy designs and subsequent modifications have influenced the adaptation of water banks to mitigating the consequences of water scarcity. We relied on content analysis of secondary data sources to assess how water banks have functioned within existing legal frameworks while instilling greater flexibility and policy intent into the water transfer process. We first evaluate water bank development over time in the U.S. West in light of the water insecurities that catalyzed their establishment. Second, we examine the institutional changes established through water banks and how such reforms have contributed towards meeting collectively defined policy objectives in ways that existing tools of governance were unable to effectively resolve. We met this objective by
examining case examples of water banks that were established in response to various water insecurities through a framework of questions intended to illustrate: 1) the exogenous drivers that prompted the implementation of water banks; 2) the interests promoting institutional change; 3) the resulting institutional entities and their position within existing water governance arrangements; 4) the newly defined water bank capacities; 5) how existing water allocation laws were integrated with market principles; 6) examples of adaptations made in the use or administration of water banks; and 7) the resulting level of water bank activity.

We provide a nuanced examination of institutional design features that bolster the capacity for water banks to mitigate water insecurity in the U.S. West. The article highlights *why* specific rules were needed in response to different water insecurities, *how* they were implemented, and the resulting institutional capacities afforded to water banks through new or modified rules. Moreover, we provide an assessment of the state of water banking in the U.S. West since the benchmark works by MacDonnell et al. (1994) and Clifford et al. (2004). We illustrate factors of institutional change that can inform future pursuits of water banking policies or for existing water banks seeking to enhance their capacity to coordinate water transfers to mitigate increasingly urgent and collectively recognized water insecurities.

**Water Banks as a Response to Water Insecurity**

Garrick and Hall (2014, p. 617) describe water insecurity as a state in which “*conditions of the aquatic environment threaten the welfare and freedoms of individuals, communities, and societies.*” Water insecurity emerges from acute events (droughts, floods), chronic conditions (scarcity, impaired water quality), or policy deficiencies (i.e.,
inequitable allocation schemes). While natural events are uncontrollable, anticipation of and response to their outcomes is a function of public policy. To this point, Pahl-Wostl et al. (2013) argue that water insecurity can result from, and yet also be abated through governance processes, and that indicators of tradeoffs are critical in guiding policies aimed at reducing water insecurity. Here, we frame water banks in the context of the U.S. West’s enduring and emerging water insecurities related to aridity and drought, and supplement Garrick et al.’s definition to include the welfare of aquatic ecosystems. This perspective contributes to illustrating the adaptive traits of water banks and how they have responded to diverse and interdependent water management challenges.

Origins and Drivers

Formalized water banks in the U.S. West originated in the late 1970s. California implemented a temporary water bank as part of drought response policy, and long-term state water planning in Idaho included establishment of a statewide water bank program (Idaho Water Resources Board, 1976; California Dept. of Water Resources, 1978). Since then, water banks of varied scale and scope have been crafted in nearly every state west of the 100th Meridian (Ebeling et al., 2019). Overall scarcity has been the prevailing driver for water transfers in the U.S. West historically (MacDonnell, 2015), and its impacts in over-appropriated watersheds have further manifested across economic sectors and aquatic ecosystems (Culp et al., 2014; Richter et al., 2020; Tempus, 2020). Table 2.1 lists various socio-economic, hydrologic, and policy-based drivers that have spurred water reallocation in the U.S. West in recent decades. In addition to administrative approaches to reallocation such as general stream adjudications, markets for water have
Table 2.1 Larger contextual factors in the U.S. West that have necessitated implementation of water banks or other policy arrangements to transfer water within or between economic sectors.

<table>
<thead>
<tr>
<th>Hydro-Physical</th>
<th>Socio-Economic</th>
<th>Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Increasing interannual and seasonal runoff variability</td>
<td>- Changing in regional economies and new industries</td>
<td>- State or federal environmental policy enactments (e.g., Endangered Species Act)</td>
</tr>
<tr>
<td>- Drought and aridification</td>
<td>- Agricultural economy shifts in response to commodity values and market internationalization</td>
<td>- Use in interstate or tribal compact arrangements</td>
</tr>
<tr>
<td>- Land use modifications</td>
<td>- Changing societal perspectives regarding beneficial use of water</td>
<td>- Declaration of fully or over appropriated watersheds</td>
</tr>
<tr>
<td>- Changes in cropping patterns</td>
<td>- Population growth</td>
<td>- Different legal regimes for groundwater and surface water that disregard their connectivity</td>
</tr>
<tr>
<td>- Over-reliance on groundwater sources and land subsidence</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

emerged as a preferred approach for meeting new demands in settings where institutional commitment and suitable infrastructure exist, such as in northern Colorado and California’s Central Valley (Howe and Goemans, 2003; Hanak, 2015). To overcome the aforementioned water market obstacles, water banks have integrated market functions with regulatory siderails and administrative support to elicit stakeholder interest in temporary water right transfers to collectively meet defined objectives (Castle and MacDonnell, 2016; Haller, 2018).

Water Bank Arrangements

Administration of water banks in the U.S. West ranges from entirely state-operated programs to privately operated entities (Haller, 2018). They are not novel creations, however. Water banks conceptually model long practiced water share trading within the region’s myriad canal companies and irrigation districts (MacDonnell et al., 1994). Clifford et al. (2004) identified 23 active water banks in the early 2000s, although
some are part of the same governing structure within the Idaho water bank system and others were in the initial phases of development but never became functional (H. Risely-White, personal communication, December 8, 2020). Brennan (2017) listed 94 separate entities in the U.S. West that “self-recognized as water banks.” However, some entities in this list were temporary or never became operational. Over two dozen local water banks have been established in Washington since 2003, and Utah passed a bill in 2020 allowing pilot water banks statewide (Haller, 2018; Utah Legislature, 2020).

Water banks have been classified in the literature by the type of water source managed, administrative format, intended purpose, or market structure (Miller, 2000; Clifford et al., 2004; Montilla-López et al., 2016). Aside from interstate agreements, most water banks in the U.S. West operate with market-based transactions. Depositing water for lease into water banks is usually limited to the consumptive portion of a water right given the highly interdependent nature of water delivery systems and other users’ dependence on return flows. Transactional arrangements vary by bank, but common approaches to stimulate participation include 1) bilateral exchanges between participants; 2) pooling of deposited water rights to lease as credit towards a mitigation need; or 3) direct payments from managing entities to encourage water conservation practices that make water available for other uses (Clifford et al., 2004). Montilla-López et al. (2016) recognized active and passive banks, with the former typology serving as a “market maker” by actively acquiring and leasing or selling water rights to interested parties. The latter refers to banks that act as clearinghouses to match interested actors and promote price discovery (if water bank rules permit negotiations). Passive banks however do not typically own or seek acquisition of water rights. Here, we define all water banks that use
market incentives to transact water rights between parties for compensation, whether bilaterally or between individuals or through pooled blocks of water as intermediaries. Those institutions without a market-based focus, such as interstate banking arrangements, are considered non-market water banks. Intermediary banks are of particular interest in this research because they represent a policy reform measure that attempts to integrate structured administrative controls (prior appropriation) with market-based transactions. This combination creates unique opportunities and challenges in meeting public policy objectives.

Water conservation practices in the agricultural sector (i.e., lease-fallow agreements, split-season arrangements) that make available fractional volumes of a water right are common in the U.S. West (Colby, 2017; Richter et al., 2017). Such practices can be stand-alone policies or included within a water bank’s operational design. As Castle and MacDonnell (2016) note however, these arrangements can lack the expediency necessary to meet seasonal needs and are often bilateral in nature. As centralized facilitators, water banks can integrate conservation practices and sharing arrangements between multiple interests in ways that enhance temporary water transfer activity in over-allocated watersheds.

**Understanding Water Banks as Institutions**

Institutional reform through water banking is situated at the intersection of governance, markets, and the provision of social goods. Ostrom (2007, p. 23) defines institutions as “*shared concepts used by humans in repetitive situations organized by rules, norms, and strategies*” within markets, business, government, and other social interactions. North (1990, p. 6) suggested that institutions reduce uncertainty in society
by “establishing a stable structure to human interactions.” Institutions can be formal (i.e., laws, regulations, court decisions) or informal (customs, ideology) (Schmid, 2004).

Institutions are also commonly discerned as the visible structures of government such as legislatures, judiciaries, and agencies that enact and execute laws and rulemaking (Kraft and Furlong, 2016). In this article, we rely on Ostrom’s (2007) definition of institutions as described in this section. Note however, descriptions in this article of institutional reform via rule changes directly involves how the governing entities function. Water governance in the U.S. West involves various formal and informal institutional arrangements that have guided the apportionment, distribution, and reallocation of water since the 19th Century.

The prior appropriation doctrine (prior appropriation) is one of the most consequential institutions implemented since European settlement in the region. It created security for early claimants of surface flows by granting seniority in access to use their water right’s full apportionment prior to those who established uses from the same watercourse later in time (Getches et al., 2009). In times of shortage, users who are “junior” in time to senior water right holders face greater insecurity in their annual allocations. Senior water rights were typically claimed by irrigators, mining operations, and municipalities. Over time, increasingly complex water allocation arrangements emerged between the federal government and irrigation entities (MacDonnell, 2015). At the individual level, prior appropriation bounds users to continuous exercise of a water right, and water right transfers are permitted only if the change in use does not impair other users accessing the same watercourse. Hence, prior appropriation provides security to senior water right holders yet constrains water access for emerging societal priorities in
overallocated watersheds. New users must therefore obtain water rights from existing uses through costly water transfer procedures.

Grafton et al. (2011) recognizes adaptive institutions as those that are “able to adjust to unexpected shocks, incorporate new and revised information, and respond in a timely manner to changes in societal preferences over how water is managed and used.” As adaptive institutions in the U.S. West, water banks interlace the tenets of prior appropriation with market concepts to cultivate more flexible water transfers intended to serve collective needs. Yet, institutional designs that balance these foundational concepts illustrates what Garrick (2015, p. 114) describes as “the dynamic tension between stability and flexibility” in water reallocation reform. North (2006) defines adaptive efficiency as “an ongoing condition in which the society continues to modify or create new institutions as problems evolve.” Adaptive efficiency differs from neoclassical economic efficiency (“least-cost” pathways) in that it emphasizes outcomes of institutional modifications over time in meeting emerging political challenges (Garrick, 2015). While transaction cost reduction has been the focus of research on water market reform (Slaughter, 2009; McCann and Garrick, 2014), water bank transactions may involve social objectives that transcend exclusive focus on minimizing economic constraints for individuals (Livingston, 2005). Hence, water banks can lessen private transaction costs for individual participants and the outcomes of water transfers can lead to socially desired goals depending on how this underlying tension is managed. But that may not result in the “highest and best use” in strictly neoclassical economic terms precisely because it is attempting to find a more politically optimal solution across social scales.
Livingston (2005) articulates the utility of examining institutional change in water governance through a political economy perspective that extends beyond the notion of economic efficiency. She notes that institutions attain equilibrium when little to no pressure exists from internal or external sources of change but fall into disequilibrium when “the political clout of potential winners exceeds the political clout of potential losers” (p. 24). In the U.S. West for example, prior appropriation brought security for water users throughout much of the 20th Century until coinciding societal priorities and increasingly threatened supplies revealed the doctrine’s limitations and necessitated alternative approaches to reallocation (MacDonnell, 2015). To assess the question of “why and how institutions change,” Livingston (2005, p. 22) stresses the importance of the social and political drivers that exist at the micro and meso levels of institutional transformations. The micro level refers to underlying societal pressures based on human values that can shape interest group action and spur institutional change (i.e., social welfare, equity). The meso level relates to the processes, facilitators, and inhibitors of institutional change, including rule structures, physical (objective) elements, social (subjective) perceptions, path dependency, and transaction costs. At this level, water reallocation reform is driven in part by rule changes within the existing allocation institutions. In the establishment of water banks, rules have involved incentivizing behavioral change in ways that ideally benefit both transacting parties while also contributing to collective goals. A key aspect in assessing institutional reform is determining the “nested” level of governance that change occurs within. The nested concept refers to the hierarchical interrelations of institutions and their inherent rule structures (North, 1990; Ostrom 2007). Regarding water allocation, Livingston (2005)
notes that rules exist within three nested layers – water laws, water policies, and water administration. These layers are analogous with Ostrom’s (1990) tiered structure of institutional rules at constitutional-choice, collective-choice, and operational-choice levels that she uses to characterize how the rulemaking process is rationed between legislative bodies, regulating agencies, and operational entities, respectively. In some states, legislatively established water laws provide the legal foundations that define how water banks are established, by whom, where, and for what purposes. How these laws are carried out is defined at the policymaking level, and how policy execution is managed can be defined at the operational level. Understanding rule changes and the levels of governance they occur at (meso level) in connection with social or political drivers (micro level) provides a framing of how water banks have emerged and evolved from existing institutional structures in the U.S. West.

This research relies on Livingston’s (2005) micro and meso level concepts of institutional change to examine the adaptive characteristics of select intermediary water banks in the U.S. West. We utilize a framework of questions (Table 2.2) to evaluate institutional change drivers at the micro level and what rule changes at the meso level have allowed water banks to adaptively respond to various water insecurities. We further examine how water banks integrate the antithetical objectives of the market (expansion of use) with those of prior appropriation (protection of existing uses). Data used in support of the findings presented in the following section was acquired from content analysis of scholarly journals, state and local agency publications, state statutes, online data, and media sources that focused on identifying specific features of institutional arrangements, rules, and objectives. Research findings were verified through written or oral
Table 2.2 Framework of questions for evaluating micro- and meso-level factors in institutional change via the establishment of water banks in the U.S. West.

<table>
<thead>
<tr>
<th>Guiding Questions in Assessing the Adaptive Designs of Water Banks</th>
<th>Objective &amp; Relevance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Micro Level</strong></td>
<td></td>
</tr>
<tr>
<td>1. Water Insecurity Drivers</td>
<td>To identify and assess the diversity in water insecurities that have catalyzed adaptive water reallocation through water banks in the U.S. West.</td>
</tr>
<tr>
<td>2. Nature of Founding Entities</td>
<td>To illustrate the diversity in institutional origins of water banks (i.e., state legislation, grassroots efforts) and the actors advancing change through water bank implementation (i.e., members of legislative or regulatory efforts, local water districts).</td>
</tr>
<tr>
<td><strong>Meso Level</strong></td>
<td></td>
</tr>
<tr>
<td>3. Structure of Implementation</td>
<td>To illustrate the modifications of existing institutional arrangements, the levels of governance in which they occur at, and how nesting and linkages of water banks with other existing entities and existing laws were designed.</td>
</tr>
<tr>
<td>4. Resulting Capacities of Water Bank</td>
<td>To identify the institutional capacities authorized for water banks in mitigating specific water insecurities that modify or exceed existing policy options.</td>
</tr>
<tr>
<td>5. Integration of Prior Appropriation and Market Principles</td>
<td>To understand how water banks have modified prior appropriation to incorporate within market-based incentives and transactions.</td>
</tr>
<tr>
<td>6. Ongoing Adaptations</td>
<td>To assess how water banks have continued to adapt to emerging water insecurities or function with greater administrative efficiency over time.</td>
</tr>
<tr>
<td>7. Progress in Attaining Policy Objectives</td>
<td>To assess the trends in water bank activity over time and how water bank entities have performed in meeting policy objectives.</td>
</tr>
</tbody>
</table>
communication with key individuals associated with the specific water bank entities discussed in this article.

**Findings**

This section first assesses the trajectory of water banks in the U.S. West framed in the context of the water insecurities that catalyzed their establishment. Then, we utilize the framework of questions in Table 2.2 to examine pathways and outcomes of institutional reform in four case examples of water banks in the U.S. West.

*The Evolving Adaptations of Water Banks*

Although similar stresses have led to water insecurity in the western states (Table 2.1), diverse water bank designs emerged to meet localized needs corresponding to unique hydro-physical, social-economic, and policy contexts. Table 2.3 characterizes five water insecurities that intermediary and non-market water banks have responded to in the U.S. West: 1) scarcity-driven asymmetries in water access, 2) environmental needs, 3) mitigation of competing uses, 4) aquifer overdraft, and 5) interstate river basin governance. “Environmental needs” refers to the application of water transfers to meet ecosystem service needs such as endangered species habitat protection or water quality improvement. While the term “ecosystem services” has taken on various meanings (Wallace, 2007; Boyd and Banzhaf, 2009), this research refers to the framing of ecosystem services as the “delivery mechanisms” between natural systems and the benefits they provide society (Danley and Widmark, 2016). Some water banks in the U.S. West have multi-scalar designs to address water insecurities involving different water types, sources, and sectors of water use, whereas others focus on single water sources within isolated watersheds or more confined areas. The timeline in Figure 2.1 exhibits the
sequential emergence of water banks across the region in response to the water insecurity drivers listed in Table 2.3 (and identified in the brown horizontal bar) and provides notational coding as to whether they were locally established (L), a response to federal initiatives (F), formed under state legislation (S), or were organized at the state or local level but not in response to water banking legislation. Snapshots of climate conditions accompany the timeline to highlight drought patterns in the U.S. West at key points in time in the emergence of water banks.

We highlight two general phases in water bank development (Figure 2.1). First was a relatively slow period from the mid-1970s to the late 1990s in which the establishment of statewide, regional, or interstate scale programs focused on mitigating generally acute (California) or anticipated long-term scarcity (Idaho, Texas). Beginning in the early 2000s, more issue-specific or local scale banks emerged in connection with greater attention to the side effects of punctuated drought that gripped most of the U.S. West in the early 2000s (Figure 2.1). These new specialized water banks focused on conjunctive management, ecosystem service needs, and aquifer management in response to drivers such as endangered species protection or moratoriums on new uses. Groundwater has been a key water insecurity issue in the U.S. West, with several water bank initiatives involving conjunctive use between connected aquifer-surface water systems, aquifer storage and recovery, or interstate water management.
Table 2.3 Major water insecurity themes that prompted the establishment of water banks in the U.S. West. Example entities and implementation drivers for those examples are provided in the second and third columns. Codes next to each water insecurity in the first column are shown on the Figure 2.1 timeline.

<table>
<thead>
<tr>
<th>Water Insecurity</th>
<th>Example Entities</th>
<th>Implementation Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Driven by drought or chronic pressures from existing and emerging demands in fully- or over-appropriated watersheds)</td>
<td>▪ CA Drought Mitigation Water Banks (1970s and 1990s)</td>
<td>Ongoing drought conditions spurring shortages for California’s municipal sector.</td>
</tr>
<tr>
<td></td>
<td>▪ Klamath Basin Water Bank program (OR, CA)</td>
<td>Competing human and ecosystem needs exacerbated by drought.</td>
</tr>
<tr>
<td><strong>Aquifer Overdraft (AO)</strong></td>
<td>▪ Central KS Water Bank Association</td>
<td>Over reliance on groundwater in hydraulic connection with surface water.</td>
</tr>
<tr>
<td>(Declining groundwater levels from extractive rates beyond the safe yield of an aquifer)</td>
<td>▪ Semitropic Water Bank (CA)</td>
<td>Long-term groundwater use exceeding recharge.</td>
</tr>
<tr>
<td></td>
<td>▪ ID State Water Supply Bank &amp; Rental Pools</td>
<td>Lower priority groundwater users impairing senior surface water rights.</td>
</tr>
<tr>
<td><strong>Mitigation of Competing Uses (CU)</strong></td>
<td>▪ Washington Water Banking and State Trust Water Rights Programs</td>
<td>Population growth, changing economies, public values in natural amenities.</td>
</tr>
<tr>
<td>(Interference of surface water flows by groundwater pumping in closed/fully appropriated watersheds)</td>
<td>▪ Grass Valley French Ditch Co. Water Bank (MT)</td>
<td>Residential developments replacing agricultural lands.</td>
</tr>
<tr>
<td>Water Insecurity</td>
<td>Example Entities</td>
<td>Implementation Drivers</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Environmental Needs (EN)</strong></td>
<td>• Central Platte Natural Resources District Water Bank (NE)</td>
<td>Endangered species needs in an over-appropriated watershed.</td>
</tr>
<tr>
<td>(Ecosystem services i.e. - endangered species habitat maintenance, water quality enhancements)</td>
<td>• NRCS Water Bank (MN, SD, ND)</td>
<td>Land use enhancements to improve critical avian habitat areas.</td>
</tr>
<tr>
<td><strong>Interstate River Basin Governance (IG)</strong></td>
<td>• Ongoing pilot projects organized by a consortium of river basin organizations in western CO</td>
<td>Potential Colorado River Compact obligations, ongoing drought, aridification.</td>
</tr>
<tr>
<td>(Arrangements between states, tribes, and the federal government to store unused river compact apportionments, mitigate shortages, maintain reservoir operations)</td>
<td>• AZ Water Banking Authority</td>
<td>Goal of full utilization of allocated Colorado River Compact water.</td>
</tr>
<tr>
<td></td>
<td>• Lower Colorado River basin state agreements</td>
<td>Coordinated interstate storage of compact water.</td>
</tr>
</tbody>
</table>
Figure 2.1 Timeline of water bank establishment in the U.S. West. Water insecurity catalysts, mode of implementation, and corresponding windows of drought severity are also shown. Note: state silhouettes do not represent exact relative areas to one another (Palmer Drought Severity Index data source: National Centers for Environmental Information (https://www.ncdc.noaa.gov/)).
The implementation drivers (Table 2.3) demonstrate the dynamic nature of allocation issues that have magnified the U.S. West’s water insecurity. The applicability of water banks to address challenges stemming from water scarcity, emerging laws, competing uses, or complex governance arrangements reveal their versatility as a policy instrument. The promotion of water banks as a type of market-based reallocation strategy tells only a part of the narrative of their utility, however. As Table 2.3 exhibits, water banks have served a role in enhancing market-based water transfers that are intended to provide social goods deemed critical by the public. The following subsections illustrate features of institutional change in four case water bank examples in the U.S. West in reference to the specific water insecurities described in Table 2.3. These water banks were chosen to present the diversity in institutional attributes of water banks as well as the unique hydrologic and social contexts in which they originated. This article does not assess interstate compact-related water banks, as their non-market designs are applied to agreements between state or regional entities and not individuals.

Security-based Asymmetries in Access to Water – Idaho State Water Bank

The prevalence of insufficient surface runoff in the U.S. West to meet contemporary water demands has brought forth opportunity for innovative reforms in water reallocation policy. Aside from periodic yet controversial administrative or judicial decisions to reapportion water (Blumm and Schwartz, 1995; Koehler, 1995; Benson, 2004), reallocation in the U.S. West has focused extensively on market arrangements to repurpose water among private and public interests alike (Iseman et al., 2012). In the state of Idaho (Figure 2.2), regulated market-based reallocation has been practiced for over four decades following the 1979 passage of legislation that established the Idaho
Water Supply Bank. Aspects of the bill were based on recommendations in the 1976 State Water Plan. Policymakers anticipated that eventual full utilization of the state’s water would necessitate new approaches to balancing available water supplies (Idaho Water Resources Board, 1976; IDWR, 2021a). Over time, this state-level policy initiative has afforded adaptive reallocation options to meeting user needs at multiple scales. Moreover, transaction costs for participants are relatively low in comparison with the expenses typically encountered in privately arranged water transfers. Costs for participants typically involve only the water supply bank’s administrative fees and the rental price for access to banked water rights. This water bank is managed by the Idaho

Figure 2.2 The state of Idaho with local rental pool service areas outlined in red, including the Fort Hall Reservation. Note that the entire state is served by the Board’s Water Supply Bank. (Map courtesy of A. Welsh)
Water Resources Board (Board) through two institutional mechanisms: the Board’s Water Supply Bank (BWSB) and locally operated rental pools (LRPs). The BWSB is operated on the Board’s behalf by the Idaho Department of Water Resources (IDWR) and considers all types of water rights. Six LRPs, including one under the jurisdiction of the Shoshone-Bannock Tribe, are administered by local water district boards. The local boards define operational rules and oversee management of storage water leased to common “pools” that is available for seasonal rentals (subject to Board approval). The locally defined rules determine levels of access for those seeking rental water as well as the annual (fixed) prices for water.

The nesting of water bank rules between the water bank statutes, the IDWR, and local entities enhances administrative flexibility and responsiveness to stakeholder needs (Idaho Administrative Procedure Act (IDAPA), 37.02.03; R. Buyer, personal communication, May 3, 2021). Water bank rules have contributed to streamlining the water transfer process through centralized administrative that also accounts for local conditions. Water rights for all beneficial uses are considered available for lease to the BWSB, and all beneficial use categories are eligible for renting leased water rights from the BWSB. While most transfers are within agriculture, the BWSB has arranged water transfers between a diverse assortment of beneficial uses. Preliminary IDWR data of approved rentals from 2013 through 2020 shows that out of 473 transactions, 139 (29%) were non-irrigation to irrigation transfers and involved multiple unique combinations of deposited water rights to fulfill rental requests (IDWR, 2021b). And, in comparison to Idaho’s traditional change-in-use transfer process, the BWSB also enhances the
flexibility in water right applications by providing users the option to rent their own water rights for experimental uses that differ from the original water right.

Integral to the flexibility in water reallocation offered through the BWSB was the forging of a policy space where market-based lease transactions are facilitated in part by adjustments to prior appropriation law. Components of the water banking statutes and subsequent rules established by the Board still conform to the review process used in traditional water rights transfers, including the status and nature of water rights considered for lease, the risk of enlargement, and the potential for injury to other water rights. However, the BWSB rules declare deposited water rights exempt from forfeiture while they are leased to the BWSB, negating prior appropriation’s requirement for perpetual beneficial use. This rule provides dual benefits for lessors through forfeiture protection as well as the opportunity for financial gain. In matching leases to rental requests, BWSB rules further alter prior appropriation’s basic premise of seniority. In matching banked water rights to rental requests, the BWSB uses an alternative hierarchy that grants first consideration of rental requests with water rights that were leased to the BWSB earliest in time (IDAPA, 37.02.03). If the eligible water rights leased earliest in time to the bank do not entirely fulfill a rental request, the BWSB can structure a rental with water rights leased later in time to fulfill the requested rental volume (R. Buyer, personal communication, May 3, 2021). This rule benefits water bank administrators and participants alike, as more robust activity is likely if interested lessors know that the priority date of their water right will not limit its chances of being rented. Of Idaho’s six operating LRPs, locally defined rules that dictate priority in rentals generally favor agricultural use within the host water district ahead of other needs (IDWR 2020a, 2020b).
Moreover, Idaho’s largest rental pool in Water District 01 charges higher rental fees for uses downstream of its jurisdiction, which most often involve environmental flows and hydropower production (IDWR, 2020a).

Use of LRPs for ecosystem service needs demonstrates the adaptability of water banking for emerging water insecurities. In 1992, Idaho and the U.S. Bureau of Reclamation agreed to augment Snake River flows with rental pool water, providing nearly a half million acre-feet annually for anadromous salmon migration during critical flow periods. This agreement helped circumvent potential conflict over federal use of state-owned water for threatened species in the Columbia River Basin (Fereday et al., 2018). In 2001, the Lemhi River rental pool was established to acquire natural flow rights to maintain minimum stream flows during peak irrigation season (Clifford et al., 2004). More recently, LRPs have been used to mitigate disputes between surface water irrigators with senior rights and groundwater users with junior priority to pump from the East Snake River Plain Aquifer. There, junior right holders have recharged the aquifer with rented water to mitigate pumping impacts on surface water rights (Matthews, 2015).

Idaho’s Water Supply Bank is arguably the most robust water bank system in the U.S. West. BWSB activity has increased since the early 2000s along with new applications of rentals from the LRPs. BWSB rentals have increased from 1,400 acre-feet/year in the late 1990s to 75,000 acre-feet/year from 2010-2017. Cumulative annual LRP rentals comprise approximately four to five percent of the total annual volume of surface water diverted for agriculture in Idaho (Dieter et al., 2018; Idaho Water Resources Board, 2019). Hence, the Water Supply Bank’s sustained level of activity and adaptability to meet emerging needs has demonstrated that foresight in institutional
reforms can lead to eventual reliance on a versatile and well-accepted water reallocation tool.

*Aquifer Overdraft – Central Kansas Water Bank*

In recent decades, overuse of fossil aquifers and increasing reliance on groundwater due to greater variability in surface runoff have elevated long-term water insecurity in the U.S. West’s agricultural sector (Scanlon et al., 2012; Wick, 2021). In response, *post hoc* management of unsustainable aquifer use has been the focus of state and local policy initiatives regionwide (Megdal, 2012; Young, 2016; Blomquist, 2020). In this section, we examine a central Kansas water bank designed to sustain groundwater resources in a subsection of the High Plains Aquifer (Figure 2.3). In the late 1990s, studies initiated by the Kansas legislature explored options to remedy declining groundwater levels in the High Plains Aquifer that were also impacting hydraulically connected streams (Kansas Water Authority, 2000). The legislature in 2001 approved the establishment of pilot water banks as “not-for-profit corporations” through the Kansas Water Banking Act (Act) (Kansas Legislature, 2001). The law set forth foundational objectives but designated rulemaking duties at both the state and local levels. The Act’s approach to aquifer stabilization combined public resource conservation objectives with an economic incentives-based program. The law requires a minimum of ten percent of any transfer volume to remain in the aquifer, as well as the use of “safe deposits” that allow irrigators to carry forward a portion of unused appropriated water for future use (less a ten percent annual reduction from the account balance dedicated to the aquifer). Furthermore, the Act expanded the allowable distance of water right transfers from 0.8...
km beyond the original point of use to anywhere within a water bank’s service area. To promote greater equity between various uses, leases of water from the bank cannot be denied in the application process based on its proposed use (Kansas Legislature, 2001; O. Feril, personal communication, December 18, 2020).

The Central Kansas Water Bank Association (CKWBA) has been the sole water bank established in the state. Created in 2005, the CKWBA covers 10,000 km² within Big Bend Groundwater Management District No. 5 (GMD-5). The groundwater-only bank was pursued through a coalescence of localized initiatives that sought to minimize impacts of aquifer withdrawals on surface drainages as well as to provide access for new water uses. Groundwater use had been capped following a 1998 “safe yield closure” on new appropriations of water in GMD-5. Rules within the Act and at the operational level within the CKWBA have facilitated the integration of market features with prior appropriation law in several ways to stimulate user participation.

First, the Act protects water rights holders by recognizing water bank deposits as beneficial uses, which negates the risk of a non-use (abandonment) ruling by the state.
Second, the CKWBA uses a sealed-bid auction process to match publicly advertised water right deposits to potential lessees. The CKWBA does not apply pricing constraints, as leases are awarded to the highest bidder. This transaction approach disregards the priority status of deposited water rights in the auction process. The bank also accommodates privately negotiated transactions (separate from the public auction). Leased water is utilized through “term-permits” issued by the state and are junior to existing wells during the time of lease. The leased right can be exercised if the state has determined that no impairment will occur at nearby wells and that pumping at new lease locations occurs from the same aquifer unit as the source water right. CKWBA’s administrative rules have also facilitated more amenable transfer options for users, such as partitioning deposits to satisfy smaller bid requests or pooling multiple deposits to meet larger needs (O. Feril, personal communication, December 18, 2020).

Ongoing institutional adaptation of the CKWBA is facilitated through the Act’s requirement for five-year external reviews. The CKWBA’s first review resulted in adjustments to rules that had been identified to hinder bank activity. Moreover, lessons from the CKWBA’s operations have informed statutory changes, including amendments to the Act in 2012 that simplified the conserved water accounting process for users. Activity within the CKWBA has steadily increased since its inception. By 2011, the bank had accepted deposits totaling 600 acre-feet and approved ten safe deposit accounts, but administered only one lease transfer (CKWBA, 2011). After its extension approval, the CKWBA has averaged three leases annually and has approved 1,665 safe deposit accounts (O. Feril, personal communication, September 17, 2021). While transfer activity
has remained steady over the last decade, interest in the safe deposits demonstrates that water rights holders see personal benefits in their operations with saving portions of their annual apportionment for future use. Moreover, the hybrid governance approach has established an institutional structure to potentially serve greater numbers of transfer in the future as climatic, regulatory, or commodity market conditions may necessitate.

*Mitigation of Competing Uses – Washington Water Banking and Trust Water Rights*

Across the U.S. West, excessive groundwater extraction from aquifers in hydraulic connection with surface water has elevated the water insecurity for needs reliant on both sources (Wen and Chen, 2006; Cech, 2010; Brozović and Young, 2014). Policies to conjunctively manage these resources vary by state and depend in part on whether existing law recognizes their interconnection (Getches et al., 2009). The state of Washington (Figure 2.4) has acknowledged this connection since 1945 and protection of instream flows was prioritized in the state’s 1971 Water Resources Act (Washington State Legislature, 2007). In 2003, ongoing drought prompted the legislative establishment of water banking to enhance the water transfer process for diversionary and instream flow needs in the Yakima River Basin (Washington Legislature, 2003; Washington Dept. of Ecology, 2009). The state’s commitment to maintaining minimum instream flows created a niche function for local mitigation water banks, particularly in fully allocated streams in connection with highly utilized aquifers (Cronin and Fowler, 2012). Water banking is a policy extension to Washington’s Trust Water Rights Program (Trust Program), which was established in 1991 and provides authority for the state’s Department of Ecology (DOE) to acquire and hold water rights in trust by the state. Water rights are acquired by the DOE via lease, sale, purchase, donation, or agreement. “Trust water rights” can then
Figure 2.4 Locations of Washington’s water resource inventory areas (WRIAs) in brown outline and those hosting mitigation water banks (purple shaded areas). Note that 15 privately water banks operate within the Yakima River Basin along with a publicly operated banking entity. (Map courtesy of A. Welsh)

be rededicated to other uses such as instream flow maintenance or mitigating new uses.

Water banking interest in other watersheds prompted the legislature in 2009 to expand the practice statewide (DOE, 2009). The legislation did not specifically define how water banks were to be structured, thus allowing flexibility in their institutional design to meet specific needs in Washington’s 62 watershed regions designated as “water resource inventory areas” (DOE, 2021a). Water banks in the state can be operated by public, quasi-public, non-profit, or private entities. Like other water banks in the U.S. West, placement of water rights into the Trust Program is considered a beneficial use. This stipulation protects water rights from forfeiture while held in the Trust Program and incentivizes participation by negating prior appropriation’s fundamental “use it or lose it” requirement. Water rights undergo different levels of appraisal by the DOE based on their intended use and duration in the Trust Program. Rights accepted for use in water banking,
also termed “mitigating” water rights, are fully evaluated to verify the right’s status and to ensure their change in use does not impair other users (DOE, 2020).

Priority in access to trust water rights for rental does not typically involve a set protocol as in Idaho’s Water Supply Bank. Water bank applicants are often in possession of or have an arrangement with a water right holder before it is placed in the Trust Program as a mitigating water right. Moreover, there is generally little competition for candidate water rights to be selected in specific areas for mitigation banking, as there are often a limited number of suitable water rights available to fulfill these needs (K. Collins, personal communication, September 10, 2021). Once established, water banks can offer mitigation credits to interested users seeking to acquire water in areas closed to new development. Prices for credits vary considerably in the state and are often location dependent. Private water banks in the Yakima River Basin have charged from $27,000 to over $131,000 USD per acre foot of consumptive use, whereas prices in public/quasi-public or NGO water banks range from less than $1,000 to $11,000 per acre foot (Haller, 2018).

Washington’s decentralized water banking model has allowed various stakeholders to experiment with water bank designs that provide water supply solutions for new consumptive uses. Moreover, in response to concerns over administrative inefficiency, speculative behavior, and water prices within certain banks, DOE has continued to assess the rules and administration of the Trust Program (Sessions and Christensen, 2020). Since 2009, 25 water banks have been established including in the state’s wetter western region (DOE, 2021b). While the volumes of water transferred through Washington’s water banks typically differ by orders of magnitude (DOE, 2021b),
the expansion of water banks indicates that private and public interests alike have found value in water banking’s adaptability for attaining specific legislatively defined goals.

Environmental Needs – Nebraska’s Central Platte Water Banking Program

In the U.S. West, overcommitment of rights to surface diversions and groundwater withdrawals can artificially drive water scarcity. Such conditions compound the administrative challenges of water provision for multiple competing needs. In the state of Nebraska’s Platte River Basin (Figure 2.5), altered timing and availability of natural flows due to consumptive uses of surface runoff and groundwater since the mid-20th Century have impaired the habitat for multiple endangered species (Aiken, 1998).

Figure 2.5 Location of the Central Platte Natural Resources District (purple shaded area) in the state of Nebraska. (Map courtesy of A. Welsh)

The evidence of habitat deterioration prompted the U.S. Department of Interior to initiate a three state Cooperative Agreement (Agreement) in 1997 between Colorado, Wyoming, and Nebraska (Jenkins, 1999). The Agreement set forth coordination of inter- and intra-
state efforts to sustainably augment stream flow during key runoff periods in Nebraska’s central Platte River corridor (USFWS, 2020). Seven years later, Nebraska’s Legislature passed LB962, a bill directing the state’s local natural resources districts that govern groundwater use to conjunctively manage surface flows and groundwater through “integrated management plans” (IM Plans). LB962 was intended to bring over-allocated watersheds into full allocation status and to bolster surface flows in meeting Agreement objectives (Nebraska Legislature, 2004).

The Platte River’s critical habitat reaches are situated within the Central Platte Natural Resources District (District). In 2007, the District implemented a water banking program within its jurisdiction as part of its IM Plan and to contribute towards attaining target flows in the critical habitat areas. The water bank came to fruition without legislative or administrative directives at the state level and exemplifies a grassroots response that used existing laws to meet meso level policy objectives (Lower Platte River Basin Coalition (LPRBC), 2014). Moreover, the District sought to use water banking as a voluntary incentive approach in lieu of administratively curtailing water use within the district (Central Platte NRD, 2007). The banking program’s strategy was multi-faceted through provision of an online water right trading platform for irrigators, use of easements, incentivizing land use changes, and active market participation by the District to acquire water rights to offset depletion of future uses (LPRBC, 2015). The District first initiated retirement of irrigated lands in high impact areas via permanent easements arranged with willing participants. District payments were dependent on the volume of stream depletion saved in the watershed through the cessation of groundwater pumping, with fixed rates starting at $3,750 per acre-foot and eventually increasing to $8,000 per
acre-foot by 2012 (Colby, 2017). While Nebraska’s surface water administration utilizes prior appropriation in the central Platte River corridor, groundwater is administered within each of the state’s natural resources districts under a non-priority permit system. The absence of meeting prior appropriation requirements contributed to expediting transfers and lessening the administrative burdens for the Central Platte NRD’s water bank by not having to evaluate for impairment to other water rights.

The acquisition of water rights has represented the bulk of the Central Platte NRD’s water banking activity. After six years, the district acquired nearly 2,500 acre-feet of groundwater rights to serve as future mitigation credits (Colby, 2017). The CPNRD has recognized this practice as an effective policy tool that has contributed to meeting mitigation goals in its first IM Plan iteration (Central Platte NRD, 2019). However, no transactions occurred through the district’s online trading platform. The lack of interest was attributed to skepticism among stakeholders of the potential financial earnings of possible transfers, despite expressions of genuine interest in water banking prior to its implementation (personal communication, B. Flyr, October 4, 2021). While this component of the water bank program failed to cultivate robust water transfer activity, the district has continued to include acquisition and banking of water rights (surface and groundwater) as a strategy to meeting mitigation objectives and attaining fully appropriated status in its most recent IM Plan iteration (Central Platte NRD, 2019).

Table 2.4 summarizes the findings to the framework of questions for each case water bank example discussed in this section.
Discussion

Examining the trajectory of water banking in the U.S. West through Livingston’s (2005) micro and meso level institutional change factors has provided a structured evaluation to understanding the question of why and how water institutions form, and how do they change? At the micro level, the drivers of institutional change through water banks have ranged from proactive anticipation of future stresses to reactive responses to drought or endangered species protection. Moreover, these changes have originated at various tiers of water governance. Traditional water markets are bilateral exchanges to fulfill individuals’ needs wherein one entity retires their water use and sells their water right to another user. Water banks, on the other hand, are the outcome of coordinated public policies that utilize economic incentives to structure and steer such transactions to help alleviate collectively defined water insecurities. At the meso level, water banks represent institutional change achieved through retooling existing water allocation laws that broaden the flexibility and expediency of the water transfer process within the foundational structure of prior appropriation. These processes have occurred primarily through legislation (constitutional level change) and the nesting of administrative and operational rules within existing or new organizations. Moreover, constitutional level changes delegate who creates the rules and how they are made.

Figure 2.6 describes five key takeaways from the regional trajectory and case examples of water banks highlighted in this article. First, active water banks in the U.S. West have been established and administered through different institutional processes. Of the four case examples, water banks developed and operated solely at the state (Idaho) and local levels (Nebraska) have contributed to meeting specific or broad policy
Table 2.4 Summary of findings regarding the institutional reform factors referred to in Table 2.2 for intermediary water banks that were established in response to unique water insecurities in different locations of the U.S. West. Note: “ac-ft/yr” refers to acre-feet per year (on acre-foot equals 326,000 gallons).

<table>
<thead>
<tr>
<th></th>
<th>Scarcity-based Asymmetries in Access to Water (Idaho)</th>
<th>Aquifer Overdraft (Kansas)</th>
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</thead>
<tbody>
<tr>
<td><strong>Specific Water Insecurity Drivers</strong></td>
<td>Geographic imbalances in water supply and demand due to anticipated full- or over-appropriated basins.</td>
<td>Withdrawals capped due to declining aquifer levels that threatened long-term groundwater supply and connected stream flows.</td>
</tr>
<tr>
<td><strong>Foundational Actors</strong></td>
<td>State legislators (informed by the State Water Plan and historic water transfer practices in upper Snake River Basin).</td>
<td>State legislators and local stakeholders.</td>
</tr>
<tr>
<td><strong>Structure of Implementation</strong></td>
<td>“Top Down” Design – Enacted by the Idaho State legislature.</td>
<td>“Hybrid” Design – Legislatively enacted, allowing locally established water banks to function as ‘not-for-profit’ corporations.</td>
</tr>
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<td></td>
<td>The BWSB operated by the IWRB, rental pools managed by local water districts.</td>
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<tr>
<td><strong>Transformative Rules and Capacities</strong></td>
<td>Centralized water rights access.</td>
<td>Portion of transferred water right must remain in the aquifer.</td>
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<td></td>
<td>Reduced transaction costs for users.</td>
<td>Creation of safe deposits.</td>
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<td></td>
<td>Tailored rental arrangements.</td>
<td>Expanded transfer distances.</td>
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<tr>
<td></td>
<td>“Self-Rentals” for water rights holders to experiment with other uses of a right.</td>
<td>Tailored rental arrangements.</td>
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<td></td>
<td>Rentals applicable to all beneficial uses.</td>
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<tr>
<td><strong>Integration of Allocation Law and Market Principles</strong></td>
<td>Leases considered a beneficial use.</td>
<td>Leases considered a beneficial use.</td>
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<td></td>
<td>Forfeiture protection and monetary return for lessors depositing rights into the bank.</td>
<td>Sealed-bid auctions, prices defined through bidding (not fixed).</td>
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<td>Fixed public rental prices, privately negotiated prices allowed.</td>
<td>Priority status disregarded; new location of use must not interfere with existing wells.</td>
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<td></td>
<td>Priority of rental assignments based on when right was accepted by the BWSB.</td>
<td>Leased water under “term-permits” and junior to existing wells during lease.</td>
</tr>
<tr>
<td><strong>Adaptive Responsiveness</strong></td>
<td>Flexibility for new uses, such as ecosystem services and water quality; ongoing focus on administrative efficiency and technology within the BWSB.</td>
<td>Refinement of administrative and operational rules occurs through 5-year reviews, prior reviews have informed legislative amendments.</td>
</tr>
<tr>
<td><strong>Progress in Attaining Policy Objectives</strong></td>
<td>Consistent activity in LRPCs and growing use of BWSB over last two decades.</td>
<td>Increasing level of activity in recent years (~ 3 transfers per year currently).</td>
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<td></td>
<td>LRPCs rentals exceed half a million ac-ft/yr, BWSB ~75,000 ac-ft/yr.</td>
<td>High use of safe deposits among water right holders (nearly 1,600 created since inception of water bank).</td>
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<tr>
<td><strong>Mitigation of Competing Uses</strong></td>
<td><strong>Environmental Needs</strong></td>
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<td>(Washington)</td>
<td>(Nebraska)</td>
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<tr>
<td><strong>Specific Water Insecurity Drivers</strong></td>
<td>• New demands in closed basins and state level priorities for maintaining instream flows.</td>
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<td>• Federally declared endangered species due to surface and groundwater diversions in an over-allocated basin.</td>
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<td><strong>Foundational Actors</strong></td>
<td>• State legislature, informed by local advisory groups.</td>
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<td>• Leadership and stakeholders within a local natural resources district.</td>
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<tr>
<td><strong>Structure of Implementation</strong></td>
<td>• “Hybrid” Design – Introduced by legislation that designated the DOE to oversee locally operated water banks as part of the TWRP.</td>
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<td></td>
<td>• “Grassroots” Design – Locally established program operating under Nebraska’s existing water laws.</td>
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<tr>
<td><strong>Transformative Rules and Capacities</strong></td>
<td>• Facilitates the water lease process for actors in lieu of bilateral negotiations.</td>
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<td>• Utilized an online trading platform for virtual “auctions” of water rights.</td>
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<td>• Flexibility in design of individual water banks to fit local contexts.</td>
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<td></td>
<td>• Relied on state’s directive to manage groundwater and surface water conjunctively.</td>
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<tr>
<td><strong>Integration of Allocation Law and Market Principles</strong></td>
<td>• Water right leases to the TWRP are considered a beneficial use.</td>
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<td>• Groundwater rights governed through correlative rights doctrine and issued through non-priority permits, negating issues of forfeiture, beneficial use, and evaluation for impairment.</td>
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<td>• Leased water rights held by TWRP are protected from forfeiture.</td>
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<td></td>
<td>• Prices for mitigation credits are not restricted and location dependent.</td>
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<td>• Prices paid for retirement of water rights responded to market signals.</td>
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<tr>
<td><strong>Adaptive Responsiveness</strong></td>
<td>• Water banks have allowed for continued economic activity in basins closed to new uses.</td>
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<td></td>
<td>• Use of satellite imagery to verify cessation of water use on retired or converted cropland.</td>
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<td>• Stakeholder input to the state has informed policy reform efforts.</td>
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<tr>
<td><strong>Progress in Attaining Policy Objectives</strong></td>
<td>• Since 2009, 25 individual water banks have been created, intent of banks vary, and contribute to meeting water bank objectives in statute.</td>
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<tr>
<td></td>
<td>• CPNRD continues to practice water banking to acquire water rights for meeting mitigation goals and meeting mitigation targets in IM Plan.</td>
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<td>• Water transfer platform no longer used.</td>
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</table>
**Approaches to Successful Institutional Changes Vary** – The trajectory of water banks in the U.S. West shows that policy objectives can be attained whether initiated and operated at the state level, locally, or through hybrid governance approaches via state-level policy action with local administration.

**Functionality Through Nested Rules** – The modification or addition of new rules that are hierarchically linked or “nested” between different levels of governance have allowed water banks to fit within pre-existing water institutions. The structure of nested rules is dependent on the institutional origins of water banks. For example, at the legislative level, statutes define who is allowed to operate a water bank and the level of oversight by the state. State agencies can then establish specific design rules and objectives, and nested within these rules can be the day-to-day operational rules of the individual water bank.

**Multiple Adaptive Pathways** – The water banks described herein have adapted to changing needs through internal administrative efficiency improvements (Idaho) as well as external processes that evaluate water bank performance and recommend rule adjustments that respond to stakeholder needs and meeting water bank objectives (Kansas).

**Time and Institutional Commitment** – The trajectory of water banks in the U.S. West demonstrate that time and institutional commitment are critical factors in determining whether intended objectives are met. Water banking activity in Idaho did not become commonplace for nearly two decades after the program’s establishment. The Central Kansas Water Bank experienced minimal interest in water transfers initially. Now into its second decade, water transfers have increased, and thousands of irrigators have established savings accounts. In Nebraska, the Central Platte Natural Resources District dedicated millions of dollars and staff resources to meeting water bank objectives as an intermediary and active market participant.

**“Success” is Context Dependent** – Comparison of relative volumes of transferred water reveals little about the overall attainment of water bank objectives. This is due to differences in the jurisdictional areas served, the nature of water rights, and the water sources handled by water banks. A more suitable evaluative criterion is whether the water bank is progressing towards objectives defined in legislation or charters. Activity levels over time may increase, decrease, or fluctuate in response to episodic weather patterns or to the long-term nature of the water insecurity that a water bank was designed to mitigate.
objectives, as well as hybrid models that delegate shared responsibilities between state agencies and local entities (Washington, Kansas). Second, within their jurisdiction, water banks operate under specific rules that are nested within and connected to higher level state water allocation laws. For example, Idaho’s local rental pools each define operational rules that control access and pricing for rental water within their service areas. Yet, these rules must be approved by the Idaho Water Resources Board, which was granted the authority in the water banking statutes to review these rules. Third, as an advantage over general water markets, water banks have exhibited the capacity to administratively adapt to changing needs. In Idaho, for example, the water banking group within the IDWR has continued to streamline the application and approval process for users through a structured, calendar-based scheduling approach. Furthermore, the agency utilizes updated hydrologic models of connected stream-aquifer systems in evaluating potential water right rentals through the Board’s Water Supply Bank (R. Buyer, personal communication, May 28, 2021). Fourth, patience should be exerted in the pursuit of institutional change via water banks. The case examples demonstrate the payoffs over time with having established rule structures and administrative capacities that can respond to stakeholder needs. Moreover, a time commitment is critical in gaining stakeholder trust and for the water user community to become aware of what water banks offer for different interests (O. Feril, personal communication, September 17, 2021). Finally, success of institutional change through water banking should be assessed through evaluative criteria of whether water bank objectives are being met rather than sole consideration of the volumes of water that are transferred. The diversity in water bank applications in the U.S. West results inconsiderably different magnitudes of transfers
annually. Whereas hundreds of thousands of acre-feet of transfers occur annually under
the Idaho Water Bank’s purview, several hundred acre-feet may satisfy the purpose of
mitigation banks in Washington. Essential evaluation criteria should include trends in use
by economic sector and geographic distribution as well as understanding exogenous
factors such as dynamics in commodity markets, seasonal weather patterns, or policy
developments that may spur broader interest in water banking.

Despite the applicability of water banks in addressing specific water insecurities
in the U.S. West, limitations in their utility remain. Institutional reform of water rights
administration has taken considerable periods of time and political will (Kenney, 2005),
particularly in relation to water reallocation. Stakeholder buy-in and institutional trust are
critical, as actors can often harbor suspicion toward policies reliant on their water rights
even for short-term durations (Anderson et al., 2018; Carney et al., 2021). Such socially
based challenges can lead to the case of southeastern Colorado’s Arkansas River Valley,
where a state-operated pilot water bank failed to complete a single transaction before
ceasing activity in the early 2000s (Simpson, 2005). Furthermore, despite the potential to
provide more equitable access to water, rules still that dictate what sectors have rights of
first refusal remain. For example, in Idaho’s local rental pools, each water district defines
what uses have priority in rental pool access, in what order, and at what price.

Conclusions

It has been nearly three decades since MacDonnell et al.’s (1994) comprehensive
review of water banks in the U.S. West. This article has assessed the present state of the
practice by illustrating the diversity in water bank applications as institutional responses
to collectively defined water insecurities. Activity and interest in water banking has
ebbed and flowed over time, yet a clear trend is evident with ongoing experimentation in their use to alleviate the effects of water scarcity in over-appropriated watersheds. While water banks work primarily with short-term transactions to address scarcity, their establishment as institutional structures can provide longer term support in water management if banking entities accumulate enough water rights to support steady transfer activity.

In recent years, concerns over reallocation by both administrative directives as well as broader marketization of water in the U.S. West have been well documented (Smith Jr., 2016; Chipman, 2020; Blevins, 2021). We argue that water banks fulfill a niche role as a policy tool of compromise. They function in a policy space between approaches that view water as a commodity and foundational elements of water law that recognize the public ownership and trust responsibilities involved in its allocation. By integrating collectively defined and state-backed rule structures with economic incentives, water banks enhance access to water while protecting those interests willing to temporarily relinquish their water rights. Moreover, as Meinzen-Dick (2007) stressed in her assessment of water institutions, water markets alone are not panaceas. Attempts to advance institutions that govern water allocation must rely on a “tripod” in which the state, collective groups, and the market each play a role. As the U.S. West continues to confront the challenges of multiple coinciding water insecurities, water banks and similar reallocation policies will be vital to enabling greater flexibility in sharing an increasingly scarce resource.
Literature Cited


*https://www.researchgate.net/publication/318010004_Political_Economy_of_Water_Markets_in_the_Western_United_States*


Idaho Administrative Procedure Act 37.02.03. Water Bank Rules. Available from:


from:


https://unlcms.unl.edu/ianr/snr/calmit/pdf/platteRiverCooperativeAgreement.pdf


Lower Platte River Basin Coalition, 2014. Nebraska Water Banking 101. Available from:


https://lprbc.nebraska.gov/MtgMaterials/20150310WaterBankingWorkshopFINAL.pdf


https://scholar.law.colorado.edu/cgi/viewcontent.cgi?article=1059&context=books_reports_studies


CHAPTER III

THE ACCUMULATING INTEREST IN WATER BANKS: ASSESSING THEIR ROLE IN MITIGATING WATER INSECURITIES

Abstract

Reallocation is often promoted as a response to the U.S. West’s growing water insecurity. Water banking is a form of reallocation utilized in several western states to facilitate temporary water rights transfers. This article frames and examines water banking’s potential influences on water security from a hydro-social perspective through a case analysis of water banking policy in Utah. It analyzes challenges of integrating the market-based economic incentives of water banks with the legal precedents of the prior appropriation doctrine to reallocate water in over-appropriated basins with hydrologically interdependent uses. Key-informant interviews and focus groups were used to examine water security’s meaning to stakeholders and analyze how water banking could affect the water security of disparate users and uses at multiple scales. Stakeholders predominately saw water security as assurance in water quantity, but water security was further equated by participants with the legal protections afforded by water rights. Multiple complexities in water bank implementation are to be expected when multi-scalar contexts are considered, including societal and hydrologic tradeoffs in settings with diverse and interconnected interests. Our research shows that examining the potential ramifications of water banking policy through stakeholder perspectives can reveal nuanced insights on

individual and collective water security issues not only within Utah, but other arid regions in general.

Introduction

Water transfers within and between economic sectors are frequent in the western United States (U.S. West) (Brewer et al. 2007; Garrick et al. 2018). Yet, some economists contend that market-based reallocation is still an under-utilized approach to alleviate the region’s escalating water insecurities that are rooted in increasingly scarce water supplies, new priorities for non-consumptive uses, water quality degradation, and climate change (Gleick 2010; Crimmel 2014; Culp et al. 2014; Hansen 2015; Milly and Dunne 2020; Overpeck and Udall 2020). Water markets are promoted to address collective scale challenges through moving water to its “highest and best use” by incentivizing monetary compensation for water rights access at the individual scale (Easter et al. 1999; Iseman et al. 2012). Water transfers in the U.S. West typically involve private leases or sales of individual rights to use a public resource, and often require legal and engineering consultation and administrative approval to avoid impairing other users. Hence, transaction costs and potential third-party impacts can limit market activity (Libecap 2012).

To minimize obstacles to water markets, many states in the U.S. West have implemented or sanctioned water banks – public or private institutional entities devised to facilitate temporary water rights transfers in a structured, incentive-based water leasing system (MacDonnell et al. 1994; Clifford et al. 2004). Water banks vary in design and purpose but, in the U.S. West, each must work within the prior appropriation doctrine – the ubiquitous legal water allocation system of states in this region (Getches et al. 2009).
Water banks incentivize temporary water reallocation by: 1) reducing fiscal and administrative burdens common to private permanent water transfers; 2) offering lessors potential financial gain in exchange for lessees’ payment for temporary access to water; and 3) providing water access for more recently recognized beneficial uses such as ecosystem services or recreation (Montilla-López et al. 2016). Although location dependent, water banks are generally intended to address specific or multiple water insecurities at individual and societal scales (Cronin and Fowler 2012).

However, reliance on market principles to transfer rights to use water is not without risks from changes to the allocation system that traditional water users are accustomed to under prior appropriation law. The existing allocation system has provided relative certainty and predictability in water deliveries for holders of water rights acquired through administrative procedures under this law. Without effective governance during a transition to a new allocation rule, existing water users could be threatened, and new water insecurities could arise for individuals and ecosystems alike (Meinzen-Dick and Ringler 2008; Breviglieri et al. 2018). Cultivating water banking’s potential benefits and circumventing possible externalities depends on how water banks are designed and governed as well as stakeholder interest and trust in new institutional mechanisms involving the temporary transfer of water rights, which in the U.S. West are privately-owned usufructuary rights to use a public resource in perpetuity.

This article presents research on water banking as part of allocation policy reform and its connection to individual and collective water security through the perspectives of stakeholders and water leaders in the state of Utah. Situated in the heart of the U.S. West, Utah’s water resources challenges are representative of those faced across much of this
region, where states and localities are grappling with competing water supply demands in the face of climate change impacts that are intensifying droughts and altering hydrologic regimes (Overpeck and Udall 2020). Established water banks in the U.S. West vary in function and form largely due to historical and institutional particularities in each locality. Their slow adoption begs a more in-depth look at how policy and institutional change comes about, how a policy reform like water banking is anticipated in advance, and how clearly the problems water banks are intended to solve are defined and agreed upon. We look at these questions through the lens of water security where the generalities of our findings are to be found.

Our policy-oriented research was conducted during a period when the state of Utah debated and passed its 2020 water banking legislation to meet multiple policy objectives (Table 3.1) (2020 Utah Senate Bill 26; Utah Code 73-31). We relied on key-informant, semi-structured interviews and focus groups with individuals who have varied professional and personal connections to water, including leadership roles in water policy at the state and local levels. The research objectives were to understand the meanings people ascribed to “water security” and the potential role of water banking in improving water security in the context of the U.S. West using Utah as an example. This analysis contributes to the water security literature through a nuanced examination of the interface between water security and water reallocation in the context of a highly industrialized country. It demonstrates place-specific dependency of how water security can be interpreted, identifies tradeoffs that could ensue from implementing water banks, and offers stakeholder insights on ways to fairly ameliorate these tradeoffs. Such stakeholder-based information, as suggested by Marston and Cai (2016), could be vital in the quest
Table 3.1 Potential functions for water banks in Utah defined in the state’s 2017 Recommended State Water Strategy (top), and water banking objectives (bottom) defined in Utah Code following passage of Senate Bill 26 in February 2020.

<table>
<thead>
<tr>
<th>Potential Functions of Water Banks Recognized in Utah’s Recommended State Water Strategy¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Add flexibility for users in the agricultural sector to improve water quantity and quality management (Recommendation 3.5)</td>
</tr>
<tr>
<td>• Create a source of water for dedication to instream flows (Recommendation 4.2)</td>
</tr>
<tr>
<td>• Facilitate temporary transfers and shared use arrangements (i.e. – split season leases) (Recommendation 9.5)</td>
</tr>
<tr>
<td>• A water source and exchange mechanism in the state’s critical groundwater management areas (Recommendation 9.6)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objectives of water banks articulated in Utah’s 2020 Water Banking Act²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promote (Utah Code 73-31-S104(1))</td>
</tr>
<tr>
<td>(a) the optimal use of the public’s water;</td>
</tr>
<tr>
<td>(b) transparency and access to water markets;</td>
</tr>
<tr>
<td>(c) temporary, flexible, and low cost water transactions between water users; and,</td>
</tr>
<tr>
<td>(d) Utah’s agricultural economy by providing access to water resources and income for Utah’s agricultural industry; and</td>
</tr>
<tr>
<td>Facilitate (Utah Code 73-31-S104(2))</td>
</tr>
<tr>
<td>(a) robust and sustainable agricultural production while meeting growing municipal and industrial water demands, such as fallowing arrangements;</td>
</tr>
<tr>
<td>(b) water quality improvement;</td>
</tr>
<tr>
<td>(c) water rights administration and distribution; and</td>
</tr>
<tr>
<td>(d) a healthy and resilient natural environment.</td>
</tr>
</tbody>
</table>

¹ Governor’s State Water Strategy Advisory Team’s 2017 Recommended State Water Strategy (accessed July 2020, [https://envisionutah.org/utah-water-strategy-project](https://envisionutah.org/utah-water-strategy-project))

² Utah’s Water Banking Act became effective 5/12/2020 and can be found in Utah Code, Title 73, Chapter 31 (accessed July 2020, [https://le.utah.gov/xcode/Title73/Chapter31/73-31.html](https://le.utah.gov/xcode/Title73/Chapter31/73-31.html))
to utilize economic-based incentives to reallocate water in stressed watersheds across the U.S. West.

**Connecting Water Security and Water Reallocation**

*The Water Security Concept*

The water security concept is utilized across multiple disciplines to frame and assess the planet’s water resources dilemmas (Cook and Bakker 2012; Garrick and Hall 2014). Use of the term gained momentum in the 1990s through discourse on inequitable access to freshwater resources and sanitary conditions in low-income nations (Falkenmark and Lundqvist 1998; United Nations 2000; Tarlock and Wouters 2010). Water security’s conceptual meaning and relevancy continue to be debated and interpreted, however (Gober et al. 2015; Zeitoun et al. 2016; Jepson et al. 2017a; Gerlak et al. 2018). Definitions generally reference assurance of access to suitable quantities of sufficient quality water for human and ecosystem needs, economic advancement, and resilience to chronic stresses and immediate crises (Zeitoun et al. 2016). Water security’s scale of application has ranged from households to the nation-state (Lautze and Manthrithilake 2012; Jepson et al. 2017b; Wutich et al. 2017) and has included numerous assessment indicators (Norman et al. 2013; Srinivasan et al. 2017). Gerlak et al. (2018) assert from their water security-based research worldwide that the concept is “simultaneously a condition to be measured, a framework for decision making, and a policy objective.”

Grey et al.’s (2013) definition of water security as “a tolerable level of water-related risk to society” captures a more recent trend of seeing water security as a risk-based concept (Garrick and Hope 2013; Hall and Borgomeo 2013). From an engineering
and systems design standpoint, water security through assurance of specified quantities of water of a desired quality is inextricably linked to the concepts of reliability (the likelihood of a source or system failing to produce or deliver water), vulnerability (the consequences of source or system failure), and resiliency (the capacity to absorb negative impacts to the source or system) (Hashimoto et al. 1982; Intergovernmental Panel on Climate Change 2012; Kumar 2015). While risk-based framing considers tolerability to different water stresses, Pahl-Wostl et al. (2013) challenge how tolerability can be defined for individuals and societies with vast disparities in access to natural and economic resources.

Recent discourse on water security considers human dimensions of inequality, adaptive capacity, and broader inclusion of stakeholders in policy processes (Kirchhoff et al. 2016; Zeitoun et al. 2016). Zeitoun (2013) calls for use of data from social science disciplines in water security research to examine the inherent potential for policies to establish winners and losers; or, as the author succinctly noted, the question of “Water security for whom?” Zeitoun et al. (2016) further observe that past water security assessments took “reductionist” approaches (i.e., quantified, risk-based solutions that simplify water resource dilemmas) but should instead strive for “integrative” pathways that recognize environmental and societal uncertainties and account for allocation inequities. Jepson et al.’s (2017a) relational water security framework further builds on the societal connections to water, envisioning water security as ensuring individuals the ability to “engage with and benefit from” the “hydro-social cycle.” This construct refers to the processes “through which water and society shape and reshape each other to produce new hydrosocial arrangements over space and time” that support “human
The relational water security framework recognizes water not simply as a substance without meaning, but “produced as a particular ‘water’, materially and discursively, and within specific moments, contexts, and relations” (Budds et al. 2014). Furthermore, water security is viewed as a process rather than a static objective and transcends the notion of water as a physical resource being secured, but rather the “wider relations through which water is organized by humans and shapes people’s lives” (Jepson et al. 2017a, p. 47). Research on perceptions of water security has demonstrated the importance of understanding how people in different contexts view the concept for water policy reform efforts and adaptations to droughts and climate change (Strickert et al. 2015; Gober et al. 2015; Budds 2018; Wheeler and Maming 2019).

**Water security through market-based transfers?**

Economists consider water reallocation through market mechanisms as an approach to alleviate scarcity by moving water to what is characterized as the “highest and best use” evaluated in monetary terms (Grafton et al. 2011; Easter and Huang 2014). While this notion makes classic economic theory assumptions such as perfect information for market participants, water market performance in reality is dependent on a multitude of contextual factors, including local allocation laws and transfer rules, water right attributes, hydrology, infrastructure, institutional transition costs, transaction costs for participants, and third-party impact mitigation (Garrick and Hope 2013; Marston and Cai 2016). These factors directly influence the assurance of water quantity and quality, ecosystem services, and water for societal health and economic progress – the foundational elements of water security – in localities where reallocation occurs (Chong and Sunding 2006). As a water marketing variant, water banks in some U.S. states have
mitigated these performance issues, such as Idaho’s state-operated water supply bank and rental pool system (Clifford et al. 2004) that resulted in steady transfer activity and flow augmentation in the lower Snake River Basin (Idaho Water Resource Board 2019a, 2019b) and a central Nebraska water bank that helped attain target flow rates to improve environmental water security in the Platte River corridor (Colby 2017).

Water markets in general have drawn criticism over their functional inefficiencies (Matthews 2004), commodification of a public resource (Dellapenna 2005), and incapacity to consider both public values and private interests in proposed transactions (Matthews 2010). Water use in the U.S. West often involves interconnected uses and hydrologic interdependencies that have underpinned competitive as well as cooperative efforts to increase water use security in the face of scarcity (Endter-Wada et al. 2009). Inescapable physical and social realities complicate the water security balancing act between transaction participants and other interests potentially impacted by water reallocation (including ecosystems) (National Research Council 1992; Matthews 2003; Goemans and Pritchett 2014). Internationally, Bauer’s (1997, 2004) case analysis of water markets in Chile under a neo-liberal regime reveals that even under a laissez-faire economy, water markets are “unavoidably complicated” and “should be approached with care and modest expectations” due to cultural practices, politics, legalities, institutional designs, and local geography. The benefits of water markets in Australia’s Murray-Darling Basin for drought mitigation, financial gains in the agricultural sector, and environmental flow enhancements were only achieved through substantial institutional and water entitlement reform that facilitated the capacity to trade permanent and seasonal water entitlements, and through several billion dollars of federal investments committed
to purchasing water entitlements for instream flows (Connor and Kaczan 2013; Wheeler et al. 2014; Grafton et al. 2016).

*Prior Appropriation and Water Security*

Central to this research is understanding how operating water banks in the context of the established legalities of prior appropriation and investments in built infrastructure systems characteristic of the U.S. West could influence water security. The existing legal priority-based allocation system affords security to entities who possess senior water rights under state water law but creates insecurities for people with junior prior appropriation rights or unrecognized federal claims who have had to seek other legal means to secure access to water. Prior appropriation was the means through which European-American settlements and extractive industries of an expanding U.S. market economy were established in a drought-prone physiological setting that was subject to large spatial and temporal variability in water supply. This state-based water allocation doctrine expropriated water along with land from indigenous peoples and gave European settlers who invested in putting water to recognized beneficial uses the legal assurance of water access in perpetuity. It was designed to curtail economic speculation as was occurring in land markets at the time and establish orderliness in water distribution, so users knew their annual apportionment under variable climatic conditions (Worster, 1985).

Prior appropriation influenced social relations with water, particularly in agricultural communities where mutual irrigation (canal) companies helped establish collective security for their shareholders’ individual enterprises. As natural waterways were diverted for agriculture and other industrial uses, intricate hydrologic
interdependencies were created through reliance on return flows and storage facilities that were subsequently used by junior appropriators (Endter-Wada et al. 2009). This interdependency structured an equilibrium in the hydro-social cycle in irrigated areas across the U.S. West. While this structure contributed to western expansion in the 19th Century and economic prosperity in the 20th Century (Wilkinson, 1992), societal and climate change pressures on water resources in the 21st Century have raised issues of water availability and equity in access. Climate change-reduced flows now observed in the U.S. West (Udall and Overpeck 2017) create water management challenges because prior appropriation allocated set quantities instead of using pro-rata burden sharing approaches to scarcity as used in other allocation systems (Hanemann and Young 2020). Thus, prior appropriation is limited in its ability to deal with growing threats to the water security of junior water rights holders, unfulfilled tribal claims, and new interests seeking access to water rights.

Garrick and Hall (2014) argue that in many settings, institutional reform is a key pathway to water security, but notes that the potential for reform is context dependent and influenced by existing path dependency from earlier policy choices. Utah’s commitment to prior appropriation and financial investment in existing water systems is such a case of institutional path dependency (McCool 1995). While the doctrine’s utility in modern times has been questioned (Wilkinson 1989; Benson 2012; MacDonnell 2015), the state of Utah has pledged it “will remain the bedrock principle of Utah’s water law” because “too many economic decisions have been made on the strength and security of priorities to abandon the doctrine” (Governor’s State Water Strategy Advisory Team (GSWSAT) 2017). States throughout the region have modified the doctrine over time through
legislation and court rulings as a means to maintain the basic structure but increase its flexibility, such as through passage of water banking laws.

**The Influence of Scale**

Moss and Newig (2010) describe scalar problems arising in environmental issues due to disparities in spatial relations between biophysical processes, administrative structures, and individual preferences. Furthermore, because water “works across multiple scales” that affect different uses, sectors, and ecosystems, governance of the resource must also shift upward to the national or supranational scale or downward to the regional or local scale (Moss and Newig 2010). Garrick and Hall (2014) argue that the water security concept “seeks to address disparate dimensions of water-related risk in an integrated way,” and that framing different water challenges in terms of water security extends “across all dimensions of water, the full range of impacts, and indirect consequences and spill-overs up to a global scale.” Scale considerations are imperative in assessing the water security implications of reallocation. Adverse outcomes from water transfers in parts of the U.S. West historically (Reisner 1993; Sanchez 2014) have demonstrated reallocation’s impact on water security at societal scales beyond the participants in the water transfer and have also led to recent public pushback where rural to urban transfers have been considered (Welsh and Endter-Wada 2017a, 2017b). Scale issues in water bank governance can emerge from institutional design factors and the jurisdictional extent granted to the managing entity. The scale of a water bank’s reach will determine who can participate in a given area, what infrastructure resources are available, and the potential impacts transfers could have on other users and the environment (MacDonnell et al. 1994). Scale increases are likely to add complexity in
water banking governance, akin to Garrick et al.’s (2018) observation of increasing complexity in water markets as they increase in size across different jurisdictional boundaries. Understanding scale impacts can also be critical in optimizing system dynamics (Gibson et al. 2000), which in the case of water banks, can assist in identifying where robust activity is most likely to occur and where to focus resources such as metering and hydrologic modeling.

Methods

This research was initiated in spring 2018 in response to growing interest and policy debate in Utah over formulating water banking legislation. Structured research was conducted to gather interview and focus group data, and members of the research team were also participant-observers of public policy discussions that resulted in passage of Utah’s Water Banking Act in 2020. Our research goal was to gather information on water banks elsewhere, and how stakeholders in the study area anticipated their potential application in northern Utah.

Study Area

Northern Utah is situated in the Intermountain West region of the U.S. West and straddles the Colorado River and Great Basins. The region’s hydrology is snowmelt driven (> 140 cm/year) via catchments in the Wasatch and Uinta Mountains (Gillies and Ramsey 2009). This runoff supports Utah’s most productive farmlands, vital ecosystems, and the highly urbanized Wasatch Front metropolitan area of 2.4 million people (U.S. Department of Agriculture 2019; U.S. Census Bureau 2019). Utah’s rapid growth rate coupled with its historical trend as one of the top U.S. states in per capita domestic water
use (674 l/d) further complicates water management efforts in the state (Dieter et al. 2018; Richards 2020).

Northern Utah’s Bear River watershed (Figure 3.1) is a mixed rural-urban region of particular interest due to rampant pressures on the watershed from multiple competing sectors and state plans to divert runoff for Wasatch Front municipalities. The Bear River’s average annual yield of 1,100 Mm$^3$ supplies approximately 60 percent of the

Figure 3.1 Study area features in the Bear River watershed (map courtesy of A. Welsh).
inflow to the iconic Great Salt Lake. The river also supports extensive wetlands that provide critical avian habitat (Downard and Endter-Wada 2013; Downard et al. 2014; Wurtsbaugh et al. 2016; Edwards and Null 2019). Upstream of these wetlands, the Bear River supports 194,000 acres (78,509 hectares) of irrigated agriculture in Cache Valley and Box Elder County (U.S. Department of Agriculture 2019). Four major canal companies and independent irrigators in Utah and Idaho rely on storage in Bear Lake for irrigation water that supplements natural flow water rights. Thus, the multiple jurisdictions, legal arrangements, and competing sectors bring considerable institutional design challenges for potential water banks.

Research Procedures

Data Gathering Protocol and Design. A formal data gathering protocol was designed for conducting semi-structured interviews and focus groups (Weiss 1994; Neuman 2011) and approved by USU’s Institutional Review Board (Protocol #9393). The protocol contained three sections: A) questions focused on stakeholders’ connections to water, current water challenges, and strategies for addressing them; B) perspectives on water banking, problems water banks could help address, and opportunities and challenges involved in water banking implementation; and, C) views on water security, including its meaning, whether water banks could improve water security, and how Utah could most fairly deal with potential tradeoffs in promoting water security. Appropriate for policy research, this approach yielded rich, qualitative, textual content that captured stakeholder perspectives on water banking and its potential impacts on individual and collective water security.
Interview and Focus Group Administration. Research participants were recruited through two sampling approaches. First, we used purposive, reputational sampling which involves researchers utilizing inclusion criteria and exercising judgment to identify and prioritize people most relevant for the research. This non-randomized recruitment approach is appropriate for policy-related research where detailed information is sought from people most involved and knowledgeable about the research subject. Accordingly, individuals representative of diverse stakeholder groups with connections to the water banking conversation in Utah and Bear River watershed governance were invited to participate in the study. Secondly, additional participants were recruited via the snowball sampling method whereby the project’s initial interviewees recommended other individuals with particular knowledge on aspects of the research topic. This aided in prioritizing some people already identified and expanding our list of potential participants in certain categories. Third, key informants in other states were sought based on their specific experience in operating water banks or expertise in water reallocation in the U.S. West.

Participants provided informed consent prior to the interview or focus group sessions. Data acquisition occurred from July 2018 through April 2019. All but two participants chose to reveal their identity for acknowledgement and all but three sessions were conducted in person. Each session was audio recorded with participant permission and ranged in duration from 45 to 180 minutes. Most sessions were conducted by two or more members of the research team.

The study recruited 76 stakeholders representing diverse connections to water in northern Utah (64) and other U.S. western states (12). Over one-third of the participants
from Utah were involved in agriculture (34.3%). Collectively, stakeholders with water conservancy districts or canal companies (26.6%) and environmental advocacy groups (23.4%) represented half of the study’s participants from Utah. The remaining interviewees were connected to water through government agencies (state or federal), industry, legal firms, municipalities, private consultancies, academia, or the state legislature. Slightly less than half (47%) of the participants were from Cache Valley, with the remainder from Box Elder County, the Bear Lake area, or the Wasatch Front. Over 92 percent of the participants or the entities they represented hold or have held water rights or water shares, and over 40 percent have transferred a water right or share. Participants from Idaho, Washington, Wyoming, and Colorado were connected to water through state agencies, the legal field, academia, state government, or water conservancy districts. Over 80 percent of the non-Utah participants were affiliated with state agencies or legal firms.

**Data Management and Analysis.** Audio recordings of each session were transcribed for later coding. Transcriptions were saved to password protected storage systems to safeguard participants’ information. Data transcripts were analyzed by multiple team members using a multi-step coding process (Neuman 2011; Saldaña 2015) with Microsoft Word and NVivo 12 coding software (QSR International). The initial coding sequence provided general themes to the participants’ responses, to which more specific sub-themes were extracted in a second coding phase. The third step involved extracting specific participant quotes to support individual sub-themes defined in the first two coding phases. The data presented in this article is based on this structure of general to specific themes and supporting stakeholder insights via illustrative quotes.


**Results and Discussion**

This section presents our analysis of responses to questions and discussion relating water banking and water security. Given participants’ diverse experiences with water, responses often included individual as well as organizational, philosophical, and practical perspectives.

*Contextualized Meaning of Water Security*

Water security cannot be pursued in the abstract. Promoting water security requires understanding what it means to people with varying connections to water in different contexts. Participants were asked the open-ended question: “What does the term ‘water security’ mean to you?” Interviewees provided 111 responses, with nearly half of the participants articulating multiple perspectives. Data coding resulted in 12 categories of responses (Table 3.2), revealing the multi-dimensional nature of water security in this particular geographic and social context. The top six categories listed include descriptions of the coded meanings of water security and the number of different vocational connections to water that participants to each category held. Six additional categories recognized by three percent or less of the participants are also listed. Of the top six categories, several relate to common water security themes found in the literature, including suitable water quantity, water quality, protection of aquatic systems, and the physical protection of water resources and infrastructure. The concepts of risk and uncertainty were not themes that interviewees explicitly associated with water security, however. The notion of water security as a condition provided through the possession of water rights and legal protections to maintain access was the second highest meaning offered by participants. Although this theme is not found in common water security
Table 3.2 The top six coded responses to the interview question - “what does the term ‘water security’ mean to you?” The second column describes each meaning, and the third column lists how many different stakeholder groups with whom participants recognizing each meaning were affiliated.

<table>
<thead>
<tr>
<th>Water Security Meaning</th>
<th>Description of Meaning</th>
<th>No. of Different Stakeholder Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reliability in Quantity (59%)</td>
<td>The availability and reliability of expected quantities of water for basic needs and livelihoods.</td>
<td>10</td>
</tr>
<tr>
<td>Water Rights and Legal Security (32%)</td>
<td>The possession of water rights or shares, or the legal safeguards within the prior appropriation system that ensure their utility.</td>
<td>7</td>
</tr>
<tr>
<td>Infrastructure Protection (21%)</td>
<td>The protection of water infrastructure (impoundment, conveyance, treatment) from physical or cyber threats, or the maintenance/replacement of aging systems.</td>
<td>7</td>
</tr>
<tr>
<td>Water Quality Protection (9%)</td>
<td>Maintaining water quality standards to ensure suitable water quality conditions for human consumption and aquatic habitats.</td>
<td>4</td>
</tr>
<tr>
<td>Water Governance (8%)</td>
<td>Water resources management processes that include citizen and community-level involvement.</td>
<td>4</td>
</tr>
<tr>
<td>Watershed Protection (5%)</td>
<td>Protection and enhancement of natural aquatic systems (i.e. - rivers, lakes, wetlands, aquifers, municipal source water catchment areas).</td>
<td>3</td>
</tr>
</tbody>
</table>

definitions from the literature (Zeitoun et al., 2016), these responses relate to Garrick and Hall’s (2014) observation that “well-defined property rights are a foundation for water security.”

Roughly one in three participants recognized the importance of water rights and the legal protection of the access provided through those rights. Most of the Utah participants have held water rights or water shares, either personally or through affiliated
organizations. Over half of the participants that shared this meaning were connected to water through irrigated agriculture or the legal field. A northern Utah farmer exemplifies this perspective as follows:

What that [water security] means to me is that no one can come in and take my water right away, not meaning that I can do anything I want with that water right, but I don’t think anyone should be able to come in once you have gone through the process of getting that water right, and be able just to take it.

Protecting water rights is how availability and reliability in water quantity is provided under prior appropriation water law. Some of the responses categorized under this meaning did not specifically mention water rights but referred to legal safeguards on the prior appropriation system as a whole and eliminating political interference, as illustrated here:

Another thing I think that needs to be about the water security is the fact that political interests can’t supersede law. That has to be a rule of law.

The physical protection of water and water infrastructure, including from cyber or bio-chemical threats, natural disasters, or aging systems was recognized as the meaning of water security for 21% of the participants from seven different vocation connections to water. The responses from several stakeholders interviewed, including managers of water distribution or treatment systems demonstrate how water systems vulnerabilities are considered in a post-9/11 world as shown below by quotes from two Cache Valley participants:

The first thing that I think of is how high is the fence and how big are the locks… you could kill everybody in Cache Valley that is not on a private well in 24 hours without trying very hard.

Well, when I first hear the term, the first word that comes into my mind is terrorism protection.
The threats to conveyance systems and water supply in northern Utah due to natural disasters - such as from seismic activity were also identified by participants:

I mean, Logan City gets most of their water from a 32-inch pipe that comes out of Logan Canyon. 32-inch pipe. What happens if that earthquake comes and breaks that pipe? Not only will it wash out half of the mountain and flood homes in Logan, but every Logan resident is not going to have water.

The responses to the question of water security’s meaning demonstrate the diversity in individual connections to water. Yet, the notion of water security as a factor of governance and legal mechanisms was highly prevalent within the coded responses. The importance of water rights to stakeholders from different categories reveals the predominance that prior appropriation law has in the livelihoods and culture of the study area, whether from those with seniority in time for agriculture or new interests seeking access for emerging priorities.

*Water Security through Water Banking?*

In the context of Utah seeking new ways to deal with growing water insecurities, we also asked research participants: “Do you think water banks can improve water security in a) Cache Valley and b) in Utah?” For participants outside of Utah, the question was asked more generally in terms of whether they thought water banking could improve water security at regional and state scales. The responses were mixed among the 79% participants who voiced a clear opinion, with 6% remaining unsure about what they thought and 15% having no response mostly due to time constraints that did not allow the question to be asked or adequately discussed.

The largest proportion (43%) was generally optimistic and believed that “Yes,” it was likely. This segment included most of the participants from the legal field and
environmental NGOs in addition to some affiliates with state agencies, half of whom were from the Idaho Department of Water Resources. It should be noted that water banking has been practiced in Idaho for several decades. Despite trepidation shared by participants in farming with regard to the transfer of water away from agriculture, about 60% of those in agriculture believed water banking could positively influence water security. Participants noted various reasons for their optimism, including the policy of “banked” water rights being protected from forfeiture and more flexible access to additional water for users in need of it. In the case of Cache Valley, participants hoped water banking would be an avenue to demonstrate to state administrators that more of the valley’s pool of water rights were in use and, thus, “their” water (originating in the valley) would be less susceptible to what they perceived as the threat of the state declaring it forfeited or abandoned under provisions of prior appropriation law.

Another 29% of participants that represented eight different connections to water saw water banks “Potentially” having a positive influence on water security. Nearly 37% of these responses were from stakeholders working for state agencies in Utah and Idaho. These participants generally expressed some reservations, with one Utah participant noting they were “optimistically skeptical” about the prospects for water banking’s success in the state. About half of the responses from participants affiliated with environmental NGOs were in this category, as well as nearly one-quarter of all participants in agriculture. Responses coded to this category were typified by statements suggesting hesitancy in believing that water banks could unequivocally or effectively increase water security. They often included caveats regarding water banking institutional design and administration, challenges of local conditions, and the need to couple them
with other water demand management tools. The following passage from a Wasatch Front environmental NGO representative exemplifies some of this ambiguity:

They [water banks] certainly could, but it doesn’t mean that they will. In general, they could create more cooperation, more of a sense that we kind of have this shared resource and we are in it together and the less we use, the more we have next year. But if not done properly, they don’t necessarily do that. They create this illusion that we have more water and people then use more and the environment is left out of the equation. So, it kind of depends. But I could certainly see a scenario where yes, they would help us as one of the tools in our toolbox.

Another 8% of the participants firmly believed that “No,” water banking will not improve water security. This position was held by affiliates with environmental NGOs, industry, federal agencies, the legal field, and a Utah state agency. One participant suggested that water banking may just result in water security being exchanged:

Right off I would say no, just because it seems that you are dealing with the existing supply already and transferring water, I guess. It would increase the security for one user but at the detriment of another user. Thinking about the water bank transfer and the existing supply from one user to another, to the extent that you balance that it’s not really a change in water security overall, but one user might reduce their water security or increase it for another.

This question was administered toward the end of the interview or focus group after considerable discussion about water challenges and water banking. Previous questions invited participants to speak to their personal and occupational experiences. This question specifically asked about anticipated effects of water banking on water security at local and state levels. Consequently, the responses to this question generally involved explanations of how stakeholders anticipated water banks would increase or decrease water security at various scales (individual, watershed-community, state). The next section analyzes these responses in greater depth.
What (in)security for whom at what scale?

Explanations for water banking’s potential influences on water security focused on the participants’ primary interpretations of the concept and how they saw water banks either increasing or decreasing the water security of individuals (e.g., themselves, people they know, hypothetical people in certain positions), their local area of residence, or their state. Stakeholder insights were nuanced and revealed potential conflicts or contradictions, typically from water banking’s countervailing scalar influences. These contradictions thus beg more careful consideration of the question: “What water (in)security for whom at what scale?”

Participants’ explanations were analyzed and categorized first according to the meaning of water security embedded in their responses, secondly according to the nature of the anticipated influence, and thirdly according to the hydro-social scale at which the influence would occur. Nearly all of the explanations related to potential water banking influences on either increasing or decreasing security in water quantity reliability and availability (Table 3.3), security of water rights/entitlements (Table 3.4), or water security through governance (Table 3.5). Within these tables, the nature of anticipated water banking influences is described (short phrases) and displayed according to the scale of the influence, and example stakeholder comments are quoted as illustrations. The individual scale included effects on individuals or entities holding water rights who could be affected by water banking activity. The watershed-community scale refers to proximate human communities and aquatic ecosystems in either a segment or entirety of a watershed setting in which a water bank would likely operate. The state scale refers to actions and consequences of water banks that would influence the state’s overall water
supply and contribute towards attaining or impeding state policy objectives for water banks.

Despite the generally favorable attitudes among stakeholders regarding water banks positively influencing water security, Tables 3.3-3.5 illustrate the water security complexities that emerge when reallocation through water banking is considered in light of what water security means to people in this hydro-social context and in a multi-scalar analytic frame. The tables also illustrate potential conflicts or contradictions. We highlight examples in the remainder of this section using themes from each table.

The first example involves an anticipated offsetting influence of water banking across hydro-social scales through pursuit of state-wide reallocation policy objectives by appealing to individual self-interest through market-based incentives. While Utah’s RSWS called for the use of water banks to incentivize redistribution of water between different uses (GSWSAT 2017, p. 88), farmers in northern Utah, working in a sector that holds some of the region’s most senior water rights, saw the influence of water banks on reliability in water quantity and availability differently (Table 3.3). At the watershed-community scale (upper half of Table 3.3), participants in agriculture commonly envisioned water banks improving water security within their livelihood by providing supplemental water to expand irrigated agriculture. This influence is counterintuitive to the policy argument for water reallocation. In lieu of reducing the high proportion of agricultural use of developed water supplies and marketing conserved water to meet other needs (i.e., for ecosystem services), many farmers saw water banking as a way for water to stay within agriculture. Some Cache Valley farmers foresaw water banks also
Table 3.3 Themes in stakeholder responses regarding potential water banking influences on security in water quantity reliability/availability.

<table>
<thead>
<tr>
<th>Scale and water banking influence</th>
<th>Example stakeholder comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual</strong></td>
<td></td>
</tr>
<tr>
<td>- Option for affordable single-season/in-season access for users</td>
<td>“If I can jump in and jump out based upon a given set of circumstances in any given year, I like the concept. The details are where it gets a little difficult, but I like the concept.”</td>
</tr>
<tr>
<td>- Increased market access for water shares restricted to canal company service areas</td>
<td>“Yeah, see my water can only be rented inside the service area of Cub River. But with a water bank, potentially I could be renting my water to Willard Bay.”</td>
</tr>
<tr>
<td><strong>Watershed-Community</strong></td>
<td></td>
</tr>
<tr>
<td>- Access to water for ecosystem needs</td>
<td>“If the bank is developed in a way that is fair for all potential users to be able to lease water, then it is possible to use water for instream purposes.”</td>
</tr>
<tr>
<td>- Incentivize arrangements to move water between communities and uses</td>
<td>“I guess to me the benefit is that we are able to move water around, those who have a lot of water to those who don’t have a lot of water. I think that is the major purpose of creating a bank - to do exactly that.”</td>
</tr>
<tr>
<td>- Potential expansion of irrigated agriculture within watershed</td>
<td>“It would definitely give us the ability, at least initially before people catch onto it, you could go acquire dry farmland and have water for it. Because that is a lot cheaper ground simply because it doesn’t have water.”</td>
</tr>
<tr>
<td><strong>State/Region</strong></td>
<td></td>
</tr>
<tr>
<td>- A way to minimize “buy and dry” scenarios</td>
<td>“The number one thing I think it can fix is the buy and dry, the idea of water getting bought up for development and that’s the end.”</td>
</tr>
<tr>
<td>- An approach to move water to its “highest and best use” in the state</td>
<td>“I think the big one is allowing water to be put to its highest and best use and letting the market work.”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ways water security could be increased</th>
<th>Ways water security could be decreased</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Individual</strong></td>
<td><strong>Watershed-Community</strong></td>
</tr>
<tr>
<td>- Hydrologic/ecosystem impairment from water bank-facilitated infrastructure modifications</td>
<td>“Because when you start putting anything in pipes, then what has been percolating down through the aquifer and showing up in the springs down below suddenly starts to change. So that is going to be a challenge for the water bank.”</td>
</tr>
<tr>
<td><strong>Watershed-Community</strong></td>
<td></td>
</tr>
<tr>
<td>- Impairment risk to multiple interests due to transfers from lower to upper watershed reaches</td>
<td>“I think that anything that is going to significantly disrupt the flow regime of the Bear River into the Great Salt Lake is problematic. That is a function of either diminished flows and/or timing, which are really important for the ecology.”</td>
</tr>
<tr>
<td>- Flow system alteration may force junior rights holders to purchase water</td>
<td>“The junior appropriators downstream from you that used to use that water when you didn’t, that is being taken down and given to someone else and they are pushed to the side.”</td>
</tr>
<tr>
<td>- Water bank “crowding” could reduce overall water security in a watershed</td>
<td>“If banks are managed in a fragmented manner, where there are just a bunch of small ones around, I think that might end up causing some problems… we might miss out on what the broader impact or benefit might be… I guess my other concern is conflict among water banks… if there is not some oversight or coordination.”</td>
</tr>
<tr>
<td><strong>State/Region</strong></td>
<td></td>
</tr>
<tr>
<td>- Paradox of water banks stimulating greater consumptive use and reducing water availability for ecosystem services</td>
<td>“The return flows getting back to Bear River Canal Company are fewer and fewer, so our dependence on Bear Lake becomes greater and greater as these other irrigation companies become more efficient.”</td>
</tr>
<tr>
<td>- Water banking will be limited to only those who can afford to participate</td>
<td>“I worry about the big money, whatever the source is, dominating that market.”</td>
</tr>
</tbody>
</table>
Table 3.4 Themes in stakeholder responses regarding potential water banking influences on the security provided by water rights.

<table>
<thead>
<tr>
<th>Scale and water banking influence</th>
<th>Example stakeholder comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>↑ Ways water security could be increased</strong></td>
<td><strong>Individual</strong></td>
</tr>
<tr>
<td></td>
<td>- Offers water rights protection and institutionalized market-based incentives for individuals to engage in water leasing</td>
</tr>
<tr>
<td></td>
<td>- Affords protection for non-use of water rights and flexibility for uses in transition</td>
</tr>
<tr>
<td></td>
<td>- Provides access to junior water right holders or other uses needing water</td>
</tr>
<tr>
<td></td>
<td>“… because now you are compensating someone for a property right that they have, you are protecting that property right just through an institution, and then creating a market where those that do not have can then purchase and get what they require. So, you are meeting a need, protecting rights, and creating an incentive.”</td>
</tr>
<tr>
<td></td>
<td>“Water banks can help water rights holders as a region transitions from agriculture to urban, [providing] a safe haven for the water right to avoid forfeiture while the holder decides future planning.”</td>
</tr>
<tr>
<td></td>
<td>“It is good for irrigators in particular. Then communities or farmers who have a lower priority water right can get some of that water.”</td>
</tr>
<tr>
<td><strong>Watershed-Community</strong></td>
<td>- Water banking could maximize beneficial use of water and hence protect water rights for future use</td>
</tr>
<tr>
<td></td>
<td>“If we set a precedence of efficiency, we are less likely to have other people come and take it… But if we are moving it around and putting it places where we can use it, we are using it. There is nothing here for you to come get, because we are using it all. We have re-allocated it and it has moved to better places…”</td>
</tr>
<tr>
<td><strong>State/Region</strong></td>
<td>- Incentivize the agricultural community to seek more efficient practices, making available conserved water to lease</td>
</tr>
<tr>
<td></td>
<td>“Water banking can offer them a really good incentive to only use the water needed to grow that crop and then, through that water bank, that water can be leased to some other user in a different area to give them an incentive to save that water.”</td>
</tr>
<tr>
<td><strong>↓ Ways water security could be decreased</strong></td>
<td><strong>Individual</strong></td>
</tr>
<tr>
<td></td>
<td>- Losing control over water rights if bank is mismanaged or lessees (e.g., cities) become reliant on water source</td>
</tr>
<tr>
<td></td>
<td>- Limited bank applicability if actors only place low priority water rights in the bank</td>
</tr>
<tr>
<td></td>
<td>“People say, well we are willing to share it or lease it. But we are not sure we will get it back when we need it, or have access to it when we need it. So that is I think where the resistance comes, from what I think I understand about water banking.”</td>
</tr>
<tr>
<td></td>
<td>“So, my biggest concern with a water bank is printing funny money and nobody puts their good water rights in the bank.”</td>
</tr>
<tr>
<td><strong>Watershed-Community</strong></td>
<td>- Diversity in water rights/shares will complicate water bank administration and impact watershed hydrology</td>
</tr>
<tr>
<td></td>
<td>- Resurrection of dormant rights could alter existing allocation system and strain water bank administration</td>
</tr>
<tr>
<td></td>
<td>“But what a water share is on the east side of the valley versus the north end of the valley versus the south end versus the west, every company is different… because I would dare say if you had water shares in a system anywhere in the valley, you wouldn’t necessarily know the volume that represents.”</td>
</tr>
<tr>
<td></td>
<td>“I think it is a bit messy. I know there are some people that haven’t used their water for a long, long time. And the state is getting more aggressive that if you are not using it, we are taking it away. And those people just throw it all into a bank and it would be protected?”</td>
</tr>
<tr>
<td><strong>State/Region</strong></td>
<td>- Complications in water rights administration at the state level</td>
</tr>
<tr>
<td></td>
<td>- Water banks in unadjudicated areas will operate sub-optimally</td>
</tr>
<tr>
<td></td>
<td>- Risk of local intensification of water consumption without adequate water bank governance</td>
</tr>
<tr>
<td></td>
<td>“There is not only priority and the water itself, but there is the timing and then there are the type of rights, flow or storage, or the best right which is a combination right. So, when we want to put everything into a lease pool of some kind, you have to realize that you are not comparing a bushel of apples. This is a fruit basket…”</td>
</tr>
<tr>
<td></td>
<td>“The challenge that we have with the State of Utah is we have not even adjudicated all of the water, so we haven’t really defined where the water is and who has it… [so] how can you put it in a bank and lease it out?</td>
</tr>
<tr>
<td></td>
<td>“There is risk of enlargement of water rights if water bank exchanges are not properly managed, in effect causing greater depletion and insecurity in terms of supply… The other thing is the violation of water law and the fact that that is acreage expansion.”</td>
</tr>
</tbody>
</table>
### Table 3.5 Themes in stakeholder responses regarding potential water banking influences on water security through governance.

<table>
<thead>
<tr>
<th>Scale and water banking influence</th>
<th>Example stakeholder comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>↑ Ways water security could be increased</strong></td>
<td></td>
</tr>
<tr>
<td>Individual</td>
<td>“But what mechanism is there for them to really guarantee that they are going to get that water in the fall? And if they could work through a bank, then they would have a greater chance.”</td>
</tr>
<tr>
<td>- More structured, contract-based agreements in lieu of “handshake deals”</td>
<td>“I think this comes back to the concept of the spot market. You really want to have flexibility in the bank to be like - I need water this season.”</td>
</tr>
<tr>
<td>- Expedites the approval process for temporary transfers</td>
<td>“Scalability of water banks as opposed to one-on-one transactions for seeking instream flows… a lot easier.”</td>
</tr>
<tr>
<td>- Ability to move larger blocks of water</td>
<td>“So, we are envisioning it very much like a republican democracy, where we have these little laboratories for each bank to see what works. People could come up with something that we didn’t even think about.”</td>
</tr>
<tr>
<td>- Allows for experimental design in local water banks to meet different needs</td>
<td></td>
</tr>
<tr>
<td>Watershed-Community</td>
<td>“I think it potentially buys us a substantial amount of time… between conservation efforts and water banking and some of these other things, we can put off major expensive construction… and do some quality planning.”</td>
</tr>
<tr>
<td>- Water banking could reduce need or delay large infrastructure projects</td>
<td>“If you could have double uses on the same tranche of water, that would be very exciting. I think that would make our resources go so much further than they currently are.”</td>
</tr>
<tr>
<td>- Opportunity for multiple benefits from a single water bank transaction</td>
<td>“But that enables much more freedom of decision making about “Do I really need to use my water this year? Or maybe I want to lease that to somebody else or I might want to leave it in the stream for that period of time.”</td>
</tr>
<tr>
<td>- Water bank could be a central repository for water to enhance decision-making</td>
<td>“A way to cultivate coordination and community in water governance”</td>
</tr>
<tr>
<td>State/Region</td>
<td>“I think it will incentivize these different water interests in a given region and maybe find a way to work together and to build relationships that they otherwise wouldn’t do… the more we can get people talking and working together with a common purpose, it is going to reduce the need for litigation…we are seeing that.”</td>
</tr>
</tbody>
</table>

| **↓ Ways water security could be decreased** | |
| Individual | “Those of us in agriculture would be more than happy to do that. But it costs money. And sometimes the feasibility of that, even though we like the idea, we can’t do it because we just plain can’t afford it.” |
| Watershed-Community | “One of the things that we would like to overcome with water banks is local bias. You know, so-and-so won’t sell to so-and-so and will give them a short shrift. I worry with locally chartered banks we’re not resolving that.” |
| - Bias in local water bank governance could heighten equity concerns | “The challenge is coming up with a service area that works, because that is the whole concept, is that you have a service area that you define that theoretically will pass kosher so you can change a water right into it.” |
| - Service area design of water banks could hinder access | “It is going to become really complex really fast. Because those who are pushing this don’t realize the levels of complexity of actually physically getting the water from point A to point B… Theoretically it could happen. I could see that it could happen, but I don’t know how it would be in practice.” |
| State/Region | “It does provide a mechanism by which lower water values, priority values, can be transferred to higher priority values. I think there are some opportunities there. The problem with it is the definition of higher values versus lower values. They tend, when you talk about banks, to be economic. And that’s what scares me.” |
| - Complexity in institutional design could limit participation | |
| - Challenges and conflicts in crafting the decision rules for valuing water and the beneficial nature of its uses | |
improving water security by keeping beneficial use of water rights local (watershed-community scale in upper half of Table 3.4), thus rendering them less accessible to interests beyond the watershed-community (i.e., preventing transfers for urban needs along the Wasatch Front). At the individual scale, the exemption of banked water rights from forfeiture and abandonment provisions of prior appropriation law was welcomed by those who saw benefit in the legal protection of their rights with the simultaneous potential for financial gain through leasing of those rights through a water bank.

Complimenting this protection, participants from various sectors recognized the mutual benefits from water bank transactions in terms of short-term access to water rights for the lessee and financial gain for lessor. Thus, the benefits of forfeiture protection for water rights, potential access to additional water, and financial compensation from leased rights represent three influences that could presumably improve various individuals’ water security. However, as shown in the lower half of Table 3.3, individual gains made through water banking could come at the expense of diminished water quantities flowing through the system and, hence, could simultaneously reduce water security at the watershed-community scale. Such conditions could create greater insecurity for other interests in the watershed, especially in a hydro-social system with highly interconnected agricultural uses that depend on return flows to satisfy users with different priority dates.

Moreover, water banking’s potential influence on protecting water in Cache Valley could reduce critical flows that support the Great Salt Lake and adjacent wetlands downstream.

As a second example of water banking’s offsetting influences across hydro-social scales, Utah’s water banking bill intends to promote “low-cost water transactions between users” through market processes. Yet, water banks facilitating transfers of water to its
“highest and best use” was a beneficial water security influence identified by some participants for increasing water security at a state-wide scale. Simple market principles of scarcity and price dictate that costs for water will increase in times of high demand unless water banks have fixed prices as done in Idaho’s water bank system. The state-regional scale influence in the lower half of Table 3.3 exemplifies the concern of several interviewees that only urban areas and larger commercial buyers who can afford to pay for water will participate, negating needs for greater equity in water access through water banking to meet societal objectives articulated in the Water Banking Act (Table 3.1). These inter-scale tradeoffs in outcomes would further suggest that water security could only be improved for those individuals who hold water rights or entities who can pay for access, a concern articulated as follows by one participant:

That could be good, unless it is benefitting solely limited private interests at the expense of the larger social group. And that is what banks tend to do. Those with the deep pockets can buy the rights and those without the deep pockets, be it environmental groups, social groups, ag people, do not have the opportunity to compete for that water, because the deep pocket developers will out bid them.

A third example involves contrasting anticipations of water banking’s influence on infrastructure development. Stakeholders expressed differing opinions about how water banking might affect controversial dam projects intended to develop and distribute additional water supplies. The view offered by a wide range of stakeholders revealed their hope that using water banks to reallocate existing supplies could perhaps offset the immediate need for large infrastructure projects in Utah (watershed-community scale in Table 3.5). Counterintuitively, the Bear River Development Project slated for northern Utah has been under active planning since 1991 when Utah’s state legislative action apportioned undeveloped water allocated to Utah through the Bear River Compact with
Idaho and Wyoming (Utah Division of Water Resources 2020), that includes Cache County. Several participants who supported water banking anticipated that the project would enable Cache Valley interests to store their apportioned share not for their own use but to market other places. Additionally, various stakeholders commented on the critical need for surface reservoirs and aquifer storage to actually allow water banks to work, as several participants were unclear how they could function without storage. The following passage from a Utah state agency representative illustrates this reasoning:

I think to have a water bank you actually have to have physical structures of actual water. You can’t just play a shell game. You need to probably have reservoirs where I am a farmer, whatever my water I am not using has to be able to be stored somewhere so it can be leased to someone else.

The data presented in Tables 3.3-3.5 reveal not only the potential individualized gains or losses in water security through water banks, but also several larger, interrelated, and inter-scale tradeoffs in potential outcomes. Because of northern Utah’s unique, closed-system hydrology and the protective policy against quantity impairment in Utah’s water code (Utah Code 73-3-8), the actual physical transfer of water through water banking activities will undoubtedly result in physical impacts to the hydrologic system. To what degree these impacts actually “impair” or “injure” water users and ecosystems is unclear. Table 3.6 displays three scale-based hydrologic outcomes that could result from water banking, to which the increase in water security at one scale could both increase and decrease water security at other scales. For instance, as indicated by the effects of the first anticipated outcome in Table 3.6, the expansion of agriculture in one area of the Bear River Watershed is likely to improve water security for certain groups of individuals, but actually risk the intensification of consumptive use, resulting in less water available for some of Utah’s most pressing ecosystem needs. At the state level, this
Table 3.6 Potential tradeoffs to water security at different scales with anticipated outcomes of implementing water banks in Utah. Plus signs (+) indicate a potential scale-related increase in water security, minus signs (-) refer to potential scale-related decrease in water security.

<table>
<thead>
<tr>
<th>ANTICIPATED OUTCOMES</th>
<th>SCALE EFFECTS</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water banks stimulating greater consumptive use in watersheds – i.e. expansion of</td>
<td>Individual (+)</td>
<td>(Supports state objective of full utilization of its water resources</td>
</tr>
<tr>
<td>irrigated agriculture in Cache Valley (upstream of critical aquatic ecosystems)</td>
<td>(Opportunity for access to water for</td>
<td>and “robust and sustainable agricultural production”)</td>
</tr>
<tr>
<td></td>
<td>individual pursuits in water bank</td>
<td>(Will limit the capacity of water moving more freely between</td>
</tr>
<tr>
<td></td>
<td>service area (i.e. agriculture,</td>
<td>competing interests if use is focused in specific sectors, as</td>
</tr>
<tr>
<td></td>
<td>industry, recreation)</td>
<td>described in the RSWS)</td>
</tr>
<tr>
<td></td>
<td>Watershed-Community (-)</td>
<td>(Will limit meeting water banking bill’s objective of a “healthy</td>
</tr>
<tr>
<td></td>
<td>(Increased consumptive use upstream of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>critical stream reaches, wetlands, or</td>
<td>resilient natural environment”)</td>
</tr>
<tr>
<td></td>
<td>lakes will reduce available water for</td>
<td></td>
</tr>
<tr>
<td></td>
<td>non-consumptive purposes)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>State (+)</td>
<td></td>
</tr>
<tr>
<td>ANTICIPATED OUTCOMES</td>
<td>INDIVIDUAL</td>
<td>SCALE EFFECTS</td>
</tr>
<tr>
<td>----------------------</td>
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<td>----------------</td>
</tr>
<tr>
<td><strong>Natural flow right transfers through water banks to diversion and consumptive uses upstream or downstream of the original location of use associated with the water right</strong></td>
<td>(+) (Improves short-term water security for individual user leasing water and lessor receiving financial compensation)</td>
<td>(-) (If transfer is from lower to upper reaches of a stream, less water remains flowing through channel, impacting ecosystem needs and other individual users)</td>
</tr>
<tr>
<td></td>
<td>(-) (Potential influence on availability of water for junior water rights, could result in lower priority entitlement holders seeking to fulfill their needs through water bank rentals (water they once received for free))</td>
<td>(-) (If transfer is from upper to lower stream reaches, water remains in channel and alters pattern of return flows originating in upstream reaches, affecting natural features and irrigators above the new diversion point)</td>
</tr>
<tr>
<td><strong>Water banks stimulating more canal company water rights devoted to leases outside of service areas</strong></td>
<td>(+) (Canal companies (as an individual entity) can gain financially from transactions through water banks)</td>
<td>(+) (Portion of canal company rights available for other sectors in the watershed, including instream flows)</td>
</tr>
<tr>
<td></td>
<td>(-) (Individual canal company members near ends of ditches could experience diminished water security due to less water in conveyance system)</td>
<td>(-) (Release of water normally diverted to canal company service area used upstream or downstream will alter return flow patterns in the system and junior users in the watershed)</td>
</tr>
</tbody>
</table>
would create a situation of paradoxical outcomes. Water banking could help fulfill the state’s full utilization objective, but counterintuitively stymy two key objectives of water banks: facilitating transfers between agriculture and other sectors and promoting “a healthy and resilient natural environment” (2020 Utah Senate Bill 26). Similar situations could arise in which changing a water right’s period of use and point of diversion would have beneficial impacts for those directly involved in water banking transactions and meet state goals of facilitating movement of water, while simultaneously risking impairment to other users or natural features that, for example, became dependent on spring flows originating from decades of canal seepage.

The potential increase or decrease in water security and inter-scalar effects that could emerge with water banking are conditioned on how the banking entities are designed and governed. This explains why, among the caveats and explanations offered for whether participants thought water banks could improve water security, issues of governance emerged as the third major theme. Table 3.5 illustrates that stakeholders believe water banks can increase water security in a number of ways, particularly if they help people coordinate use of water and pool larger blocks for reallocation. But participants also acknowledge how water banks can reduce water security if they are not strategically designed to include values other than price in their decision making and operate in ways that serve goals other than just brokering water.

*Fairness in Promoting Water Security*

After discussing with participants the meaning of water security and whether it can be improved by water banking, we asked them what they thought would be the fairest
way for Utah to promote water security in light of anticipated future tradeoffs. Coded responses to this question are presented in Figure 3.2.

The top two categories of responses relate to government measures and market principles. These represent the two major water allocation mechanisms that Utah’s water banking act seeks to balance in ways that people see as fair. Water banking involves the application of market-based incentives under the existing government legal system of water allocation through prior appropriation. The facts that these two responses were most prevalent, but that people cited government measures more often than market principles, aligns with people’s concerns about ensuring that water banking exchanges should not just involve water rights and financial currency, but also the need to incorporate other values recognized through government measures to promote water uses beneficial to society. Responses categorized as “social-

![Figure 3.2 Categorized responses to the interview question regarding fairness in policies that promote water security.](image-url)
behavioral change” showed recognition that addressing issues of fairness in promoting water security involves managing basic human behavior, which government measures and market principles can be designed to do. Having inclusive dialogue and using science-based decision support were seen by some people as necessary to fairly promote water security. Interestingly, reliance on local management and control was mentioned least often as the fairest way to promote water security. In light of the other results presented in this section, this can be interpreted as additional support for the need to deal with the complexity of influences across hydro-social scales and to fully assess and account for whose water security is being strengthened or diminished.

Conclusions

Our study contributes to the evolving discourse and application of the water security concept by examining its meaning through the perspective of stakeholders in a hydro-social setting representative of the U.S. Intermountain West. We assessed stakeholder views regarding how they thought reallocation through water banking will influence water security in a prior appropriation-based allocation system. Participants’ primary interpretations of water security focused on availability and reliability of access to established quantities of water that are provided through state-administered water rights and afforded legal protections. The emphasis on water rights as a water security pathway recognizes the historical trajectory of harnessing hydrology in an arid region of a high-income national setting. This history resulted in, from a societal perspective, “sustained development of human capabilities and wellbeing,” a key water security outcome identified in the relational water security framework (Jepson et al. 2017a). The water security interpretations drawn from this research reflect how water rights,
considered pillars of water security by various stakeholders, can now become water bank currency as Utah begins to facilitate water reallocation through a legislatively enacted water banking program. Moreover, with prior appropriation’s prevalence throughout the U.S. West, similar perspectives of water rights undergirding individual water security could be expected among holders of senior water rights in other watersheds in the region.

Framing Utah’s accumulating interest in water banking within Gerlak et al.’s (2018) characterization of water security illustrates the multifaceted nature of reallocation governance in the U.S. West. First, increasing Utah’s water security through water banking legislation is a policy objective. Water banks are intended to provide access to water through leasing of rights for traditional uses as well as underserved and new interests. However, in attempting to fulfill the objectives in Table 3.1, Utah policymakers recognized that the hydrologic uniqueness in the state’s watersheds would require flexibility in water bank design to address locally unique circumstances and policy objectives. While this approach aligns with dialogue in the literature on multi-level and adaptive water governance (Bakker and Morinville 2013; Varady et al. 2016), the risk of tradeoffs or potential conflict remain. While Utah’s Water Banking Act included state oversight provisions, it does not define how water banks are to be designed. This intricate process is left to the local interests seeking to establish water banks. This decentralized approach to water banking thus ties closely with Gerlak et al’s (2018) second water security concept – the notion of water banks as a framework for decision making.

This research revealed multiple ways in which reallocation through water banking can impact water security at different scales. Water bank establishment creates several decision points for both water bank administrators and participants alike. For
administrators, the rules that determine who can participate and how water rights are exchanged are key questions that can influence water security at the individual, watershed-community, and regional scales. Water banks can also afford individuals and groups a broader set of choices and decision points in how they exercise their water rights. While Utah policymakers are banking on the notion of economic-based incentives catalyzing water transfers in the state, they also established a law in the 2020 legislative session enabling the formation watershed councils. Their purpose is to establish forums of diverse stakeholders to “facilitate discussion of and collaboration on local watershed issues” (2020 Utah House Bill 166). While these two bills may seem contradictory, several stakeholders revealed that water banks could lead to uniting the water community if their establishment treats water as a shared resource.

Stakeholder-identified tradeoffs likely to emerge from reallocation illustrate another critical issue that must be accounted for in the water bank design process. Our data revealed a strong sense of connection within the agricultural community and a desire to not only gain individually from water banking but help expand irrigated agriculture in northern Utah. Water banks in some locations have been created as an alternative water reallocation method to buy-and-dry to facilitate ag-to-urban transfers (Lepper, 2006; Dilling et al. 2019). However, our case study shows that water banks could work as a tool to keep water within a local agricultural community if banks prohibit transfers beyond the watershed-community scale. Although such a model would help engender irrigators’ trust with the water bank, the potential exclusion of certain interests, such as those seeking aquatic ecosystem protections, would limit a water bank’s capacity to meet the state’s water banking objectives. The data in tables 3.3-3.6 demonstrate that scalar-based
tradeoffs are likely unavoidable when considering the water security outcomes of water banking in the northern Utah context. This is a result of hydrologic realities and institutional artifacts of approaching reallocation with two fundamentally different policies in prior appropriation and market incentives. We contend that enabling these contrasting policies to work in tandem is not implausible however, as water rights under the prior appropriation doctrine exist within the hydro-social cycle of a community of water right holders. If water security is prioritized in an inclusive decision-making framework, water banks can be designed to build on existing societal connections to water that also include emerging societal needs.

Legal and governance safeguards are imperative in water reallocation schemes (Garrick et al. 2018). While one in four participants saw the market as the fairest way to promote Utah’s water security, a greater number believed government policy would more fairly address water security tradeoffs (Figure 3.2). Institutional governance is thus critical to ensure water banks are not merely reallocating water security between interests. While water banking is a relatively simple policy concept, our analysis shows that complexities in its implementation emerge when local contexts are examined. This is due to in part to coinciding issues such as differing individual and collective priorities, infrastructure challenges, and the value of goods and services (economic or social) provided through the beneficial use of water.

Finally, water banks can provide measurable data to assess the state of water security in different settings. In areas where banks are active, it is likely that individual or collective interests are seeking to bolster their water security. Another critical metric is understanding what sectors water is moving between and at what price. For example, data
on the movement of water to key ecosystem service needs can inform policymakers as to whether a voluntary market mechanism can, over time, serve as an effective policy tool in maintaining the Great Salt Lake or other terminal lake ecosystems in the U.S. West.

Our research demonstrates that water bank design and governance requires a commitment from state and local leadership to strong legal protections and oversight to mitigate for the likely tradeoffs that can ensue at different scales. Moreover, leaders must understand the adherence stakeholders across multiple sectors have towards water rights as their predominate pathway to water security. This is likely a universal perspective that must be considered in planning and devising reallocation schemes in states across the U.S. West that also adhere to prior appropriation water law. Whether the allocation approach is proportional, such as in Australia’s water entitlement system, or temporal-based seniority with prior appropriation in the US. West (Hanemann and Young 2020), assessing stakeholder perspectives can enhance reallocation policy. The lessons from this research are critical to institutional design considerations of water banks and are prerequisite for building capacity to fairly and effectively contribute to alleviating individual and collective water insecurities.

**Literature Cited**


Colby, B. 2017. Water Trading Innovations: Reducing Agricultural Consumptive Use to


Utah Code – Title 73, Chapter 3, Section 8. https://le.utah.gov/xcode/Title73/Chapter3/73-3-S8.html

https://water.utah.gov/bear-river/


http://dx.doi.org/10.1016/j.cosust.2016.11.001


https://doi.org/10.1016/j.landusepol.2018.12.034


https://doi.org/10.1016/j.wasec.2017.09.001


https://doi.org/10.1016/j.gloenvcha.2016.04.010
CHAPTER IV

THROUGH THE EYES OF STAKEHOLDERS: USING SOCIAL DATA TO ASSESS DETERENTS AND PATHWAYS TO WATER BANKING IN UTAH, USA

Abstract

Implementation of market-based water reallocation schemes often face multiple institutional and social obstacles. Approaches to more flexibly reallocate water for competing needs require policy reforms that overcome hindrances in institutional arrangements and individual behaviors. We used socially based qualitative research to examine the reciprocating influence between existing institutions and stakeholder perceptions and behaviors in the U.S. state of Utah, where water banking as a reallocation policy was introduced in 2020. Through key-informant interviews and focus groups, we found that stakeholders questioned the need for water banks and expressed notions of risk aversion, protectionism, and hesitancy towards water right transfers. Water bank designs must also account for prevailing agricultural practices, resistance to water use metering, and informalities within irrigation companies. We attribute these findings to path dependencies rooted in allocation institutions, the legacy of conveyance infrastructure designs, and individual circumstances regarding water use needs and practices. This research highlights how path dependencies can influence individual perceptions of market-based reallocation schemes. We argue that understanding these linkages is critical to designing new policy pathways, and that user perceptions explain in part why water markets have been less universally accepted in the western U.S. than economists have.

**Introduction**

For decades, water markets have been promoted as a policy response to global water scarcity (Howe, 1986; Easter et al., 1999; Bjornlund, 2003; Glennon, 2005). Economic and legal scholars have championed their use as a hedge against climate change impacts, population growth, ecosystem impairment, and inter-sectoral disparities in access to water (Garrick et al., 2009; Culp et al., 2014; Rosegrant et al., 2014). Water markets are intended to financially incentivize the reallocation of water from low economic value applications such as forage crop irrigation to uses yielding higher economic returns (Rosegrant and Binswanger, 1994). Market-based water reallocation can occur through permanent transfers of water rights or leases of water for various durations within and across economic sectors (Brewer et al., 2007). Despite theoretically idealized societal benefits, a wealth of research has examined inherent limitations to water markets, with transaction costs commonly cited as a principal hinderance to their broader application (Hadjigeorgalis, 2009; Grafton et al., 2012; Breviglieri et al., 2018; Endo et al., 2018).

North (1990: 362) defined transaction costs as “the costs of measuring and enforcing agreements.” In water markets, these costs can derive from the need for institutional changes, additional information acquisition, water infrastructure upgrades, and enforcement, monitoring, and mitigation of third-party impacts caused by water transfers (Marston and Cai, 2016). In the western United States (U.S.), transaction costs are, in part, driven by attributes of the prevailing water allocation system (i.e., prior appropriation law). Water rights under prior appropriation are usufructuary in nature and priority in access is based on when diversion from a water source for a beneficial use first
occurred (Kundis Craig et al., 2017). While water right transfers in the western U.S. are
guided by individual state laws, a ubiquitous aspect of the water transfer process in all
western U.S. states is the “no harm” rule that protects other users from hydrologic effects
of transfers. Pre-transfer evaluations for non-impairment can result in expenses that
render market participation cost prohibitive (Hanemann and Young, 2020).

In explaining human adaptation to social and natural environments, Schmid
(2004: 264) argues that “individuals affect institutions and institutions affect the
preferences and cognitions of individuals.” While the term institution has several
meanings, we refer to the basic concept of ordered relationships (both formal and
informal) that define rights, privileges, and responsibilities among individuals (Schmid,
2004), or as North (1990: 3) offers, “the rules of the game in a society.” Coincident with
transaction costs, certain social dimensions (i.e., beliefs, norms, actions) within
institutions and at the individual level play a consequential role in the establishment of
market-based water reallocation schemes. In addition to state laws, rules governing local
irrigation entities can limit water market activity (Ghimire and Griffin, 2014; Aylward et
al., 2016). Moreover, apprehension towards water markets can be deeply rooted due to
negative outcomes of market exchanges and fear of state or private interests interfering
with the existing allocation system (Marston and Cai, 2016). In the western U.S.,
potential impacts in areas-of-origin have limited proposed water transfers, such as in
California’s Central Valley (Hanak, 2005), southeastern Nevada (Welsh and Endter-
Wada, 2017), and southern Colorado (Bowlin, 2019). Furthermore, culturally based
views that reject the commodification of water persist in many societies globally
(Bjornlund and McKay, 2002; Ingram et al., 2008).
As existing rules underpinning current water allocation law (i.e., prior appropriation) collide with the reality of water scarcity in the western U.S., the paramount questions facing the water governance community is how will transformation of long-established institutions controlling water allocation occur, and will it support sustainable use of limited water supplies and more flexible and equitable approaches to water allocation? Overcoming historically rooted circumstances of how water is allocated will require investments in institutional reform that include broader stakeholder engagement (Garrick, 2015; Marston and Cai, 2016). Understanding how existing institutions and proposed reallocation measures can influence as well as be influenced by decisions at the individual level is vital in the policy design process, particularly for those policies in which behavioral changes are a key component of meeting collectively defined objectives.

This research utilized qualitative social science research to examine how specific social dimensions (individual behaviors, attitudes, outlooks) in a water user community are shaped by established water allocation institutions, and how these dimensions may influence user interest and participation in water reallocation schemes. This examination relies on key informant insights regarding the potential implementation of water banks in a fully appropriated watershed in the western U.S. state of Utah. Water banks are institutional arrangements that rely on market-based exchanges to incentivize temporary water right transfers (Clifford et al., 2004). They facilitate water right transfers through entities that centralize the administrative process as compared to privately sought, bilateral water market transactions (MacDonnell et al., 1994). The study area selected for this research is representative of many western U.S. watersheds that face multiple
coinciding water management dilemmas. Our work centers on understanding: 1) how social dimensions among agricultural producers are shaped by existing water allocation institutions; 2) how individual choices in water use practices may create or limit opportunities to participate in water banking, and 3) how these interconnections between institutions and individuals are attributed to path dependencies rooted in the historic development of water allocation law and infrastructure in the western U.S. Understanding these path dependent interconnections is central to informing water reallocation policy designs that are reliant on user participation to meet policy objectives.

Through social science and policy analysis data, our findings contribute insights on water reallocation by illustrating an alternative or supplemental perspective to “economic transaction costs” on why market-based water transfer schemes in the western United States have been limited in practice. This research compliments economics-based assessments of water markets by examining how fundamental social attributes of water users create obstacles to water reallocation reforms. We argue that the allocation system in the western U.S. that provided water for the needs of generations of users historically has also led to path dependent practices at the individual and institutional levels. Over time, these social practices have created a culture of apprehension among key groups of water users that hinder opportunities for water reallocation reform. We use a narrative presentation in the results and discussion section that interweaves participant insights with interpretive analysis to address the overarching questions of this research. This approach is well suited for presenting contextually based qualitative textual data that describe stakeholder thoughts, opinions, observations, histories, and actions.
Perspectives on Institutions and Individuals

The following subsections provide a brief literature overview on the background constructs used to frame this research. Discussion on the role of institutions in water reallocation reform is first presented, followed by an overview of literature highlighting stakeholder perceptions of water reallocation. The final section highlights elements of the path dependency concept within institutions and at the individual level.

Institutional Elements of Water Reallocation

Meinzen-Dick and Ringler (2008) identified three principal pathways to water reallocation: administrative, market-based, and collective negotiations. The suitability of each approach depends on various social, economic, and political factors and, in practice, water reallocation often involves a combination of these measures. Water markets, in economic theory, facilitate the transfer of water to its “highest and best use” and are often regarded as efficiency-seeking alternatives to administrative rulings (Chong and Sunding, 2006; Hadjigeorgalis, 2009). Formal markets for water are considered most appropriate where mature institutional arrangements exist, such as well-defined property rights and administrative capacities (Easter et al., 1999; Young, 2015). Determining the applicability of water markets can require substantial investments. Wheeler et al.’s (2017) framework for assessing water market “readiness” defined a process for evaluating water market “enablers” that include the state of existing institutions (property right arrangements, governance capacities), social drivers (why reallocation is needed), and hydrologic features (watershed connectivity, monitoring, available data). These preconditions do not guarantee optimal economic or social outcomes of water markets, however. Breviglieri et al. stressed that “there is a significant difference between the idea
of markets as proposed by economic theory and practice in the water sector,” (2018, p. 1087) and that water markets must evolve from “purely an economic mechanism” to institutions that are “embedded in the socio-political context” of their place of use (2018: 1087). Marston and Cai’s holistic framework for guiding reallocation decision-making stresses the use of social data to address water reallocation barriers, which include “a lack of information support and limited stakeholder involvement” (2016: 672). The authors stress the use of social data to elevate transparency and “clarify stakeholders’ values and beliefs” (2016: 672). While reliant on market elements, water banks can be administratively structured to account for broader social and political considerations through their institutional design and responsiveness to individual or societal needs.

**Institutional Reform and the Stakeholder**

The Organization for Economic Cooperation and Development (OECD, 2015, p. 35) defines “stakeholder” as a “person, group, or organization who has an interest or stake in a water-related topic, may be directly or indirectly affected by water policy, and/or have the ability to influence the outcome positively or negatively.” Stakeholder perspectives on the marketization of water are hence crucial to informing reallocation policy designs, as key actors (those who hold water rights and those willing to pay for water access) are integral to market exchanges taking place (Easter et al., 1998; Marston and Cai, 2016). In this study, we defined stakeholders as people or entities directly connected to water through its application towards a beneficial use or involved in its governance though legislative, regulatory, legal, or non-governmental connections. To avoid redundancy, we also interchange the terms “participants” or “interviewees” for stakeholders in this article’s Findings and Discussion section. In settings where market-
based reallocation has been pursued, stakeholder research often followed. Reluctance among water right holders to take part in new water market schemes has been documented (Tisdell and Ward, 2003; Giannoccaro, 2013), but gradual acceptance and increased participation has also been observed over time (Grafton et al., 2016).

Furthermore, conflicting views on water as a tradable commodity versus its necessity as a vital resource that is connected to the land on which it is applied have been noted in multiple countries (Bauer, 1997; Tisdell and Ward, 2003).

In the western U.S., Keenan et al.’s (1999) survey of agricultural and residential water users in western Colorado and California’s Kern County found contrasting views of water markets. Colorado participants in agriculture were generally less positive and saw markets as a threat to their water rights. California respondents, who tended to be absentee owners of large agricultural enterprises, were generally in favor of their use. Following an unsuccessful pilot water bank program in Colorado’s Arkansas River Valley, Lepper and Freeman (2010) found that stakeholders lacked trust in the state at the project’s onset, and that ambiguous participation rules, limited local control, and the perceived threat to senior water rights hampered interest. In Nevada’s Walker Lake Basin, Singletary and Narayanan’s (2003) survey of interest in water banking among water rights holders found that about half of the respondents were willing to participate if they had direct involvement in the water bank’s design and if water rights had forfeiture protection. Those not willing to participate opposed non-agricultural water use and harbored mistrust towards the federal government. Although a water bank was not pursued, Hockaday (2020) found that of the reallocation measures eventually implemented, senior water rights holders favored temporary transactions over a local
conservancy group’s water rights acquisition program focused on permanent transfers. In an assessment of water conservation barriers in Colorado River Basin agriculture, Taylor et al. (2019) concluded that in complex watersheds, “every ditch is indeed different,” and that the diversity in allocation challenges across the basin necessitate local innovations.

Multiple Forms of Path Dependency

The path dependency concept refers to “developmental trajectories that are inherently difficult to reverse” (Hacker, 2002, p. 54) and stresses the importance of past choices and events shaping and potentially limiting possible future options and outcomes (Sewell, 1996). The path dependency perspective offers a lens to understand the interactions and feedbacks of institutional and individual choices and the resulting impediments to adaptive policies such as water banks. When positive feedbacks ensue from an existing trajectory, reversal or altering courses over time becomes increasingly more costly (North, 2006). Understanding institutional change (i.e., reversing path dependency) has been the focus of different research perspectives on institutionalism. In assuming stability in the social and political environment, rational choice institutionalism has centered on the individual and views institutions as “coordinating mechanisms” structured to maximize personal gain (Thelen, 1999). Historical and sociological institutionalism framings see institutions as the legacy of concrete historical processes” that continue to face ongoing “contestation” over time (Thelen and Conran, 2016, p. 11). These perspectives contribute to understanding the path dependency concept with emphasis on how institutional arrangements impact human behavior and the subsequent outcomes over time. While assumptions of institutional stability are foundational in each of these perspectives, pathways to reform have been debated between incremental
adjustments or punctuated system “shocks” (Thelen and Conran, 2016). In an alternative perspective on institutional reform, Campbell (2010: 98) suggested that existing institutions should be viewed as resources rather than constraints, noting that institutional rearrangements can occur in “new and creative ways.”

Path dependency within institutions influences how past decisions and actions constrain present-day options facing an individual or organization. Over time the benefits of the current path become increasingly more attractive or self-reinforcing relative to the costs of systematic change (Pierson, 2000). With an emphasis on how history connects to the present day, Garrick (2015: 79) notes that “path dependency underscores the role of time and the dynamic interplay of stability and change.” Water institutions in the western U.S. based on prior appropriation and rooted in hydrologic and societal circumstances of the 19th and early 20th Centuries have created dilemmas in addressing the water needs of the 21st Century (Heinmiller, 2009; Libecap, 2011; Dettinger et al., 2015). Historically, prior appropriation created a status quo favoring senior water rights holders who put water to the historically predominant uses in agriculture and mining. Moreover, path dependency is reinforced by past infrastructure projects that have since limited the potential options to mitigate contemporary dilemmas such as the health of aquatic ecosystems and anadromous fish species (Leonard et al., 2015; Schmidt et al., 2016; Wheeler et al., 2021). While outcomes of past policy decisions are often cost prohibitive to reverse entirely, reforms that adapt to changing circumstances can incrementally alter existing institutions. Hence, diagnosis of past choices is imperative to reforms that modify yet still function within existing allocation institutions (Garrick, 2015).
Path dependency in individual behavior has received considerably less attention in the literature than in the concept’s application at the institutional level (Roedenbeck, 2011). Barnes et al. described behavioral “lock-in” as a condition when the individual actor is “stuck” in an “inefficiency or sub-optimality due to habit, organizational learning, or culture” (2004: 372). They further identified institutional pressure, hesitancy to relinquish power and control, and status quo “inertia” as keys to locking in behavioral attitudes and practices of the producer and consumer alike. Moreover, the authors suggest that market forces alone may not result in changing attitudes. While early studies of individual behavior and path dependency have focused on consumer choices, parallels exist in water user practices. Agricultural producers in semi-arid regions regularly face multiple operational decisions that are often shaped by coinciding circumstances, including the seasonal availability of water. Availability is determined by both climate conditions and water rights, and the more senior a right is, the less variable water is a decision factor for producers. Administering water rights through prior appropriation’s temporal hierarchy creates individual path dependencies reliant on established patterns of water distribution and use. The security offered to some individuals through seniority in water rights has led to Anderson et al.’s (2018: 199) characterization of prior appropriation as a “formidable ‘change-resistant institution’.” Moreover, they attributed resistance to the expansion of water use metering among surface water irrigators in Montana’s Yellowstone River Basin to “steadfast commitment to the status quo” (Anderson et al. 2018: 205) of how prior appropriation law has historically been interpreted and exercised in Montana (i.e., preservation of individual property rights and personal liberty in water use).
Central to our research is understanding the dynamics linkages between institutional and individual path dependencies in light of establishing new water reallocation reforms. Understanding these linkages and how attitudes and behaviors are shaped is critical in policy reforms that are dependent on behavioral changes and worldviews at the individual level. To examine these dynamics, this research follows from Marston and Cai’s holistic framework of examining barriers to water reallocation through the perspectives of key informant stakeholders and interprets their insights and individual behavioral patterns through the path dependency lens.

**Study Area Context**

Based on Utah’s 2017 Recommended State Water Strategy (GSWSAT, 2017), a legislative working group tasked to examine Utah’s instream flow dilemmas concluded that water banks could serve as a viable policy option to support increased access to water rights for non-diversionary purposes (Utah Division of Water Rights (UDWRi), 2018). The group’s multi-year effort resulted in the 2020 passage of a bill sanctioning pilot water banks in the state (2020 Utah Senate Bill 26; Utah Code 73-31). Table 4.1 displays the objectives for water banks set forth in the legislation. One candidate area to implement pilot banks is Cache Valley, the non-montane area within Cache County that hosts mixed urban and rural land uses. Cache Valley is situated in the Bear River Basin (BRB) (Figure 4.1), a closed watershed confronting many of the same hydro-social challenges as much of the western U.S. (Denton, 2007; Burnham et al., 2016). Societal pressure on the BRB’s limited water resources has escalated in recent decades from population growth, land use changes, and increasing recognition of water for ecosystem needs (Wurtsbaugh et al., 2016; Li et al., 2017, Li et al., 2019; Gehrke, 2021). Variation
in the BRB’s snowmelt-sourced runoff contributes to management challenges involving multiple consumptive and instream uses across three states (www.bearriverinfo.org, Endter-Wada et al., 2009; DeRose et al., 2015; Larsen, 2018).

Table 4.1 Objectives of water banking in Utah as defined in the state’s 2020 water banking legislation.

<table>
<thead>
<tr>
<th>Objectives of water banks articulated in Utah’s 2020 Water Banking Act¹</th>
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<tbody>
<tr>
<td>Promote (Utah Code 73-31-S104(1))</td>
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<tr>
<td>(a) the optimal use of the public’s water;</td>
</tr>
<tr>
<td>(b) transparency and access to water markets;</td>
</tr>
<tr>
<td>(c) temporary, flexible, and low-cost water transactions between water users; and,</td>
</tr>
<tr>
<td>(d) Utah’s agricultural economy by providing access to water resources and income for Utah’s agricultural industry; and</td>
</tr>
<tr>
<td>Facilitate (Utah Code 73-31-S104(2))</td>
</tr>
<tr>
<td>(a) robust and sustainable agricultural production while meeting growing municipal and industrial water demands, such as fallowing arrangements;</td>
</tr>
<tr>
<td>(b) water quality improvement;</td>
</tr>
<tr>
<td>(c) water rights administration and distribution; and</td>
</tr>
<tr>
<td>(d) a healthy and resilient natural environment.</td>
</tr>
</tbody>
</table>

¹ Utah’s Water Banking Act became effective 5/12/2020 and can be found in Utah Code, Title 73, Chapter 31 (accessed August 2021, https://le.utah.gov/xcode/Title73/Chapter31/73-31.html)
The lower section of the BRB within Utah (Figure 4.2), and Cache Valley in particular, provided a unique opportunity to examine the social and institutional dynamics of water reallocation policy reform within one of the state’s predominant agricultural areas. Cache Valley and neighboring Box Elder County combined (hereafter referred to as “northern Utah”) accommodate over 78,000 hectares of irrigated cropland, a majority of which consists of forage crops (alfalfa, hay) (USDA, 2019). Cache Valley lies upstream of the Wasatch Front urban corridor (est. population of 2.4 million residents), and critical aquatic ecosystems within and adjacent to the Great Salt Lake (Downard et al., 2014; Wurtsbaugh et al., 2016; U.S. Census Bureau, 2019).
Within Utah’s portion of Cache Valley, an expected doubling of the county’s population by 2065 is anticipated to result in further conversion of agricultural land for urban growth (Perlich et al., 2017). Sharing of the Bear River between Utah, Wyoming, and Idaho has been guided by the Bear River Compact since 1958 (Jibson, 1991; Endter-Wada et al., 2009). And unlike most western U.S. watersheds, river operations downstream of Bear Lake are managed by a privately-owned energy utility (PacifiCorp). Within Cache
Valley, municipal water distribution is decentralized, and both agricultural and urban irrigation is provided through dozens of private irrigation companies (Cache Water District, 2021). The recently formed Cache Water District (CWD) has provided a county-wide water governing entity with the means to represent area water interests at the state level (CWD, 2021).

Contemporary water governance in northern Utah is at a crossroads with multiple interests reliant on or vying for the BRB’s finite water resources (Denton, 2007; Larsen, 2018). An additional 271 Mm$^3$ is expected to be developed annually from the BRB via the Bear River Development Project (Utah Division of Water Resources, 2020). The project is designed to benefit water districts in northern Utah and the Wasatch Front, including nearly 150 Mm$^3$ for Cache and Box Elder Counties. Project opponents note its potential ecological impacts however (Utah Rivers Council, 2019), citing estimates of 106 Mm$^3$ of additional depletion annually to the Great Salt Lake.

And as within most western U.S. watersheds, pressures on the BRB’s water resources historically have maintained a tension between risk of conflict and opportunity for cooperation. Endter-Wada et al. (2009) traced efforts among several prominent groups of water stakeholders that transcended prior appropriation’s “first-in-time, first-in-right” principle through cooperative sharing of BRB resources during periods of extreme drought. Furthermore, evidence of collaboration between the federal government, PacifiCorp, and local irrigators to supply water for migratory bird habitat in Box Elder County demonstrates the potential for diverse interests to creatively share BRB resources (Downard and Endter-Wada, 2013).
Research Methods

This study relies on qualitative data acquired through semi-structured interviews and focus groups involving stakeholders with diverse connections to northern Utah’s water resources. This research approach was utilized to acquire rich, context-specific insights that can provide nuanced information vital for policy analysis. These methods allow participants to convey their thoughts openly and respond to follow up questions, enabling for greater detail and unexpected insights in comparison to structured surveys with pre-defined responses (Neuman, 2011). Data acquisition occurred from July 2018 through April 2019 and followed a formal protocol approved by Utah State University’s Institutional Review Board (Protocol #9393). Informed consent was received from each participant prior to each interview or focus group session. Participant recruitment involved non-randomized selection of individuals based on their connections to water use or governance in northern Utah. Selection of participants focused on individuals involved in the dialogue on water banking at the state level, local water and irrigation district leaders in northern Utah, and water users in the BRB known to the research team. Additional participants were invited via the snowball sampling method, wherein initial interviewees provided suggestions of other people knowledgeable of the subject matter. In total, 64 individuals participated in the study that included 56 semi-structured interviews and two focus groups. Research participants were connected to water through agriculture, environmental advocacy, water conservancy districts, state agencies, private consultancies, academia, the legal community, and government at the local, state, and federal levels. Insights from those involved in agriculture or agricultural advocacy were
of particular interest in this research due to the prevalence of senior water rights held in that sector.

Interviews and focus groups involved questions regarding personal involvement with and views on water use practices followed by questions specific to water banking. We asked participants about their connection to Utah’s water resources, the current water challenges they or their organization face, their responses to these challenges, and potential innovations that could contribute to mitigating the region’s water predicaments. We also asked participants about their familiarity with water banking and how they perceived the implementation of water banks affecting their connection to water. Perspectives were further sought regarding water bank governance, including institutional and operational arrangements, water infrastructure needs, and potential legal reforms. Finally, we asked participants to offer thoughts on potential hindrances to water bank implementation and what institutional design provisions would contribute to building stakeholder trust. The research protocol, including specific research questions is provided in an online appendix.

Interview and focus group sessions ranged from 45 minutes to 3 hours in length and were audio recorded for later transcribing. Transcripts were analyzed via a multi-step coding process (Saldaña, 2015). General themes in response to specific questions were initially coded. From these results, additional themes relating to the specific research questions of this article were extracted and categorized in a second coding phase. For example, content regarding attitudes toward water banking in general was first identified, such as whether the participants expressed interest or had reservations toward the concept. From these broad level themes, participant responses were subsequently coded
to identify specific subsets of these categories (i.e., “agricultural practices” or “concerns regarding metering”). The predominant themes that emerged in the second coding phase were further categorized in relation to this article’s research questions, and unique participant quotes were selected to illustrate the specific themes pertaining to attitudes, behaviors, or observations regarding water reallocation in northern Utah.

Results and Discussion

The following subsections describe and assess participant responses to questions regarding water banking, water use behavior, and views on water-related institutions and infrastructure needs. First, we present perspectives on water banking in northern Utah that reflect the general understanding of water banks and how the concept fits within existing water use practices. This section is followed by an examination of behavioral factors in water and land use practices that relate to the anticipated functionality of water banks in northern Utah. Then, we identify and assess how the overall social dimensions coded in the research data are influenced by institutional and individual path dependencies and summarize their potential implications on the advancement of water banking in northern Utah.

General Opinions on Water Banking

The Utility and Need for Water Banks. Research questions first focused on characterizing participants’ knowledge of and potential interest in water banking. Views on the concept varied considerably. Enthusiasm for the potential opportunity to temporarily lease or acquire water rights was expressed by a wide range of participants, while others asserted that the practice would receive little interest in Cache Valley’s agricultural community. Responses tended to have general alignments with participants’
connections to water. For instance, interest in the concept was more commonly shared by those in the legal profession or environmental advocacy, whereas varying degrees of skepticism were expressed by some government participants. A broad range of perspectives on water banking was shared by agricultural producers, however. Practitioners of irrigated agriculture reflected on the benefits and obstacles of water banking in the BRB that relate to the broader societal tradeoffs that water reallocation policies must account for in balancing emerging needs for water with long-established practices. Some participants spoke to the informal water share trading that already occurs within northern Utah’s canal companies. Data on the actual volumes exchanged is sparse, however, and study participants who spoke to the issue indicated a very small percentage of shares are transferred seasonally. Since transferring water is already an option for many irrigators, the need for formal water banks was questioned by stakeholders within and outside of agriculture. One interviewee asked: “Is there a big demand to have the flexibility to move water around on a facilitated basis there? I honestly don’t know, but I haven’t heard of that… So, I really struggle with what the need and purpose for a bank is on those rivers.” However, others in agriculture considered water banking as a tool that provides broader options in how they can lease water, as noted by an irrigator in northern Cache Valley: “My water can only be rented inside the service area of [specific irrigation company]. But with a water bank, potentially I could be renting my water to [a more distant location].” Others saw water banking as a way to protect Cache Valley water rights in a collective sense if more of the valley’s water is continuously put to beneficial use and not flowing out of the valley. As noted by one Cache Valley irrigator: “if we are
moving it around and putting it places where we can use it, we are using it. There is nothing here for you to come get, because we are using it all.”

Some farmers felt that during periods of average runoff, water supplies are sufficient for local uses and interest in water banking within the agriculture community would likely be minimal. Cache Valley benefits from mountain snowpack, numerous springs, and groundwater sources that supply water for 124 canal companies, 25 municipalities and unincorporated villages, and other independent users (Kariya et al., 1994). In reflecting on this relative abundance, one participant remarked “I think there is ample water on a regular year” for local uses. Another interviewee thought that long-time water users who have benefited from the existing allocation system may see water banks as a threat to their family enterprises, noting “It has operated just fine for them, why do they need somebody or something helping them when they can do it all themselves?” These perceptions exhibit how, under periods of normal runoff, the long-established system of capturing, allocating, and distributing BRB runoff has provided agricultural users with relative security in water availability. Stakeholders with non-agricultural connections to water, however, saw potential for water banks to fulfill non-consumptive needs, such as compliance with surface water quality standards, as noted by one interviewee: “I think it could solve some water quality issues, more cost effectively than just strict pollution reduction regulations would, so that is exciting.” Other participants noted the potential for water banks to contribute to instream flow needs while also benefitting the water right lessors, as pointed out by a participant from the Wasatch Front: “So it provides a tool to do that that is not controversial, that is still providing some sort of an economic benefit to whoever puts the water into the bank.” The
variability in perspectives on the utility of water banking revealed important insights on how water use in general is perceived in northern Utah and how participants from various sectors envisioned benefitting from water banking. Understanding the views of agricultural producers is particularly vital to informing reallocation policy designs, as the vast number of mostly senior water rights are held and used in the agricultural sector. For example, numerous Cache Valley irrigators expressed interest in the practice, but only if it would benefit themselves or other agricultural producers within the valley. These views indicate that while willingness to participate exists under certain conditions, meeting the state’s objectives of broader cross-sectoral transfers via water banks may remain limited.

**Irrigation Customs and Prior Appropriation.** Prior appropriation’s “use it or lose it” concept has been suggested to promote inefficient water use in agriculture and has generated calls for policy reform in the literature (Wilkinson, 1989; Noroian, 2011; Benson, 2012; MacDonnell, 2015). The concept, which is situated in most western states’ abandonment or forfeiture statutes, originated from common law in the 19th Century to prevent speculative behavior and ensure the continuous application of water towards beneficial uses (Kundis Craig et al., 2017). The loss of water rights through non-use is generally rare, however, as most states govern abandonment or forfeiture via onerous standards for proof of non-use as a way to limit legal or administrative actions and to protect the water rights of existing users (Benson, 2012; Kundis Craig et al., 2017). Despite this historic trend in enforcing abandonment or forfeiture in the western U.S., the fear of loss of water rights as revealed by some participants has led to paradoxical behavior in regard to prior appropriation’s fundamental objective of limiting water waste. Agricultural producers shared that unused water is rarely available in northern Utah, as
irrigators often apply their entire annual allocations regardless of the seasonal climate or crop needs. As described by one irrigator: “Guys are always pretty careful to use it up, even if it is watering a stubble field... after they go in and cut the wheat, they just go and pour the water onto it. There is nothing out there but dirt, but they are setting a precedence of ‘we use a lot of water.’” Such actions can partly be explained by fear in the agricultural community of the UDWRi or other users gaining awareness of an irrigator not using their full allocation. As one interviewee explained: “There is no benefit to conserve water. If I own 50 shares and I use 40, I am going to lose 10. So, I might as well use all 50, whether I need it or I don’t. Because the day I quit using it, somebody is going to file on it.” The practice of using the entire apportionment of water right, whether needed or not, demonstrates that excess water beyond consumptive use needs may at times be present in the hydrologic system and could be made available for other uses with sufficient water still available to maintain existing agricultural practices while also avoiding impairment to other users.

Participants also shared that a sense of risk aversion towards any type of water transfer scheme exists in the agricultural community due to state rules requiring evaluation of a water right’s historic use prior to transfer approval. This process has resulted in some irrigators foregoing formal water right transfers as the evaluation process could “expose” underutilization of a water right and result in partial forfeiture. One participant indicated that: “There is a real incentive to never do any changes (transfers). Because you could lose in the end. So, I think that is another reason why you haven’t seen moving [of water rights], because there is so much to be lost and so little to be gained.”
Hesitations Over Leasing Water Rights. Water banking has been promoted in Utah as “local, voluntary, and temporary” leasing in outreach efforts by the state (www.utahwaterbank.org). Despite this messaging, participants wondered what “temporary” entails. Multiple interviewees expounded on perceived risks of increasing dependency on banked water by lessees in the municipal or industrial sectors. One participant expressed the fear this way: “The bringing it back home thing. That’s the biggest problem. I’m afraid that once a water right has been loaned to a person for so long, not necessarily in agriculture but if it went the other way from ag to municipal, I just don’t see how that could ever be brought back to that ground. I just don’t.” This concern highlights the dueling intentions of stability versus flexibility as provided by prior appropriation and markets, respectively. An interviewee questioned whether temporary leases are the best approach to satisfying long-term needs: “So, if you got a farmer that for some reason isn’t going to be irrigating a set of acres for a couple of years and lets it come down the river rather than lose it, what happens when he needs it back? So, the temporary fixes, that is the concept of water banking that I am not sure, I don’t think anybody has the answer.” A counter point to this perspective was shared by another interviewee who indicated that the option to even lease temporary water rights through a centralized entity instead of through one-on-one negotiations could provide cost savings in the process of finding water to satisfy instream flow needs.

Tension Between Conflict and Cooperation. In recent decades, stakeholder engagement has become a common component in crafting or reforming environmental policies in the U.S. and elsewhere (Megdal et al., 2017; Wehn et al., 2018). Water banking represents a particular form of engagement in which active and ongoing
stakeholder participation is the policy objective. Yet, as several participants in this study revealed, long simmering political frictions among some northern Utah communities must be considered if water banking is to catalyze broader watershed scale cooperation.

As one interviewee observed: “... it is not all honey and roses within the local area, either. There are a lot of differing opinions... I could give you a lot of folks who don’t agree with each other in an hour’s notice. So, there is a lot of contention that is built up within the local communities. They are the ultimate decision maker... it is an emotional thing, this water stuff. You hear all of the stories about fights on ditch banks and now we throw attorneys at each other instead.” Citing disputes within his own canal company, one irrigator cautioned against the assumption of community collaboration: “If you had one community so set in their ways that they would not budge to allow this other to benefit, it is going to affect your bank. It is going to have an impact on your bank. So, I think you need to watch for that, watch for those kinds of frictions and controversies.”

Another interviewee reflected on inertia to systemic change of water use and resource sharing in Cache Valley based on what he perceived as a sense of entrenchment in attitudes at the individual and community levels. When asked if other policies besides water banking existed to meet local water challenges, he explained: “I think we are pretty limited as to a strategy. The first one [limitation] has to be political, because you are talking about getting a lot of entities together that have been independent for a lot of years. And when it comes to water, we tend to huddle around our own and aren’t really willing to open the books if you know what I mean.”

Protectionist attitudes reveal a tension between maintaining local water resources within existing uses and providing water rights access for a broader range of needs in the
BRB. Further complicating this dynamic is how lease and rental prices are determined. Fixed prices can limit price discovery of what different users are willing to pay, yet they can ensure that water rights access through a bank is affordable and accessible for interests outside of municipal or industrial sectors. Conversely, unrestricted pricing may entice greater water bank participation on the part of lessors. Hence, water bank designers must consider how the “free market,” in terms of who has access and at what price, is incorporated in the design of water banks. Some interviewees anticipated water banks serving as pathways for Wasatch Front interests to “take” Cache Valley’s water, as suggested by one irrigator: “I do think if water banks really take off it will probably be the demise of Utah agriculture, because I think that the Wasatch Front is so thirsty that they will suck it all up with lots of money.” Counteracting this dire prediction, however, a Salt Lake City area interviewee remarked: “This drives farmers and local people crazy, but if there is not a need for the water in Cache Valley, why not send it down the river and let someone on the Wasatch Front use it? I think they will change their tune as soon as they start saying, ‘oh, I can get compensated?’ Right now, they are just sending it to someone else for free and it rubs them the wrong way.”

**Behavioral and Decision Factors Affecting Interest in Water Banking**

**Farming Practices.** On-farm practices and market dynamics can each play a major role in determining water use needs. Participants in the agricultural sector elaborated on how cyclical processes in farming create decision points that could factor into whether participating in water banking provides viable economic options for their operations. An irrigator noted that the most fundamental decisions in farming center on what he termed “brutal economics,” and that mortgage payments are what “keep the ag
“folks awake every night.” One interviewee stressed that water banks would need to provide irrigators with timely response to applications for water leases during the growing season, noting the sunk costs in crop production prior to planting: “You have to remember that we’re not deciding to plant wheat until the fall before planting. So, [a farmer’s] buying $10,000 worth of seed in hopes that all of the stars line up in six months. So, he needs his water bank to understand that.” Hence, water bank participation must fit into the financial, timing, and risk management issues characteristic of farming.

The forage crop alfalfa presents unique challenges and opportunities for irrigators considering water banking. Although its production in the semi-arid western U.S. is often criticized because of its high rates of water consumption, it remains a cornerstone commodity in Utah’s agricultural economy with global market reach. As described by one Cache Valley irrigator, market dynamics and climate would likely influence whether a producer would utilize a water bank: “And in dry years, it is just going to depend on how that guy feels about his alfalfa crop… ‘Am I going to buy water for this alfalfa crop?’ Maybe China is really gung-ho again and they are taking it and he is going to do it.” However, its production pattern could influence how producers would utilize water banks. One Cache Valley irrigator noted, “timing would be everything” regarding when alfalfa growers would be interested in leasing their water rights, or, alternatively, to acquire water when shortages occur. As a quasi-perennial plant, alfalfa can produce multiple cuttings annually for upwards of six years before replanting is required. Hence, irrigators are committed for multiple years to a particular strategy in their operations if alfalfa is their primary crop. This dynamic is critical in Cache Valley, where over 67 percent of irrigated lands are dedicated to alfalfa or hay (USDA, 2019). This trend reveals
considerable homogeneity in the county’s irrigated cropping patterns. While perennial and commercial crops typically generate higher revenues than forage crops, Cache County has roughly 240 hectares of vegetable crops and less than 40 hectares of orchards (USDA, 2019). Thus, for intra-agriculture transfers through water banks, substantial price differentials between alfalfa and other crops likely would be needed to entice participation.

**Infrastructure Needs.** In response to the question of infrastructure needs for water banking in Utah, one interviewee remarked: “it is hard to run a bank on consumptive use if we don’t have the data and the information.” This comment was in reference to the consumptive portions of water rights typically used in the accounting of transfers in the western U.S. Consumptive use values vary by crop type and other physical factors and are estimated through computational formulas or satellite imagery (Hill, 1994). Ensuring that the estimated consumptive use volumes are accurately accounted for is essential for administering water transfers. Moreover, detailed hydrologic data is required to monitor diversions of transferred water as well as to shepherd leased water between points of use. Despite these necessities, study participants described a culture of apprehension towards metering, as described by one irrigator: “saying the “m” word, the meter word, is not good. There are a lot of people really sensitive to that, because people just don’t like having people watching over them. I mean, agriculture people are an independent lot, and it drives us crazy if somebody is watching everything that you do.” Paradoxically, irrigators were characterized as harboring fear of being caught not using the entirety of their water rights or shares more so than overuse, as unused portions of water rights are subject to forfeiture by the
UDWRi (Utah Code 73-1-4). Countering this fear however, an interviewee with expertise in water law enforcement remarked that that the fear of water right curtailment by the state is often overstated, noting “Really in practicality it doesn’t happen very often, but the fear of it is very real.” Interestingly, participants also noted how suspicion of other users persists among irrigators, further indicating the independent nature of water users in agriculture. As one participant observed: "everyone thinks they are doing what their right allows, but they think everyone else isn’t." Some participants shared from personal experience that in parts of Utah, how metering was framed could influence attitudes on its implementation. Interest has been noted to increase substantially after users learn that metering and monitoring systems allow people to see what other users are doing with their water, coordinate their water deliveries (especially in the Bear River with long transit times on storage water), and work together to maximize management and use in the system (Endter-Wada et al., 2009).

**Role of Canal Companies.** While seasonal water share transfers occur within northern Utah canal companies, the informal rules and norms of water distribution can hinder the ability to quantify volumes of water associated with individual company shares. The timing of “turns” to divert and flow rates are often loosely tracked according to some interviewees. Additionally, some canal companies disallow water share transfers beyond their service areas. Such challenges are evident in the management of northern Utah canal companies during the growing season. An irrigator described the informal approach to diversions within his company, noting the lack of monitoring and disorderliness in the timing of user turns to divert water: “There is no meter anywhere… I can’t say, ‘well I’m going to lease my water or sublease my water,’ it is just a matter of
you tell us when you need water and you have it until you are done. But as far as actual volume of water, there is no direct correlation to the shares that I own and the water.”

Substantiating the issue of accounting, many canal companies do not assign a water volume or flow rate to shares, and some do not issue shares, as noted by one irrigator:

“The two irrigation companies that I am involved in, I don’t think it is even possible to do anything [transfers] within those companies, because an individual holds no shares.”

Conveyance system design challenges can further limit water banking opportunities. A Cache Valley irrigator noted that canal systems generally have too much “traffic” (i.e., already at full capacity) to where shareholders could not benefit from leasable water available from a water bank, noting: “there are times where there might be a stream of water that is available, but another neighbor has already got part of the canal tied up, so I can’t access that water and there is really not much that can be done.”

Some systems cannot deliver adequate flow to users at the ends of laterals even at full capacity. Interviewees from one canal company noted that holding senior water rights does not guarantee all users in its service area receive their apportionment at all times:

“You have this really good delivery system. You have a set amount of water that comes through. And that is not always what is needed to meet the needs of your farmers... So, in the end, you have farmers like < name omitted > here at the end of their canals and the canal dries up. The water just doesn’t make it there. So, he has to add that into his management scheme of having a dry time in the middle of the heat of the summer.”

Hence, the physical characteristics of conveyance systems can limit the ability of canal companies as a whole to participate in water banking if external transfers result in a decreased canal system flows that end up further impairing a greater number of
shareholders. Yet, if potential exists for the canal company to participate in water banking without impairing other users, financial earnings from a water bank transaction could provide funds for infrastructure upgrades.

*Dependable Paths Through Path Dependency*

Our research has revealed various social complexities involved in water reallocation policy reform. Understanding the origins of these complexities is essential to informing policy designs that attempt to modify water user behaviors that are in part rooted in long-established water allocation institutions and water development and delivery systems. To illustrate the origins of these complexities and their relevancy to the establishment of water banks, participant insights were associated with the foundational sources of path dependency (water allocation law, established infrastructure, or individual behaviors) that have over time incentivized individual agricultural water use behaviors and shaped beliefs regarding water reallocation. These associations are summarized in Figure 4.3.

The 19th Century adoption of prior appropriation in the western states set the region on a path of allocating water in ways that provided early users and following generations stability and predictability in their individual water needs. This security in water access granted irrigators and mining companies assurance of continuous, dependable supplies to support their investments depending on the priority of their rights. Yet, over time prior appropriation’s stipulation of the continuous exercise of a water right has generated reluctance among individuals to seek or participate in formal water right transfers. According to irrigators in this study, concern for scrutiny by the state over water rights abandonment has generated an environment in which water right holders have little
A summary of the path dependencies rooted in water allocation institutions, their influence on individual behavior, and relevancy to water banks based on the social data provided by study participants.

incentive to conserve water in their practices. Even if abandonment or forfeiture are not commonly ruled on by the state for underuse of a water right, the fear of curtailment persists. While this aspect of prior appropriation is often criticized (Noroian, 2011; Benson, 2012), users putting their water right to full use are acting on what they perceive is in their best interest based on what existing water law requires. Prior appropriation law has thus led to water use behaviors and mindsets towards water transfers that must be considered in reallocation policies.

Participants offered further details on how path dependencies within irrigation companies are locked into conveyance system designs and operational rule structures.
While system designs are difficult to change without substantial financial infrastructure investments, operational rules are more easily amenable to reform. Construction of canal systems to divert BRB runoff across northern Utah’s agricultural lands was a defining accomplishment of the early pioneers, yet the established networks of ditches and laterals dictated who gets water, where, and in what volumes, as conveyance system designs were built to certain flow capacities. However, for present day shareholders who seek to receive leased water from an outside source, system capacities likely won’t allow for “extra” water. And if some shareholders wish to lease their shares, less water flowing through canal systems can leave those at the end of ditches in even more precarious positions. Moreover, the informal approaches to tracking and sharing “turns” in some canal systems can impact the ease with which shareholders could lease their water rights. To overcome these obstacles, irrigation companies would need to upgrade how they measure flow rates and timing of use so shareholders would know the volume of water they could deposit in a bank. While the notion of an irrigation company receiving its annual apportionment and independently managing distribution within its boundaries has worked effectively in meeting shareholder needs for decades, expanded tracking of water use could bolster the flexibility in canal company operations in ways that contribute to both maintaining agriculture and meeting water demands in other sectors. With over 100 irrigation companies in Cache Valley alone (Utah Division of Water Rights Database, 2021) the potential efficacy of water banks in northern Utah will in part be dependent on canal company operations and each entity’s willingness to alter long practiced rules and ability to invest in necessary technologies to track and control water distribution. Figure
4.4 displays the distribution and names of 50 of the largest canal companies in Cache Valley (Cache Water District, 2021).

Research findings further revealed ways in which individual path dependencies affect the capacity of users to participate in water banking. Items displayed in Figure 4.4 relate to the economics within farming operations that can impact an irrigator’s interest in acquiring or leasing water through a water bank. As described by several participants within agriculture, cropping practices can create temporary path dependencies in water needs. Although, unlike institutional-based path dependencies, producers can more easily control these practices over time to meet changing market or physical conditions. Economic considerations such as financing machinery or irrigation equipment can further define the options available to irrigators. Hence, financial factors will play into whether agricultural producers can transact in a water bank, particularly when specific incomes are needed to meet loan payments. Users who are accustomed to certain cropping practices will need assurance of the benefits of water bank participation, whether through acquiring water or depositing their water rights or shares. Overcoming hesitancies due to economics of individual producers or prevailing cropping practices will require efforts that incentivize crop types, irrigation methods, or soil management in ways that are economically advantageous. Furthermore, the physical characteristics of the farmland could factor in land use practices, as areas of marginal soil quality could be taken out of production, and the water formerly applied to less productive land could become a banked water deposit and provide the water right holder an additional income source. As a wide range of conservation options are available to producers (Colby, 2017), financially incentivizing change in crop selection or irrigation methods implemented will be key in
Figure 4.4 Irrigation company locations within Cache Valley. Note that this map does not include the entire list of companies listed in the online canal company database managed by the Utah Division of Water Resources (https://www.cachecounty.org/gis/canal-interactive-web-maps.html).
Figure 4.5 Path dependencies connected to individual behaviors and their influence on potential interest and capacity to participate in water banking as shared by study participants involved in northern Utah agriculture.

gaining interest and buy-in from farmers who harbor reservations towards any type of water right transfer. Finally, the physical location of a farm within a conveyance system or natural stream is a path dependent artifact of past patterns of settlement or property purchases. Where farms are situated can determine how, or if at all, a producer can participate in water banking. Some shareholders within canal companies may only be able to benefit by depositing shares to a bank, but not from acquiring supplemental water. Moreover, canal companies participating in transfers to outside uses must ensure that remaining flows within the conveyance system (i.e., carrier water) are sufficient to meet user needs at the ends of ditches and laterals.

**Summary and Conclusions**

This research has articulated the challenges of water reallocation reform in the western U.S. through a qualitative examination of how social dimensions of water users are influenced by various institutional and individual path dependencies. Following Marston and Cai’s (2016) call for greater inclusion of social science research to
overcome water reallocation barriers, we revealed how social dimensions in the agricultural water user community are shaped by path dependencies within existing institutions, and how these linkages in turn influence stakeholder interest in water banking in northern Utah. Key insights from agricultural producers highlighted the influence of prior appropriation law on individual behavior, most notably with the *use it or lose it* concept incentivizing the full application of water without individual benefits to users from conservation practices. The necessity of full use has also led to distrust of the water transfer process in general, as users suggested the transfer process can put water rights at risk if the state evaluation reveals less than full exercise of a water right. Moreover, shareholders within irrigation companies who are interested in water banking beyond their company’s service areas face limitations in both infrastructure and administrative capacities. In addition to these institutional factors related to prior appropriation, path dependencies that are centered on individual choices include the economic status of irrigators, cropping and irrigation practices, the physical setting of their operations, and characteristics of their farmland.

Our research has demonstrated how past choices in conveyance system design and allocation policies made well over 100 years ago have remained influential on individual water use behaviors in the present day. From a historical institutionalism perspective, attaining stability in the water allocation system was shaped by how settlers confronted the given physiographic and hydrologic conditions of northern Utah to develop conveyance networks and water user organizations (Peterson, 1997). Moreover, prior appropriation was a “borrowed” concept following its diffusion from California mining camps across the western U.S. in the later 19th Century (MacDonnell, 2015). The
combination of these components, along with eventual federal infrastructure investments provided “increasing returns” via relatively stable institutions for decades as agricultural water needs could be satisfied by existing supplies. While institutional stability in the allocation system had been achieved in the latter half of the 20th Century in much of Utah, allocation institutions failed to keep pace with the encroaching instability emerging from hydrologic and societal pressures on the state’s finite water supplies. As lawmakers remain steadfast in their commitment to prior appropriation, stakeholders at the user and management levels are left with finding what Campbell (2010) defined as “new and creative ways” in adapting existing institutions to emerging challenges while maintaining an acceptable balance between “the dynamic interplay between stability and change” in reallocation policies (Garrick, 2015). One such approach is through policy “layering,” in which new formal rules are attached to existing rule structures that then alter how the latter function (Thelen and Conran, 2016). In the case of Utah’s water banking statute, the law protects deposited water rights from abandonment or forfeiture and allows leased water to be used for any beneficial purpose. While path dependencies in infrastructure are problematic to reverse, new paths can emanate from existing allocation law such as Utah’s water banking bill and incremental legislative efforts to improve instream flow access.

To the question of why water markets are not more prevalent in the western U.S. (Culp et al., 2014), we argue that coinciding institutional and individual path dependencies have led to combinations of decision factors that individuals must consider in the water transfer process. As rational choice institutionalism would consider water markets a pathway to maximum utilization of a water right, our findings demonstrate that
various social factors exist that constrain whether water users can attempt to pursue “highest and best use” of a water right or whether such “rational” outcomes are even desirable or attainable. In northern Utah, and across the western U.S., thousands of individual agricultural producers each operate on independent paths with unique water rights and dissimilar economic conditions that continually vacillate in response to market conditions, climate, and individual interests. Moreover, Pierson (2004) stressed that gaps occur between the idealized expectations of outcomes of institutional arrangements (such as markets) and what occurs in reality due to most institutions emerging through political compromise. For example, state rules governing water transfers and irrigation company rules place limitations on how water transfers occur. Breviglieri et al.‘s (2018) argument that water markets must evolve from “economic mechanisms” to arrangements that are “embedded in the social and political context” of a watershed is thus apropos for northern Utah’s water user community. To be “embedded” in the region’s social context, water banks must untangle the interlacing of institutional and individual path dependencies in ways that acknowledge established water use practices while offering new opportunities for emerging societal priorities. The societal transitions and hydrologic realities facing Utah and neighboring states are impacting individual users and collective institutions alike and reversing path dependencies such as those identified in this article are critical in meeting the state’s diversifying water needs and interests.

Water banks are but one policy tool available to reform components of prior appropriation and expand water rights access. Their implementation has been in response to punctuated events as well as anticipated future stresses in the western U.S. (Carney et al., 2021). In northern Utah, our findings found a range of views regarding the need for
water banks, indicating that there is also disparity in the urgency for their implementation and use. Addressing stakeholder needs in policy designs that account for path dependencies prior to their implementation can potentially help avert negative outcomes such as what occurred in Colorado’s lower Arkansas River Valley’s water banking experiment. According to Lepper and Freeman (2010), that bank witnessed zero transactions despite having state and local entities involved. Because all reallocation policies are dependent on the cooperation of users possessing senior water rights, policy designs must satisfy the deeply emotive human element of trust in institutions and other individuals. Without their participation, meeting Utah’s water banking objectives will face considerable difficulties.

While limitations exist in the generalizability of this research due to the contextual uniqueness of watersheds across the western U.S., our findings mirror other research focused on water user perspectives. Attitudes towards reforms in water allocation administration found herein were similar to those described by Anderson et al. (2018) in Montana’s Yellowstone River Basin, particularly in regard to disinterest among stakeholders in expanded use of metering to better account for use of existing resources. Participants in this study also offered similar perspectives as Keenan et al.’s (1999) study on water market perspectives in western Colorado, particularly in regard to fear of water being reallocated to distant interests in ways that could harm or perhaps even lead to the demise of agriculture in general.

From a broader water management perspective, the pursuit of water banking could be construed as a process to assess and modernize a region’s water governance apparatus. Regardless of the level of water banking activity attained, the policy dialogue
inherent to reallocation reform draws attention to water conservation, efficiency, equity, economics, and tradeoffs. How water use is governed in the western U.S. by the mid-21st Century will be determined by institutional reforms and social investments made now, including, as Marston and Cai (2016) stress, increased stakeholder engagement. Utah’s water banking bill was crafted with this intent in mind by promoting user informed, local water bank designs that fit specific watershed contexts. While stakeholder participation in the policy design process does not guarantee successful outcomes, accounting for diverse water user needs may improve the likelihood that water banks or other similar reallocation tools will eventually be considered a resource through which there is so much to gain and so little to lose.

Acknowledgements

Support for this research was provided through a grant from the Extension Water Initiative at Utah State University and matching funds from the Cache Water District and the state of Utah’s Divisions of Water Resources and Water Rights. The authors extend gratitude to these project sponsors, to our colleague Niel Allen, and to the participants listed alphabetically - Clare Allen, Will Atkin, Connely Baldwin, Don Baldwin, Don Barnett, Nathan Bracken, Sterling Brown, Paul Burnett, Carly Burton, Blaise Chanson, Scott Clark, Jared Clawson, Boyd Clayton, Steve Clyde, Claudia Cottle, Dave Cottle, Earl Creech, Nathan Daugs, Bryan Dixon, Lynn de Freitas, Jim DeRito, Shaun Dustin, David Erickson, Jack Evans, Tage Flint, Erica Gaddis, Peter Gessel, James Greer, John Hardman, David Hartvigsen, Candice Hasenyager, Tim Hawkes, Charles Holmgren, Clark Israelsen, Braydon Johnson, Kelby Johnson, Kent Jones, Elizabeth Kitchens, Emily Lewis, Kirt Lindley, John Mabey, Curtis Marble, Ryan Merrill, Megan Nelson, Ann Neville, Trevor Nielson, Eric Olsen, Herm Olsen, Jay Olsen, Warren Peterson, Bret Randall, Dave Rayfield, Brett Roper, Marcelle Shoop, Nick Schou, Hilary Shughart, Jeannie Simmonds, Casey Snider, Barbara Tidwell, Jim Watterson, Regan Wheeler, Jon White, Teresa Wilhelmsen, and two participants who chose to remain confidential.

Literature Cited

Path Dependency or Boundary Object?” *Journal of Environmental Policy and Planning* 20 (2): 198-213. https://doi.org/10.1080/1523908X.2017.1348286


https://doi.org/10.1146/annurev.energy.31.020105.100323


https://doi.org/10.1016/j.jhydrol.2015.01.014


http://dx.doi.org/10.5751/ES-06412-190223


Front.” Watershed Sciences Faculty Publications. Paper 875. Available from:

https://digitalcommons.usu.edu/wats_facpub/875


http://nicholasinstitute.duke.edu/publications
CHAPTER V
SUMMARY AND CONCLUSIONS

As the western United States grapples with increasing water scarcity in the 21st Century, inter-sectoral cooperation in how water is shared will be critical for maintaining the region’s communities, ecosystems, and industries. This dissertation involved social science and policy research to illustrate the inherent complexities involved in market-based water reallocation using the water security paradigm. Water security, and its inverse, water insecurity, entail framing the risk of harm to or from water across multiple physical dimensions (scarcity, excess, quality, ecological) and social issues of equity and access (Garrick and Hall, 2014; Jepson et al., 2017). This research was conducted in northern Utah’s Bear River Basin, where market-based water banks have been promoted to alleviate the strain on water supplies resulting from climatic influences and societal transitions occurring in the region. Many of the quandaries facing northern Utah are representative of those experienced in much of the western United States, with multiple water use sectors contending for increasingly variable water supplies in an era of shifting priorities in how water is used. Hence, understanding stakeholder perceptions regarding the governance of water reallocation is vital to informing policy designs of water banks in which active water user participation is central to fulfilling reallocation objectives. Specific social and institutional nuances of reallocation via water banks are explored in three chapters prepared in the multiple-paper format.

Chapter 2 examined the policy designs and applications of water banks to mitigate various forms of water insecurity in the western United States. First, the overall trajectory of water bank development in the U.S. western states was assessed, followed by case
analyses of four water banks in contextually diverse settings. Drivers of water bank implementation were categorized by five water insecurity typologies: scarcity driven by asymmetries in access, aquifer overdraft, mitigation of competing uses, environmental needs, and interstate river basin governance. Early water banking generally served state or regional scales and focused on existing or anticipated imbalances in water supplies. Around 2000, however, water bank designs and applications diversified in response to more specific and localized water insecurities. The case analyses identified five key insights from assessing the drivers and outcomes of institutional change through water banks. First, context matters. Approaches to successful institutional change vary and there is no single archetype in designing water banks. Second, nested rules within different levels of governance have afforded water banks greater flexibility in administering water bank transactions as compared to traditional water transfer procedures. Third, as institutions, water banks can adapt to changing internal or external circumstances through governing oversight and rule changes. Fourth, time and institutional commitment are critical for water banks attaining policy objectives. And fifth, “success” should be judged specifically to policy objectives and should not be determined solely on volumes of water transferred. Water banks integrate institutional and market features that serve as a compromise between state-level legal determinations to reallocate water and unfettered market activity that relies on economic prices signals to determine beneficial use and access to water.

The focus of this dissertation shifted to northern Utah’s Bear River Basin in Chapters 3 and 4. The basis of each chapter centered on use of primary data from interviews and focus groups with Utah stakeholders on topical themes unique to each
chapter. Additionally, a select group of experts on water reallocation in neighboring states also participated in this research. Insights on the policy design process were also acquired through participant observation of a legislative working group focused on crafting water bank legislation in Utah. Chapter 3 entailed two primary research objectives. First, we assessed the meaning of water security among study participants with diverse connections to water. We wanted to determine how interpretations of the widely used paradigm from actors in an industrialized world setting aligned with definitions in the academic literature. Participants offered numerous meanings to the term, but issues of assurance in available quantities of water and the legal protection of access through water rights were the predominant themes disclosed. The second theme – water security through water rights – is generally absent in the literature. We argue that this second interpretation reflects the advanced stage of water resources development in the western U.S. to where reliable water access is assumed for many users because of long-established institutions and conveyance infrastructure. Next, participants’ perceptions of water banking were framed within the stakeholder-based water security themes to illustrate the potential scalar-based influences of reallocation on water security in northern Utah. Stakeholders revealed multiple ways in which water security could be positively or negatively impacted by water banks. However, scalar-based tradeoffs are seemingly inevitable for some water transfer arrangements. While water bank transfers can temporarily increase the water security for a single lessee and the financial status of a lessor, alteration of the hydrologic and water distribution systems will occur to some degree. For example, considerable favorability was expressed toward water banking if it promoted conserved water staying within agriculture. This outcome could however result
in increased evapotranspiration and reduce available water for non-consumptive needs. Hence, the stakeholder identified tradeoffs must be carefully evaluated in the water bank approval process at the state level to minimize the risk to the water security of all interests within Utah’s watersheds.

In Chapter 4, research is presented that sought to understand the reciprocating influences between existing water institutions and stakeholders in northern Utah’s water user community and how these dynamics create obstacles as well as opportunities to the establishment of water banks. Participants in agriculture revealed how path dependencies resulting from provisions in the prior appropriation doctrine as well as within local irrigation organizations have led to water right holder reluctance to participate in changes involving the state’s water right transfer process. Furthermore, stakeholders detailed how on-farm practices, such as existing cropping patterns and timing of when water would be needed could limit water bank transactions unless water banks are able to rapidly respond to lease applications. Stakeholder responses were then further assessed through the path dependency lens to illustrate how institutional and individual path dependencies have led, over time, to certain attitudes regarding water reallocation and water use behaviors that could hinder interest in participating in water banks. Understanding obstacles and concerns at the stakeholder level and the past policy decisions that contributed to their emergence can lead to better informed policies that account for individual needs for all interests and would contribute to cultivating long-term interest and trust in water banking at the individual level.

This dissertation has demonstrated the complexities of water reallocation in the western United States that are imbedded in the social and institutional attributes of a
diverse water user community governed by allocation laws designed over 170 years ago. This research contributes to the discourse on water reallocation by illuminating how key stakeholders characterize the extant water governance dilemmas facing the western United States and how they envision being part of proposed change solutions. Water banking is just one of many options available to address the clear and present challenges of water scarcity. The research described herein provides a window into views of individuals in irrigated agriculture who will be relied upon in the coming years to voluntarily reduce their sector’s use of water, as well as perspectives from those seeking access for emerging ecological priorities. While many participants in agriculture expressed cautious enthusiasm regarding the potential opportunities to temporarily transfer water for financial gain, a latent sense of fear of how these arrangements function is apparent in these research findings. At issue are the perceived threats to the security in access to water that has existed for generations in certain sectors of northern Utah’s water user community. This sense of water security in part explains stakeholder hesitancy towards any changes to the allocation system that they believe could lessen their position in the hierarchy of water access under prior appropriation. The paramount social challenges to the reallocation puzzle in the 21st Century will be developing policy designs that maintain this sense of security in water rights among existing users while providing suitable and affordable access to new water use interests. And as demonstrated in this dissertation, these processes will take time, transparency, investments, and ongoing engagement with all stakeholders to cultivate trust and buy-in not only in the watersheds of northern Utah, but those across the entire western United States.
Literature Cited


APPENDICES
APPENDIX A

KEY INFORMANT INTERVIEW AND FOCUS GROUP PROTOCOL
WATER BANKING IN CACHE COUNTY PROJECT
LIST OF INTERVIEW/FOCUS GROUP QUESTIONS
IRB 9393

A. Interviewee’s Involvement and Water Challenges

We would like to start by asking you a few questions about your involvement with water and any challenges you currently face.

A1. So, to start off, can you tell [me/us] about your involvement in working with water?
   If not specifically addressed ask:
   Do you own water rights?
   What positions do you hold in water organizations?

A2. What do you consider to be the main water challenges…
   … you currently face?
   … the organizations you work with face?

A3. How have you and the organizations you work with responded to those challenges?

A4. What do you think are some of the most promising innovations or strategies for dealing with Cache Valley and Utah’s water challenges?

B. Water Banks

As you might know, last year the State Water Strategy Advisory Team presented Governor Herbert with some recommendations for addressing the water challenges Utah faces. Water banking is one strategy being employed some other places and is currently being discussed in Utah. Water banks are mechanisms for the lease or transfer of water. They can serve different purposes and be structured different ways. So, we would like to hear your ideas on this subject.

B1. What do you know about and think of the concept and practice of water banks?

B2. What problem(s) could a water bank help solve and how would it do that …
   … in Cache Valley?
   … in Utah?

B3. Are there other strategies that you think could better solve these problems?

B4. Do you think operating a water bank is an appropriate function of the Cache Water District?
   Why or why not?
B5. How would a water bank [in Cache Valley] potentially fit into …
   … the operation of the Bear River?
   … plans for water development in the Bear River?

B6. In order to operate a water bank [in Cache Valley] …
   … what type of institutional structure would be most suitable?

B7. What changes to state water law might be necessary to make water banks effective?

B8. What physical infrastructure might be needed to operate a water bank [in Cache Valley]?

B9. Have you ever transferred water on a temporary or permanent basis?
   How was this transaction handled?
   What did you think of the transaction process?

B10. What provisions would need to be in place for you to trust transactions in a water bank?
   *(By provisions we mean institutional arrangements, level of oversight of transactions, methods of matching participants (buyers and sellers))*

B11. How might the option to participate in a water bank provide you with greater flexibility in [your farming/organization’s] operations?

B12. What do you see as obstacles to implementing water banks in Utah?

C. Water Security

*Now we would like to talk to you about the concept of water security.*

C1. First off, what does the term “water security” mean to you?

C2. How can water security be improved in Cache Valley?

C3. How can water security be improved in Utah as a whole?

C4. Do you think water banks can improve water security in…
   … Cache Valley?
   … Utah?

C5. In attempting to increase water security throughout the state, Utah could potentially encounter some difficult trade-offs to protect the water security of different areas of the state and of different types of users.
a. What do you see as the water trade-offs that lie ahead?

b. What strategies do you think the state should use to deal with these trade-offs?

c. In light of these trade-offs, what do you think would be the fairest way for Utah to promote water security?
APPENDIX B

INFORMED CONSENT AGREEMENT
Water Banking in Cache County, Utah
Letter of Invitation for Interview

Introduction
We are conducting research on the potential for a formal water bank in Utah’s Cache Valley. *In order to better understand various perspectives on this issue, we are conducting in-depth interviews with people involved in water from Cache Valley and other parts of Utah*. This research will investigate the feasibility, challenges, social interest, and potential governance arrangements of an institutionally-managed water bank. We will also explore how such mechanisms for facilitating water exchanges would impact water security in Utah. The information from these interviews will be combined with other data sources on water banks and used to inform public decisions about implementing and designing a water bank in Cache County, with potential implications and applicability statewide. Research results will be included in a final report provided to the Cache Water District and made publicly available, as well as in research publications.

Research Team and Sponsorship
Our Utah State University research team includes Dr. Joanna Endter-Wada, Dr. Lisa Welsh, and Clint Carney from the Department of Environment and Society, and Dr. Neil Allen from the Civil and Environmental Engineering Department. This research is jointly supported by Utah State University Extension, the Cache Water District, the Utah Division of Water Rights, and the Utah Division of Water Resources. We are advised by representatives from these partnering agencies.

Research Procedures
The interviews and focus groups will involve approximately 40-50 individuals selected to provide their insights on water management and the roles that water banks could have in Cache Valley and the state overall. *You have been asked to be interviewed because of your involvement or interest in water resources in Cache Valley*. Participation time for an individual interview will be approximately 1.5 hours. The interview will take place in a location of your choosing. This research strategy relies on information from key experts, and the validity of the findings rests, in part, on the reputations of the participants and the information they share. With your permission, your name will be associated with the information provided. If you prefer to not have your name included with the research findings, you have the option to remain confidential.

Benefits and Risks
Your participation in this research will benefit the Cache Water District and other local water entities as they chart the valley’s water future. This is a minimal risk research study. That means that the risks of participating are no more likely or serious than those you encounter in everyday activities. The foreseeable risks are potential loss of confidentiality or discomfort during the interview/focus group. However, we will minimize these risks through the following research procedures. Your participation is completely voluntary and may remain confidential if you choose. You may withdraw at any time without consequence and any information you prefer to keep “off the record” will be kept completely confidential and deleted from the interview records. You may choose to not
answer any questions you might be uncomfortable addressing (but continue with the rest of the interview). If you decide to withdraw from the study at any time before it is complete, all information shared prior to that point will be destroyed.

**Interview Permission and Information:** *We are seeking permission to interview you, record the interview, and transcribe the digital recording.* This procedure will ensure we have correctly heard and understood the information you provide. The recording and transcription will be stored with code numbers and, if you choose to keep your name confidential, it will not be associated with any reported findings or acknowledgements. Records will be kept secure via storage on password-protected databases managed through Utah State University. The information will be used for research purposes only, and information access will be limited to the project researchers. The digital recordings will be destroyed within two years from the interview date, and codes linking people to interview transcriptions will be destroyed by June 2021.

**University Approval:** *The Institutional Review Board (IRB) for the protection of human participants at Utah State University has reviewed and approved this research study.* If you have questions about your rights as a research participant or want to obtain information from a university representative other than the researchers, please contact the IRB Director, Nicole Vouvalis at (435) 797-0567 or irb@usu.edu. Obtaining the informed consent of research participants is a required and important component of university procedures. We will retain a copy of this consent form in our records and are providing you a copy as well (it includes our contact information so you can contact us after the interview if you choose to do so).

**Contact Information:** *We greatly appreciate your time and want to thank you in advance for your participation in our study.* If you have any questions or concerns about the research itself, please contact either Dr. Endter-Wada, Dr. Allen, or Dr. Welsh (contact information provided below). They would be happy to answer your questions.

**Researcher Certification**
We certify that the research study has been explained to the individual, and the individual understands the study’s nature, purpose, and the benefits and possible risks associated with participating in this study. Any questions that were raised have been answered.

Joanna Endter-Wada, Ph.D., PI  
435-797-2487 (phone/voice mail)  
joanna.endter-wada@usu.edu  

Niel Allen, Ph.D., Co-PI  
435-994-4369 (phone/voice mail)  
niel.allen@usu.edu  

Lisa Welsh, Ph.D., Co-PI  
435-797-0922 (phone/voice mail)  
lisa.welsh@usu.edu  

Clint Carney, Ph.D. Student Researcher  
970-222-9166 (phone/voice mail)  
clint.carney@aggiemail.usu.edu
**Informed Consent**

By signing below, you agree to participate in this study. You indicate that you understand the risks and benefits of participation, and you know what you will be asked to do. You also agree that you have asked any questions you might have, and are clear on how to stop your participation in the study if you choose to do so. Please be sure to retain a copy of this form for your records.

____ I agree to be interviewed and understand that my participation is voluntary

____ I agree to have the interview/focus group digitally recorded and transcribed

____ I prefer that my participation in this study remain confidential (my name will not be associated with the information shared during the interview/focus group)

Participant’s Signature
Date

Participant’s Name (printed)

Signature of Interviewer(s)
Date

Signature of Interviewer(s)
Date
CURRICULUM VITAE
## Clint P. Carney

Doctoral Candidate in Environmental/Water Policy  
Dept. of Environment and Society - Quinney College of Natural Resources  
Utah State University, Logan UT, USA  
2547 North 300 East  
North Logan, UT 84341-1572  
970.222.9166  
cpcarney5@gmail.com  
https://www.linkedin.com/in/clint-carney-msc-pg-411b868

### Education & Certifications

#### Degrees

**Utah State University**, Logan, UT  
Ph.D. Candidate  
Department of Environment & Society  
Fall 2021

**Areas of Research Focus**: Water Policy and Governance, Water Security, Water Reallocation, Policy Analysis


**Dissertation Committee**: Dr. Joanna Endter-Wada (advisor), Dr. Niel Allen, Dr. Karin Kettenring, Dr. Jack Schmidt, Dr. Lisa Welsh

**Awards**: Quinney Dissertation Fellowship, 2016; Babbitt Dissertation Fellow, 2020

**Colorado School of Mines**, Golden, CO  
MSc., 2009  
Hydrology  
Advisor: Dr. Eileen Poeter

**Northern Illinois University**, DeKalb, IL  
M.S., 2000  
Geology, Geographic Information Systems  
Advisor: Dr. Colin Booth

**Iowa State University**, Ames, IA  
B.S., 1997  
Geology (major) and Environmental Studies (minor)  
**Major Advisor**: Dr. William Simpkins

### Certifications

Professional Geologist – State of Utah, Registration No. 8638827-2250  
Professional Geologist – State of Wyoming, Registration No. PG-3763  
Professional Geologist – State of Nebraska, Registration No. G-0286
Positions Held

**Research Assistant** – Department of Environment and Society, Quinney College of Natural Resources, Utah State University, Logan, UT 2017-present

**Research Assistant** – Innovative Urban Transitions and Aridregion Hydro-sustainability Project (iUTAH), Utah State University, Logan, UT 2016-2017


**Project Hydrologist** – Exploration Resources International, LLC. Golden, CO September 2013 – September 2015


**Project Hydrogeologist** – Leonard Rice Engineers, Inc. Denver, CO July 2009 – March 2010


**Hydrogeologist/Modeler** – Platte River Cooperative Hydrology Study (COHYST) & Nebraska Public Power District North Platte, NE (*worked remotely (Colorado) from May 2003 – June 2009*) August 1999 – June 2009

**Research Assistant** – Northern Illinois University. Wellhead protection assessments and groundwater modeling funded by the Illinois Environmental Protection Agency. DeKalb, IL 1998, 1999

**Graduate Teaching Assistant** – Northern Illinois University. Taught multiple entry-level geology course labs and assisted course instructor in administering lectures and exams. DeKalb, IL 1997-1999

**Laboratory Research Assistant** – National Soil Tilth Laboratory, Iowa State University. Ames, IA 1995-1997

**Undergraduate Research Assistant** – Iowa State University. Field assistant with the ISU Hydrogeology Lab supervised by Dr. William Simpkins. Tasks included groundwater level measurements, monitoring well installation, water sampling, and well site maintenance. Ames, IA 1996
Publications

Peer-Reviewed


In Preparation


Technical Documents


Abraham, J.D., **Carney, C.P.,** and J.C. Cannia. 2014. *Data Report on Mapping the Hydrogeology of the Clarkson Area within the Lower Elkhorn Natural Resources District Using an Airborne Electromagnetic Survey*. Prepared for the Lower Elkhorn Natural Resources District, Norfolk, NE.

Carney, C.P., 2008. *Groundwater Flow Model of the Central Model Unit of the Nebraska Cooperative Hydrology Study (COHYST) Area*. Available at: https://cohyst.nebraska.gov/archive/cohyst_preliminarydata.html#docs


**Periodical Submissions**


**Research and Professional Presentations**

**Cache Water District (March 2020) – Logan, UT**
*Water Banking in Cache County*
Authors: J. Endter-Wada, L. Welsh, C. Carney, and N. Allen

**AWRA Annual Conference (Nov 2019) – Salt Lake City, UT**
The Water Bank(ing) Experience in the Western United States and Insights from Utah’s Neighbors
(Contribution to the session and panel discussion titled: *Water Markets and Banking – Fostering Better Water Use?*)
Authors: C. Carney, J. Endter-Wada, L. Welsh, and N. Allen

**AWRA International Water Security Conference (Sept 2019) – Beijing, China**
September 2019
*The Compounding Interest in Banking Water and Water Security*
Authors: C. Carney, J. Endter-Wada, and L. Welsh

**Northern Utah Water Conference (April 2019) – Logan, UT**
*Water Banking in Cache County: A Research Update*
Authors: C. Carney, J. Endter-Wada, L. Welsh, and N. Allen

**Utah Water Conservation Forum (May 2018) – West Jordan, UT**
*Water Conservation Motivations and Societal Outcomes*
Authors: J. Endter-Wada, C. Carney, and J. Thomson

**AWRA Annual Conference (Nov 2017) – Portland, OR**
*Confounding Conservatism in Utah: Strong Citizen Support for Government Involvement to Confront Water-Related Stresses in a Red State*
Authors: C. Carney and J. Endter-Wada
Role of Water Demand Management Infrastructure: Tapping New Potential and Assessing Tradeoffs
Authors: J. Endter-Wada, C. Carney, J. Thomson, D. Wuenschell, and L. Welsh

Montana Water Resources Association Annual Meeting (Oct 2014) – Billings, MT
Solutions for Water Resources Challenges – Understanding the Subsurface
Author: C. Carney

GSA North-Central Section Annual Meeting (April 2014) – Lincoln, NE
AEM Mapping of Groundwater Resources within the Glacial Deposits and Cretaceous Dakota Formation of eastern Nebraska
Authors: J. Cannia, C. Carney, and J. Abraham

NE Assoc. of Resource Districts Annual Conference (March 2005) – Kearney, NE
COHYST Groundwater Modeling Project Update
Author: C. Carney

Geological Society of America Annual Meeting (Oct 2002) – Denver, CO
Authors: C. Carney, R. Luckey, and S. Peterson

GSA North Central Annual Meeting (May 1999) – Champaign-Urbana, IL
Modeling the Groundwater Flow-system and Five-Year Recharge Area of the Fawn Hills Subdivision, Peoria County, Illinois.
Author: C. Carney

Professional Training/Continuing Education

Water Conflict Management and Transformation Workshop
American Water Resources Association’s Annual Conference
November 8, 2020 (virtual in 2020)

Utah Water Law & Policy Seminar – Conflict, Consensus, and Adapting Water Law
March 18, 2019 (St. George, UT)

Utah Water Law & Policy Seminar – Water Distribution and Administration
March 19, 2018 (St. George, UT)

Groundwater High-Resolution Site Characterization
March 22-23, 2016 (Denver, CO (US EPA CERCLA Education Center))

Groundwater Contamination and Remediation: Principles and Practices
March 8-9, 2016 (Lone Tree, CO)
Funding & Awards

2020 – USU SA Grad Enhancement Award ($2,000)
2020 – Seely-Hinkley Scholarship from USU’s Quinney College of Natural Resources (one semester tuition and fees)
2020 – Babbitt Dissertation Fellowship – Lincoln Institute of Land Policy ($10,000)
2019 – USU Graduate Student Travel Award ($700)
2019 – Friends of Great Salt Lake Doyle W. Stephens Graduate Student Scholarship ($1,000)
2017 – USU Water Initiatives Grant (with support from Utah Divisions of Water Resources and Water Rights and Cache Water District), Student Researcher/Collaborator (2 years full graduate student support)
2016 – S.J. Quinney College of Natural Resources Graduate Fellowship (2 years full graduate student support)

Professional Affiliations

American Water Resources Association
International Association for Society and Natural Resources
National Ground Water Association
American Association for the Advancement of Science
American Geophysical Union

Service and Other Professional Activities

USU Department of Environment and Society Graduate Mentor, 2019.
Moderator – Restoring the West Conference, Utah State University, Logan, UT October 8-9, 2019
Moderator – Restoring the West Conference, Utah State University, Logan, UT October 17, 2018
Ecosystems Services Endowed Professorship Search Committee. USU Dept. of Environment and Society. Fall 2017
Volunteer External Reviewer for Utah’s Recommended State Water Strategy – February 2017
U.S. National Committee Liaison for the International Association of Hydrogeologists to the American Geosciences Institute, 2017-2019