Factors Influencing the Expansion of Environmental Water Markets

A Group Project submitted in partial satisfaction of the requirements for the degree of Master of Environmental Science and Management for the Bren School of Environmental Science & Management.

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MAMMOTH TRADING

Bren School of Environmental Science & Management
UNIVERSITY OF CALIFORNIA, SANTA BARBARA

Water for Food
ROBERT B. DAUGHERTY INSTITUTE
at the University of Nebraska

Factors Influencing the Expansion of Environmental Water Markets

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The Group Project is required of all students in the Masters of Environmental Science and Management (MESM) Program. It is a three-quarter activity in which small groups of students conduct focused, interdisciplinary research on the scientific management, and policy dimensions of a specific environmental issue. This Final Group Project Report is authored by MESM students and has been reviewed and approved by:

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Abstract

Growing water demand in the western United States has led to the reduction and even loss of stream flows that provide vital ecological benefits for fish and other wildlife. Environmental water markets provide a means to redistribute water from existing uses to environmental flow smoothly and flexibly. Many factors have obstructed environmental water markets from expanding to a scale that can address widespread flow restoration needs. In order to understand these obstructions and identify how they might be overcome, this report analyzes the demand for and supply of environmental water, legal constraints, and current market approaches, revealing strategies that can expand environmental water markets. The report recommends that environmental water buyers do the following: (1) work closely with water right holders to identify beneficial approaches for reallocations to streamflow; (2) expand into new areas strategically and conservatively; and (3) utilize diverse funding streams whenever possible to allow for maximum flexibility of approaches.

List of Definitions

Environmental Water Buyer: An organization of any kind that facilitates and engages in the process of buying environmental water.

Environmental Water Funder: Any public or private entity that provides funding for environmental water for any reason.

Environmental Water Transaction: In this report, an environmental water transaction is any transaction that purposefully results in environmental flow and associated ecosystem benefits.

Environmental Water Market: In this report, an environmental water buyer with an ongoing presence in a basin conducting multiple transactions is considered an environmental water market.

Market Enabling Policy Conditions: The legal and regulatory framework that impacts the tools and strategies that environmental water buyers have available when engaging in environmental water transactions.

Environmental Water Buyer Toolbox: The spectrum of market strategies that can be employed by an environmental water buyer as a function of market enabling policy conditions.

Environmental Flow: Water left in a specific length of a stream for environmental purposes.

List of Acronyms

BOR - Bureau of Reclamation

CBWTP - Columbia Basin Water Transactions Program

CWT - Colorado Water Trust

DRC- Deschutes River Conservancy

ESA - Endangered Species Act

TFT - The Freshwater Trust

TU - Trout Unlimited

WWT - Washington Water Trust

Executive Summary

Growing water demand in the western United States has resulted in the dewatering of thousands of streams and rivers. These low flows threaten the many species that rely on aquatic ecosystems to survive. Environmental water markets have emerged as a flexible means of restoring flow to streams and rivers to meet ecological needs. Environmental water markets provide incentives for water rights holders to engage in transactions with stakeholders who value environmental flow, resulting in stream flow benefits. Environmental water markets have yet to expand to the scale necessary to address long-term, widespread flow restoration. To address this, our objective is to identify the conditions that enable current environmental water markets and highlight strategies that allow environmental water buyers to expand their scope and effectiveness in reaching ecological outcomes. To reach these objectives, we engaged in the following tasks:

1. Conducted a literature and source review on market enabling policy conditions, sources of funding, common strategies, and institutional arrangements that enable environmental water transactions in the Western United States.
2. Compiled a list of environmental water buyers, their funding sources, and relevant regulatory agencies.
3. Conducted interviews with environmental water buyers, water rights holders, regulatory agencies and academics to gain a deeper understanding of the obstacles facing environmental water markets, and how they can be overcome.
4. Synthesized interviews, literature and available market information to:
    a. Build a framework for analyzing the current state of environmental water markets.
    b. Identify the key obstacles to expanding environmental water markets, and highlight strategies for overcoming them.

This approach provides a progression from understanding conditions influencing the current state of environmental water markets, to identifying key strategies for expanding their scope and ecological impact. The report is structured to reflect this progression:

1. A general template of the most critical supply and demand characteristics influencing the development of environmental water markets (Section IV). The demand for environmental water is based on the quantified ecological need for environmental flow coupled with a source of funding. The supply of

environmental water is a function of its current use characteristics, such as crop value, diversion location, and local irrigation infrastructure and institutions.

2. A discussion of market enabling policy conditions and regulatory implementation across western states and an illustration of how these conditions influence the environmental water buyer toolbox (Section V). Environmental water buyers have a toolbox of possible approaches based on written state law, which influences the legal transferability of water to environmental uses in different circumstances. The implementation of these laws influences the effectiveness of these tools, where long review times and complicated regulatory processes can increase transaction costs.
3. A discussion of program operations, such as water valuation and transaction costs, and compiled information regarding environmental water market outcomes (Section VI). The valuation of environmental water and the transaction costs associated with searching for, negotiating, implementing and monitoring transactions influence the market outcomes from different approaches and strategies environmental water buyers employ.
4. A discussion of key obstacles and highlighted strategies and solutions that will lead to more effective movement of water to environmental use (Section VII). These key strategic takeaways include:
    a) Understanding seller needs and learning about their operations leads to identifying mutually beneficial approaches.
    b) The organization administering the environmental market impacts market engagement.
    c) Water valuation should be transparent and based on ecological outcomes.
    d) Environmental water buyers should not spread resources too thin when expanding into new areas.
    e) Environmental water buyers should utilize diverse funding sources to allow flexibility in identifying mutually beneficial projects.
    f) Drought response is a useful approach in many scenarios, but should not distract from long term environmental flow goals.
    g) When setting quantified flow targets is cost prohibitive, targets can be identified through trial, monitoring, and refinement as opposed to modeling and prediction.

Harnessing these lessons and others, the environmental water market movement must continue to expand into new areas and become more impactful to address the enormous need for restored environmental stream flow.

I. PROJECT OBJECTIVE

Understand conditions that enable current environmental water markets and identify strategies that allow environmental water buyers to expand environmental water markets.

We achieved our objective through four stages of investigation, each informed through reviewing literature, conducting informational interviews, and analyzing data where applicable:

- Construct a generalizable template of the most critical characteristics influencing the supply of and demand for environmental water (Section IV)
- Examine market enabling policy conditions and implementation across western states and illustrate how these conditions influence the environmental water buyer toolbox of approaches (Section V)
- Compile and analyze information regarding program operations and environmental water market outcomes (Section VI)
- Identify key obstacles and highlight strategies and solutions that will lead to more effective movement of water to environmental flow use (Section VII)

II. PROJECT SIGNIFICANCE

Water is diverted from natural rivers and streams to serve the needs of communities, agriculture, industry, and other economically valuable operations. Diversions from these natural river systems can potentially threaten the complex riparian and terrestrial ecosystems that they support. Thousands of miles of river have been dewatered across the West, with over 4000 river miles dewatered in Montana alone (Reeve & Harmon, 2010). Recently, the scarcity of water has become increasingly apparent with the rising demand of urban populations, growth of valuable water intensive crops, climate change and the looming threat of ecosystem and species loss (Culp et al. 2014; Karl 2009). A market approach provides a mechanism to move water from out-of-stream uses back to the environment during water shortages and in reaches where water is chronically over-allocated. This approach aligns incentives through voluntary exchanges to protect the environment.

The existing allocation of water supplies does not reflect modern day demand. Market exchanges or regulatory reallocation can return water to the environment. Regulatory reallocation can be difficult to implement due to stakeholder influence over legislation and water right holders' perception of regulatory action as a takings. Regulatory approaches tend to be politically contentious and frequently unpopular amongst water right holders, due to their rigid implementation. Water markets offer a method to address short and long term water allocation issues and continue to adapt to societal values over time (Howe et al., 1986). Markets also lead to a focus on the financial value of water by water rights holders, reflecting the scarcity of the supply and its value to the economy, municipalities, and the environment. Markets optimally allocate water towards parties that can generate the most financial earnings and benefits to society (Culp et al., 2014). Furthermore, markets provide financial incentives to conserve water and encourage negotiation between stakeholders to maximize water use efficiency.

Despite their potential, progress has been slow in establishing environmental water markets and success varies across states and basins (Scarborough, 2010). High transaction costs and regulatory impediments to transferring water rights for environmental purposes, among other social and cultural factors, have been significant barriers to the development of these markets (Howe et al., 1986).

Environmental water buyers, such as water trusts and government agencies, must face and work around these barriers to obtain and restore water in stream. These organizations and agencies often operate with relatively small budgets, limited capacity, and the uphill battle of negotiating with long-established irrigators who are often protective of their water rights and skeptical of water for environmental uses (Scarborough, 2010). Water is more than a financial asset to many irrigators; it is the social and cultural backbone of local irrigator communities that is central to their way of life (Scarborough, 2010).

In order to facilitate and expand environmental water markets to a scale that is large enough to address widespread environmental water shortages, it is vital to understand the fundamental attributes that influence the creation and operations of environmental water markets. Understanding these attributes is imperative in forming a viable management strategy aimed at market expansion that is flexible across multiple political, cultural, and ecological regions.

III. RESEARCH METHODOLOGY

The objective of the project is to understand conditions that enable current environmental water markets and identify strategies that allow environmental water buyers to expand environmental water markets. A process was developed to progress from an understanding of conditions influencing current environmental water markets to strategies that allow for their expansion. The first step in understanding conditions that enable environmental water markets is to understand the characteristics that influence the demand for and supply of environmental water (Section IV). The second step is to examine market enabling policy conditions and implementation across western states and illustrate how these conditions influence the toolbox of approaches an environmental water buyer can utilize (Section V). The third step is to gain an understanding of current environmental water market program operations and strategies. Through this process of examination, key obstacles were identified, and strategies for overcoming these obstacles were highlighted (Section VII).

A literature and source review was conducted, focusing on peer-reviewed literature and information from the websites of environmental water buyers. In order to gain a deeper understanding of the factors influencing environmental water transactions, 51 total interviews were conducted with environmental water buyers (25 interviews), government officials (12 interviews), non-governmental organization staff (6 interviews), water rights holders (5 interviews), and academic researchers (3 interviews). A set of questions was used to guide these interviews (Appendix A).

Environmental water buyers were asked about the obstacles they commonly faced, and which approaches have been most successful in overcoming these obstacles. Government officials were asked how regulations shape environmental water markets, how the government coordinates with agencies involved in environmental flow restoration, and what their responsibility and capacity is in processing lease and transfer applications. Water rights holders were asked about their perceptions of the value of environmental flows and the values they and their communities place on water. In regard to drought, water right holders were asked about their irrigation schedules and how the timing of drought year leasing interacts with their operations. Academic researchers were asked about obstacles facing water market

development and solutions for increasing market participation. Interview notes were compiled for analysis. Relevant trends and strategies identified throughout the interview process are included throughout the report, and key takeaways are summarized in the conclusion.

Factors influencing the demand for and supply of environmental water were organized into a template. The ecological needs for water and availability of funding to acquire this water were identified as key demand factors. Current value and use of water rights, presence of irrigation institutions, and irrigation infrastructure were identified as key supply factors. The template provides an organized means of understanding why environmental water markets are active in some basins and absent in others (Section IV). Next, state level policies were identified across western states, and the regulatory implementation of these policies was considered. The tools and approaches that an environmental water buyer can employ as a function of a state's legal framework and regulatory implementation are discussed (Section V).

The final focus of analysis considers market mechanics and program operations of environmental water buyers. This involves discussion of how environmental water buyers approach water rights holders, transaction costs associated with administering programs and pricing and valuation of water. The Washington Water Trust and The Freshwater Trust provided transaction cost data (Appendix B), which allowed for analysis of the leasing process and where transaction costs accrue. (Section VI).

Throughout our interviews with environmental water buyers we identified key barriers and strategies for overcoming them (Section VII). Interviews were examined for common themes, and any comments pertaining to these themes were compiled together for deeper analysis of agreement and disagreement on important components. Key strategies are based on wide agreement among interviewees.

IV. DEMAND FOR AND SUPPLY OF ENVIRONMENTAL WATER

Environmental water buyers must weigh costs and benefits of working in one basin as opposed to another. As The Nature Conservancy's Robert Wigington explains, they must identify areas with the highest water flow needs coupled with where they predict progress being possible at a reasonable cost (Personal Interview, Robert Wigington, 2015). Our project aims to synthesize this complex and dynamic basin identification process through illustrating important concepts that are considered by environmental water buyers when targeting their work (Table 1).

Table 1. The Supply-Demand template and where to focus attention.

Demand	Description
Impact of Current Allocation on Ecosystem Health	The need for additional environmental flows is based on the gap between existing flow levels and ecological target flow levels.
Funding Availability	Funds available for flow restoration in an area are based on regulatory drivers, private investments, philanthropic donations, and other creative sources.
Supply	**Description**
Availability of water rights for transfer to environmental use	The type, value, and seasonality of crops planted in the basin can affect valuation and the participation of water rights holders in a market.
Irrigator Organization	The degree to which irrigators are organized into local irrigation organizations, and the characteristics of these organizations and districts, can impact transaction costs and flexibility of participation.
Irrigation Infrastructure	The degree to which irrigation infrastructure is already efficient in a basin decreases an environmental water buyer's opportunities to acquire additional environmental water through conservation.

A. Factors Influencing the Demand for Environmental Water

The fundamental demand for environmental water in any stream is based on the gap between how much water remains after water rights holders have diverted their share, and how much water is needed to support healthy ecosystems. Addressing this gap requires funding motivated by a combination of regulatory drivers, private investments, and philanthropic donations.

1. The Need for Environmental Flow

a) Predicting Ecosystem Flow Needs

Growing numbers of water right diversions has led to depleted streamflow and habitat degradation across the Western U.S. (Aylward, 2013). The need for increased flow in a given stream depends on the extent of diversion and how it impacts habitat quality. The need for environmental flow is represented by the gap between measured flow levels and a quantified target flow (Figure 1, Appendix C). Instream needs are quantified into streamflow targets by regulatory agencies in some rivers in the Western U.S. (Sacramento Fish and Wildlife Service; CA Department of Fish and Wildlife).

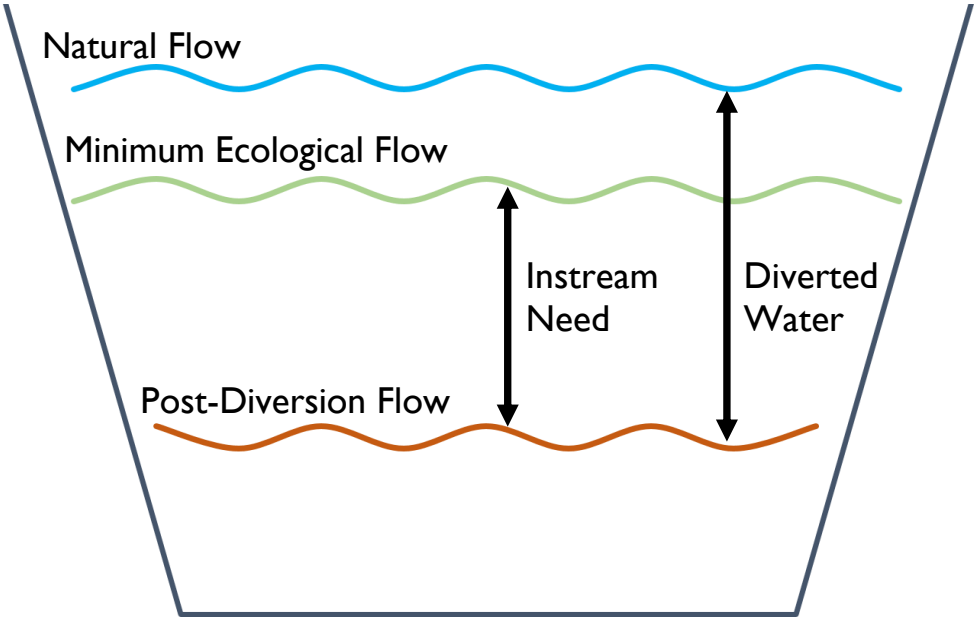

Figure 1. Visual representation of instream flow need.

The specific process for quantifying desirable flow levels varies by state and by local managing authorities. The Instream Flow Incremental Methodology Program has been accepted by many in the field as the best available tool for determining the relationship between stream flow and fish habitat. (WA Department of Ecology, 2015). In a multi-step process, scientists gather information on basin hydrology, biology, and other metrics in order to build models that predict how target fish species will respond under different flow conditions (WA Department of Ecology, 2003; WA Department of Ecology, 2015; CA Department of Fish and Wildlife, 2015). However, this method for predicting ecological flow requirements can be very time consuming and expensive.

As mentioned by Sarah Rupp from Friends of the Teton River, setting flow targets is challenging when there is a lack of sufficient funding to gather and analyze the necessary data needed to set environmental flow targets (Personal Interview, Sarah Rupp, 2015). Jeanmarie Haney from the Nature Conservancy in Arizona sees the science behind modeling streamflow targets and predicting ecosystem response as very important, but feels that these studies should not always be a requirement prior to action. For example, instead of spending time and resources predicting exactly what stream flow will lead to a desired ecosystem response, available data and expert knowledge can guide decisions about a reasonable amount to lease for a period of time, where the ecosystem response can then be carefully documented. Conclusions from monitoring can be fed back into future water transactions decisions in an adaptive management process. (Personal Interview, Jeanmarie Haney, 2015).

Unquantified releases, however, require care. If the true ecological need is underestimated, ecosystems may be harmed. Further, as informed by our interview with Kim Schoneck, overestimating flow targets can be harmful to community relationships, where a reasonable target shows community members clear limits to the amount of water targeted for transfer from current uses to environmental use (Personal Interview, Kim Schoneck, 2015).

b) Politics Surrounding Environmental Flow Targets

Quantified streamflow targets can aid environmental water buyers in targeting their operations, and show nearby communities that there is a limit to the amount of water that will be targeted from a given area. The legal framework surrounding the

use of certain tools can also use quantified flow targets to constrain where environmental water buyers can and cannot operate. As discussed by Anne Janicki of the Colorado Water Trust, the dry year environmental leasing tool utilized in the Request for Water Program is limited by statute to streams and rivers where an environmental flow target has already been established. This limits where this particular tool can be applied, preventing these types of leases in areas of the state without set targets, even if flow restoration is clearly needed. Furthermore, in the event that a river ends up flowing at a level higher than the target flow, and water was already leased to reach the environmental flow target, then the excess water cannot be legally protected as environmental flow (Personal Interview, Anne Janicki, 2015).

Monitoring streamflow to ensure that downstream water users are respecting a purchased or leased water right for protected environmental flow use can be a challenge. In many basins, a water master is in charge of assuring that water rights holders are respecting the relative priority of other water rights when exercising their own rights. According to Mike Jolliffe from The Freshwater Trust, water masters have a potential conflict of interest in that they live in communities they monitor, which makes the prospect of curtailing water use of a friend or neighbor to protect environmental flows especially difficult, even if the environmental flow right is more senior. Since water masters have a lot of ground to cover the process of enforcement is reactive rather than proactive (Personal Interview, Mike Jolliffe, 2015). For this reason, environmental water buyers must not only search for and negotiate transactions but also monitor to ensure transacted water remains instream, which can be costly.

2. Funding is Critical to Market Creation.

For an environmental water market to exist, an instream need must be coupled with sufficient funding sources to cover operations and transactions that can address the scope environmental flow need. Funding for environmental water transactions can come from a variety of sources, ranging from federal or state appropriations issues to philanthropic donations. However, not all funding sources are created equal. Differences in the consistency, scale, specified use designation, and sources of funding can all impact the longevity and success of a water market.

a) Compliance of Federal and State Regulations Provides a Strong Driver of Funding.

The Endangered Species Act (ESA) has been one of the more successful pieces of legislation in creating funding opportunities for flow restoration. Because low stream flows can directly threaten the habitats of ESA-listed aquatic species, motivation to preemptively address the problem or provide alternative solutions often result in the allocation of funds for restoration purposes. Examples of this can vary spatially and temporally, ranging from a one-time forbearance of a water right to provide environmental flows for an ESA-listed fish species (Big Hole River, Montana; Appendix D) to the creation of entirely new basin-wide programs for mitigating the consequences of hydropower operations on salmon and steelhead runs (Figure 2; Columbia Basin Water Transaction Program, Appendix D).

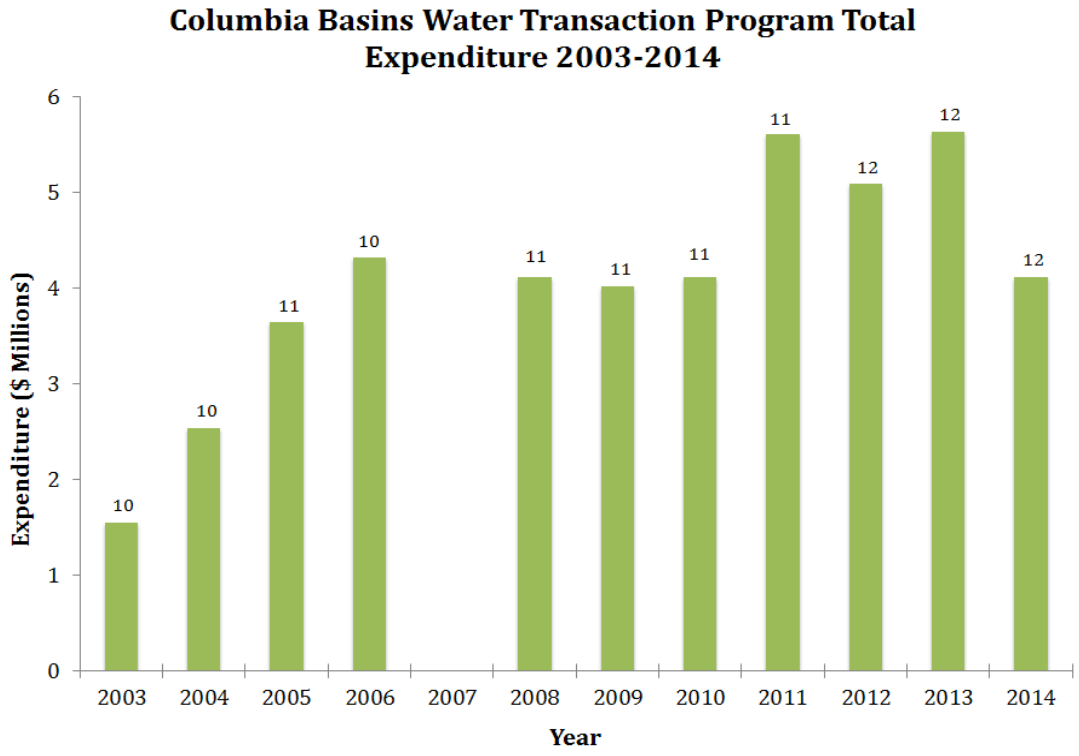

Figure 2. Columbia Basin Water Transaction Program Total Expenditure (2003-2014). Total expenditures ($) for the Columbia Basin Water Transaction Program. The number above each bar indicates the count of organizations funded for that year. Funding has generally increased, with the number of programs being funded also increasing. Note: data was not available for 2007. (Source: CBWTP Annual Reports 2003-2014; excluding 2007)

Programs with revenue based on federal or state appropriations can be particularly vulnerable if the appropriations depend on annual renewal from legislative action (Benson, 2012). Programs where the appropriations are specified for a certain number of years provide some insulation to these vulnerabilities. ESA mitigation efforts, such as the Columbia Basin Water Transaction Program, can provide consistent funding from year to year, offering environmental water buying organizations stability for creating programs with long term goals.

b) Private Foundations, Philanthropic Donations, and Other Creative Sources of Funding

Aside from government funding, private foundations can offer a source of environmental flow restoration funding. The Walton Family Foundation is a private foundation that collaborates with local stakeholders to improve flows in the Colorado River. In 2014, the Walton Family Foundation provided over $17 million in grants to promote and restore healthy river flows, with a portion of this funding addressing the expansion of water transactions in the basin (Walton Family Foundation - Freshwater Conservation; Aylward, 2013).

The Bonneville Environmental Foundation (BEF), a non-profit organization funded in part by the Bonneville Power Administration, offers private sector customers the opportunity to purchase Water Restoration Certificates (WRC's) as an offset to their residential or institutional water footprint. BEF contracts with environmental water buyers to fund flow restoration projects, which are certified by NFWF (Reeve, 2010). In this regard, BEF administers a funding source for watershed restoration organizations, with the sources of funds coming from private and institutional customers with stewardship-minded goals.

While public regulatory drivers and private foundations offer the majority of conventional funding situations, additional opportunities for creative funding possibilities have also occurred. One unique source of water acquisition funding is the Central Valley Project Restoration Fund, which generates funds for water rights acquisitions through a $6/acre-foot surcharge placed on California Central Valley Project water and power users (Benson, 2012). Other examples of funding sources include using a percentage of lottery proceedings for wildlife habitat restoration (Oregon's Measures 66 & 76); voluntary options of public contributions on water utility bills (Albuquerque's Living River Fund) and state income tax returns

(Colorado Healthy Rivers Fund); and with funds mandated as part of the litigation settlement from water quality lawsuits (Truckee River Water Quality Settlement Agreement) (Benson, 2012).

c) Overview of Funding

For many environmental water buyers, it is necessary to maintain a diverse portfolio of funding sources to build and maintain water restoration projects. While regulatory drivers can often be the catalyst for transactional funding in particular regions, such funding itself usually only comprises a portion of the total required, as illustrated by the Deschutes River Conservancy's 2014 funding sources (Figure 3). In this case, 43% of DRC's funding comes from individual, foundation and corporate donations. The Columbia Basin Water Transactions Program (CBWTP) provides an example of how the funding stimulus and consistency can come from regulatory mitigation which leads to the establishment of a market, while philanthropic donations can allow environmental water buyers to expand their operations outside of the scope of the initial funding.

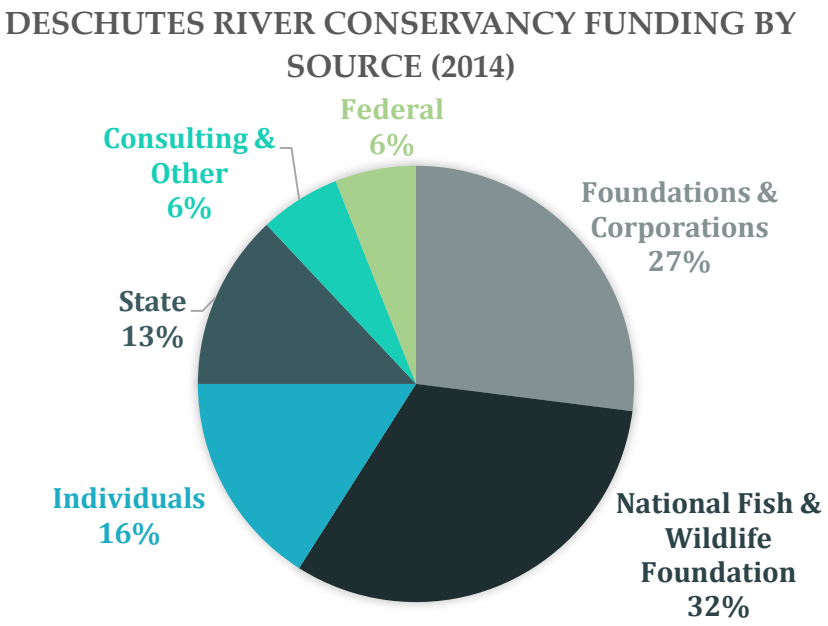

Figure 3. Funding for the Deschutes River Conservancy Fiscal Year 2014. Source: Deschutes River Conservancy, http://www.deschutesriver.org/about-us/funders/

One important funding component in reaching environmental outcomes is to better align current investments with projects and organizations that can demonstrate a

quantified ecological benefit (Whitworth, 2015). Aligning funding with outcomes will require grant proposals to point to quantitative ecological outcomes, compared to the qualitative and descriptive proposals common today. This will "turn supporters of dreams into buyers of outcomes – an important shift" (Joe Whitworth, 2015).

Another important component in expanding the scope of environmental water markets in reaching concrete environmental outcomes is increasing the availability of funding. Currently, flow restoration funding is not generated at a scale that can meet the vast need for restored streamflow. Stan Bradshaw at Trout Unlimited states that there needs to be more funding sources that take into account the costs of monitoring project outcomes (Personal Interview, Stan Bradshaw, 2015). The addition of private capital to instream flow funding sources can provide money at a scale necessary to address the problem across the West. Private investors can seek a return on investment for projects that benefit the environment. For example an investor can provide the upfront costs necessary for farmers to transition to higher value, lower water use crops, where part of the profits can go to the investor (Whitworth, 2015). This is just one example of many new financing schemes that will bring private capital into projects that benefit the environment (Culp et al 2015).

B. Factors Influencing the Supply of Environmental Water

The supply of environmental water in a given basin is based on how water supplies are currently being used, and the associated value, geography, relatively priority of water rights, local institutional arrangements, and the sophistication and conveyance of irrigation infrastructure.

1. Availability of Water Rights for Transfer

a) Current Use of Water Rights as an Indicator of Financial Value

Close to 80% of water use in the United States is used for irrigation, so it is unsurprising that the majority of environmental water transactions involve irrigators (Brewer, 2008). The net value per unit of water for crop production is approximately equal to the gains in the net value of production due to irrigation. This value of production is a useful indicator of the minimum price point an irrigator might accept to lease or sell their water right. This value, however, does not

take the non-financial returns that farmers may receive from irrigated farming, such as a sense of pride and culture associated with farming (Personal Interview, Jonathan Yoder, 2015). Nevertheless, an area with a lower net return per unit of water will be perceived as a more likely location for water transactions to occur than an area with a higher net return for water.

Water rights associated with annual crops are more available for purchase or lease compared with those associated with perennial crops. Perennial crops, such as apples, are long-term investments and cannot be fallowed for a season without losing the whole investment. Annual crops, such as alfalfa and wheat, provide more flexible options for irrigators because temporary fallowing of these crops is possible without losing long-term investments. Whether or not an area is irrigating primarily perennial crops versus annual crops is an important consideration in shopping for environmental water (Garrick, 2014).

b) The Impact of Stream Size and Location

A holistic view of the magnitude, location, priority, and use of water rights can determine the practicality of restoring environmental flows. For a standard environmental water transaction, there will be a stretch of river that is most critically in need (Aylward, 2013). According to Mike Jolliffe from the Freshwater Trust, stream order is usually inversely related to impact. Adding a unit of water to a smaller stream often has more impact ecologically than the same unit of water in a larger river (Personal Interview, Mike Jolliffe, 2015). For this reason, non-profit environmental water buyers have found their niche by primarily focusing on smaller streams, often upstream on tributaries, where they can have a bigger impact at lower cost. Restoring environmental flows in larger rivers, where more water is required to make an impact, involves larger scale action such as stakeholder agreements, integrated plans, government agency involvement, and dam reoperation. Water transactions can be a part of this process but are often not sufficient on their own. Since non-profit environmental water buyers are primarily focused on small tributaries, the location of water rights upstream from a targeted river reach can be limited; thus, the relative priority of water rights is also important to consider.

2. Irrigator Organization Centralizes Decision Making.

Irrigation districts and ditch companies tend to be more organized and conglomerated than disaggregated private water right holders. Therefore, they have the power to facilitate and scale up environmental water buyer efforts by making more water available through one source. Conversely, if they are unwilling to cooperate and work with environmental water buyers, they can block environmental water buyers from accessing water within their jurisdiction. At least 50% of irrigated acreage in the Western U.S. is served by either a private or public irrigation company or district (Rosen, 1993). The water right is owned by the irrigator who exercises the right and simultaneously belongs to the irrigation district that delivers it. Neither of the two parties can transfer the right without the other's approval (Podolak, 2014). If the irrigation district management is open to discussing collaborations and fallowing programs then the environmental water buyer can potentially negotiate with fewer individuals for larger scale environmental water transfers.

Mike Jolliffe from the Freshwater Trust describes higher levels of irrigator institutionalization leading to the pooling of money and decision making authority. This pooling leads to a higher likelihood that a board or manager is going to make a rational economic decision that benefits the district financially, fulfilling their fiduciary duty. This leads to negotiating that is based more on solid economic arguments, as opposed to years of trust building and discussion with individual water rights holders. The Freshwater Trust focuses primarily on upland tributaries which tend to have less organized irrigation institutions, but the years where there are dramatic increases in the volume of flow restored by TFT are due to deals that were made with irrigation districts (Personal Interview, Mike Jolliffe, 2015).

Whether an irrigation district is open to discussing possible transactions with an environmental water buyer depends on many factors. One is the structure of the board and how voting is conducted and weighted within the district. As discussed by Brett Golden from the Deschutes River Conservancy, irrigation districts can place a cap on how much water can be leased away from their district and have policies, infrastructure and operational challenges that make it difficult for them to adapt to creative approaches (Personal Interview, Brett Golden, 2015). Tod Heisler of the Deschutes River Conservancy stresses that irrigation institution managers can have their hands tied in different ways, but that successful transactions are often the

result of good relationships (Personal Interview, Tod Heisler, 2015). Amanda Cronin of the Washington Water Trust describes the relationship between irrigation districts and environmental water buyers as situation specific. If there is a need to restore flow on a large scale, ideally an irrigation institution in the environmental water buyer's basin of interest will be willing to work with them. In many cases, however, it is more efficient to work with individual landowners as opposed to navigating large irrigation institutions (Personal Interview, Amanda Cronin, 2015).

Shared irrigation infrastructure, even without formal institutional limitations, can also be a significant barrier to water market activity. Irrigation conveyance systems are often very basic, and are designed to be easily accessible to irrigators only when the ditch is full of water. If an irrigator along a ditch chooses to sell or lease their water, they must come to an agreement with their fellow ditch users as to whether their water transfer will impact the other users. Often if a consensus cannot be reached, the default is for the transfer to not occur. In evaluation of Colorado Water Trust's 2012 Request for Water Program, a commonly cited barrier to participation is that group consensus was required for mutual ditch partnerships or associations (OMNI Institute, 2013).

The presence of supply chain contracts or social obligations for crops can preclude water leasing. Jonathan Yoder, director of the State of Washington Water Research Center, explains that dairy operations for instance often rely on a steady stream of alfalfa, corn, or other crops, and they often rely on formal written contracts or informal verbal agreements to assure this supply (Personal Interview, Jonathan Yoder, 2015). These contracts can reflect local social relationships that are difficult to quantify or break.

3. Conservation Projects and Irrigation Infrastructure

In an effort to avoid primarily moving water to environmental flow at the expense of agriculture, environmental water buyers have focused on subsidizing water conveyance efficiency projects, irrigation efficiency projects, and other means of getting environmental flow gains without altering the production and economic output of agricultural communities. Historically, if an irrigator engages in a conservation project, their conserved water will no longer be a part of their water right and will simply become available to the next user (Whitworth, 2015; Culp,

2014). As discussed by The Nature Conservancy's Robert Wigington, there is often a disincentive to improving the efficiency of irrigation systems in states with less progressive practices of prior appropriation, as the conserved water cannot be changed to an environmental flow water right. (Personal Interview, Robert Wigington, 2015; Whitworth, 2015). In states where there is no avenue to protect saved water in stream, conservation projects are targeted towards downstream river reaches with no water diversions. The Nature Conservancy's work in the Verde River is an example of targeted projects where there is focus on permanent projects and conservation measures as a means of increasing the availability of environmental water. By building a new headgate for a previously ill-equipped ditch, The Natural Conservancy rewatered a previously dewatered river reach, even without legal protection of the conserved water (Personal Interview, Kim Schonek, 2015).

When engaging in conservation projects, understanding the surrounding hydrology is important because gains to streamflow can be difficult to predict. For instance, switching farmers from flood irrigation to pivot irrigation does not necessarily result in a streamflow benefit (Personal Interview, Stan Bradshaw, 2015). Pivot irrigation can allow for irrigation later in the season when water levels would otherwise be too low for flood irrigation. Late irrigation season coincides with when the environment needs the water most. Pivots also allow higher seasonal crop yields per acre, which might lead to increased overall consumptive water use. Furthermore, conservation measures can impact flow timing, increasing the uncertainty of whether environmental benefits will occur. Therefore, environmental water buyers often must conduct pilot projects to measure whether there is an impact on the stream.

V. POLICY CONDITIONS ENABLING ENVIRONMENTAL WATER MARKETS

In *Getting Our Feet Wet*, Mary Ann King notes, "state water law shapes the opportunities for and constraints on water trusts." (King, 2004). Large differences in the extent of water transactions across western states suggest "that water markets and transaction costs of trade vary considerably" (Libecap, 2010). Environmental flows featured little consideration in the early legal frameworks of western states. Today, some states have adapted their laws to consider the importance of environmental flows, while others have not. This results in large differences in environmental water market activity and associated transaction costs between states (Charney, 2005). *Water in the West* identified 10 legal elements that are most central to environmental water transfers, and compiled to what degree these legal elements are addressed in western states (Szeptycki et. al, 2015). These elements range from whether the state recognizes environmental flow as a beneficial use to the state's stance on split-season leases, where water rights can be shared between irrigation uses and environmental flow.

The combination of legal elements in each state is a major determining factor in the ease of transactions between environmental water buyers and water rights holders, and the costs associated with each transaction. 1800 leases and 113 water transfers have occurred in Oregon, while Utah and New Mexico have had only 8 and 1 transactions in total, respectively (Szeptycki et. al, 2015). This stark difference in transactions within differing legal frameworks is based largely on which state legal elements pertaining to environmental flow a given state has. Table 2 features the 10 legal elements and which are present in each western state. It is clear that there are significant differences in how conducive western state's legal frameworks are to environmental water transactions.

Table 2. The 10 legal elements most relevant to environmental flow transactions, and which western states have these elements (Szeptycki et. al, 2015).

	Arizona	California	Colorado	Idaho	Montana	Nevada	New Mexico	Oregon	Texas	Utah	Washington	Wyoming	✓ (out of 12)
State law explicitly recognizes fisheries habitat, recreation, or other environmental purposes as beneficial uses	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
Transfers of existing diversionary rights to instream or other environmental uses allowed by state law	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12
Transfers of water rights for environmental purposes explicitly recognized by statute	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	10
Private parties can hold instream flow rights		✓			✓	✓			✓	✓			5
Permanent transfers of diversionary rights to instream or other environmental uses allowed	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	11
State law explicitly recognizes short-term leases and provides form of expedited review for approval		✓	✓	✓	✓	✓		✓			✓		7
Transfers of rights for environmental uses are subject to significant limitations that do not apply to other water rights transfers, including geographic limitations, limitations as to purpose, or more stringent procedural requirements		✓	✓		✓			✓	✓		✓		6
The state has a conserved water statute that explicitly allows some portion of water saved by irrigation efficiency improvements to be dedicated to environmental purposes		✓			✓		✓	✓	✓		✓		6
State allows the instream uses to be added to a water right, along with diversionary uses, so that the holder of the right may "stack" instream and diversionary uses on a single water right and allocate water between the two uses each year without the need for additional state review or approval		✓							✓				2
The state's law provides some mechanism for protecting informal short-term private transactions, such as split season agreements or forbearance agreements, from any risk of forfeiture or abandonment			✓	✓			✓				✓		4
Number of Elements (out of 10)	4	9	7	5	8	5	5	7	8	5	8	4	

A. Strength of Legal Framework

States with a strong combination of legal tools, such as Oregon and Washington, are very friendly towards environmental flow transactions, as evidenced by the number of transactions that have occurred in each state, 1,913 and 1,118, respectively (Szeptycki et. al, 2015). Oregon's favorable legal policy includes the potential for conversion of usage and diversionary rights to environmental flow rights and an expedited review process for leases of water rights (Charney, 2005).

Other states in the West feature a legal code that is less conducive to environmental water transfers. Arizona recognizes the value of environmental flows and includes provisions for protecting it, however their state law and combination of legal elements related to environmental flows has resulted in zero environmental flow leases or sales to date (Szeptycki et. al, 2015). While any individual can appropriate water for environmental use, only the state government can transfer consumptive rights in stream (Boyd, 2003). Environmental water buyers in Arizona, Nevada, Wyoming and other states with limited legal framework must operate around existing rules and statutes, finding ways to keep water in stream that do not involve the traditional leases or transfers of water rights.

Transfer prohibitions, such as a lengthy review time, impact permanent and temporary transfers of water rights, rendering them difficult and potentially impossible (Gould, 1989). It is important to understand the transferability of water rights in a target area as a function of written law, as improved transferability will likely result in lower transaction costs. The implementation of these laws is also very important to recognize. Table 3 demonstrates the wide variation in transaction review time from state to state. One example is Colorado, which relies on a water court to approve all water transfers, resulting in an average transaction review time of 6.5 years for long term transfers (Szeptycki et. al, 2015). A long review process results in increased transaction costs and can diminish many of the favorable written legal elements present in a given state. Any environmental water buyer considering entering a new state should be aware of the transaction review process and average review time, as it will have an effect on which tools might be most successful.

Table 3. The environmental water transaction review time in western states (Szeptycki et. al, 2015).

State	Average Review Time
California	1.3 years; 4 months (short term)
Colorado	6.5 years
Idaho	3.8 months
Montana	1.5 - 2 years
Oregon	2.8 years ; 30 - 40 days (short term)
Texas	1 year
Utah	1 - 2 years
Washington	0.5 - 6 years
Wyoming	1 year

B. Enabling Conditions Provide a Toolbox of Approaches.

"Sizing up 21st century water problems, I eventually reached the conclusion that the tools we've been using aren't enough to solve the challenges we face. It's like trying to paint an entire house with a 1-inch paintbrush when what you really need is a spray gun. In the same way, the tools we're using to protect the environment aren't getting us where we need to be." (Whitworth, 2015)

As a function of the legal and regulatory framework they must work within, environmental water buyers develop a "toolbox" of approaches that they can strategically employ. Different tools will be appropriate in different scenarios, depending on hydrology, funding designations, landowner needs and the goals of the environmental water buyer. These tools range from conducting conservation projects to engaging in permanent and temporary water transfers. Table 4 illustrates an example of a toolbox used by the Columbia Basin Water Transactions Program.

Table 4. Columbia Basin Water Transaction Program Toolbox. Data from "Finding Balance" - NFWF, 2015.

Technique	Tool
Water Acquisitions	Short and long-term leases
	Permanent Purchase
	Split Season — A portion of a water right is used for irrigation in the spring and the remainder is left in stream in late summer/fall
	Dry Year Option — An opportunity to lease a water right during a particularly dry year
	Forbearance agreement
	Diversion reduction agreement
Boosting Efficiency	Switching from a flood to sprinkler irrigation system
	Modernizing headgates
	Improving ditch efficiency
Conserving Habitat	Protecting/restoring stream habitat and changing a portion of the associated water right
Rethinking the Source	Changing the point of diversion from a tributary to a main stream in order to improve stream flows
	Switching from surface to ground water source
Pools	Rotational pool — A group of irrigators take turns leaving a portion of their water in stream
Banks	Water Banking — Producers in an irrigation district "bank" water they may not need so it can be available for other uses

The ability to respond to drought conditions depends on having flexible tools that can approve leases quickly. The timing of drought response is critical, since by the time it is certain that a given summer will be excessively dry, there is very little time to react. Andy Fischer from the Clark Fork Coalition discussed this challenge, stating that by early spring there isn't a clear indication that it will be a drought year. Once this becomes clear, there is a lack of temporary reduction tools that are available to work within this timeframe. Even employing temporary reduction tools on a contract basis can be a time intensive process, often taking 4 to 5 months to secure funding and draft contracts. If funding becomes available and deals are made too early in the season and drought does not occur, the environmental water buyer risks unnecessarily rolling out an expensive leasing program. If the drought response is administered too late, farmers will have already financially committed to a growing season, lowering the chance of participation in a fallowing transaction (Personal Interview, Andy Fischer, 2015).

The ability to secure funding on such a short time scale is difficult even for general projects. This is further complicated when environmental water buyers have constraints placed on the designated use of their funding. Scott McCaulou of the Columbia Basin Water Transactions Program mentioned that one of the criteria in considering whether to fund a project is if it accounts for future climate change and uncertainty, and generally how a given project will permanently address the issue of over allocation (Personal Interview, Scott McCaulou, 2015). Short-term drought responses are considered for certain areas where the water is needed, but generally funds are prioritized for approaches that lead to longer-term solution. Availability and appropriate application of tools will improve an environmental water buyer's flexibility, and will allow them to expand operations more easily.

C. Application of Toolbox

A developed and complete toolbox will allow an environmental water buyer to apply different tools depending on the hydrologic, legal, and financial variables they face in a target basin. A flexible toolbox will result in improved efficiency in water transactions. Colorado is the only western state in which transfers must be approved by the state water court, which results in longer transaction review times and sometimes prohibitively high transaction costs (Charney, 2005). There is, however, a legal element in Colorado that allows environmental water buyers to engage in

expedited lease agreements with water rights holders outside of water court, allowing for a quick drought response. This tool is limited in that an environmental water buyer may only use it with a given water right holder 3 times during a 10 year period, then may never use this tool with this water right holder again (Szeptycki et. al, 2015). This provides the Colorado Water Trust with an excellent tool for returning water to target streams and tributaries in drought years, as it features many of the elements present in a traditional lease without the transaction review time and its associated costs. The CWT has taken this legal tool and incorporated it into its Request for Water program, a drought-response program in the form of a reverse auction, aimed at maintaining ecologically healthy environmental flow during drought years (Colorado Water Trust, 2013). A reverse auction is the opposite of a traditional auction, where willing water rights holders are asked to submit a bid with their willingness to accept to not irrigate their crops and transfer their water right. By incorporating this legal tool into their toolbox and determining the most effective way to use it, CWT has increased their ability to respond to drought in a way that would not be possible within the traditional water court system.

Although Washington features favorable legal elements to environmental flow transactions, transaction review times can still be costly and potentially hinder environmental water buyer operations in target basins (Szeptycki et. al, 2015). Similarly to the Colorado Water Trust, one aspect of the Washington Water Trust's toolbox is a reverse auction program, which they have implemented in the Dungeness basin. The Dungeness reverse auction program relies on forbearance agreements, which features similar actions and durations as a lease, but avoids the legal process associated with leases (Aylward, 2013). One drawback to forbearance agreements is the lack of legal protection for the water from other diverters with priority (Aylward, 2013). Forbearance agreements are effective in the Dungeness Basin due to the partnership with the Dungeness Water Users Association, which agrees to prevent downstream diversion of the conserved water. Even in states that do have a legal framework that allows for formal leasing, there are scenarios where forbearance agreements are simpler and just as effective at reaching goals.

Between states, there are different legal tools that environmental water buyers can utilize when engaging in environmental water transactions. Within states in different basins and scenarios, environmental water buyers benefit from understanding the legal tools available and selecting the most effective tools to reach their goals, given local characteristics and landowner needs.

VI. PROGRAM OPERATIONS

A. Market Engagement

A crucial component of developing and growing environmental water markets is identifying initial transaction opportunities and successfully negotiating deals. This involves engaging with communities by building relationships with water right holders, who sometimes have great uncertainty and fear surrounding the security of their water rights. With this uncertainty in mind, environmental water buyers must earn their trust, quell uncertainties, and identify mutually agreeable and beneficial transactions. It is important to clarify program details and intentions, since a well-informed community can make well-informed decisions about their water (Personal Interview, Jeff Dengel, 2015). Local success stories and support from influential community members can help others learn about programs, easing wariness of environmental water transactions (Personal Interview, Amy Campbell, 2015). However, building initial momentum in a basin can be a challenge.

Short-term leases can allow irrigators who are unsure about working with environmental water buyers to test out the process and ease doubts about the system. They are then more likely to agree to longer-term, larger scale transaction (Personal Interview, David Yardas, 2015). Forbearance agreements are also a useful initial transaction tool that allows water right holders to experiment with transacting water. This tool is ideal for responding to the uncertainty and skepticism water right holders often have with government agencies. The result is an efficient method that provides little risk to other water rights holders and leads to clear economic gains (Scarborough, 2010). The on-the-ground relationships environmental water buyers develop are important in overcoming social and cultural barriers, and enabling these initial transactions (Scarborough, 2010).

The outreach involved in marketing a program is important in that news and information about the market needs to be available to the right parties. A program that no water rights owners know about is unlikely to succeed. However, many environmental water buyers operate in a more opportunistic manner rather than a proactive one. Instead of mapping areas, identifying ideal water rights, and targeting these rights, there is more of a general call for water in an area, leaving water right holders to approach environmental water buyers. These general calls for

water can take the form of newspaper ads, flyers, webinars, and utilizing existing connections. However, while proactive and focused outreach efforts may be an important component in the growth of environmental water markets, limited staff and resources can constrain outreach efforts (Personal Interview, Zach Smith, 2015). It is not immediately clear how environmental water buyers can increase their engagement with water right holders through more sophisticated and proactive outreach but is a relevant component to expanding environmental water markets.

B. Valuation should be based on Ecological Outcomes.

For out-of-stream uses of water, there is typically a clear and quantifiable output production value or valued consumptive use for every unit input of water. Water transactions between two out-of-stream water users, who each have a transparent and quantifiable value per unit of water, negotiate from these values to an agreed upon price. For agriculture, this output is a bushel of crops with a clear market value per unit of water. What environmental water buyers are really interested in buying is ecological outcomes, and these outcomes are not easily quantified and valued. A given volume of water can lead to drastically different ecological outcomes based on stream size, channel morphology and local ecology. This leaves environmental water buyers with a challenge in expressing their own unit value of water, which is different across space and time.

A consideration in identifying the value of water is based on the value of foregone agricultural production that the water would have been applied to, or to whatever tradeoffs are associated with that water (Personal Interview, Aaron Maxwell, 2015). Without a concrete means of placing an ecological value on the unit of water, environmental water buyers often value water based on its current use, and pay a premium on this value to incentivize sellers who are not already environmentally motivated to participate. However, they are not negotiating from a quantified ecological value of their own, which can make sellers uneasy. Further, there are social and psychological factors leading water right holders to over value their own water right in emerging markets (Aylward et al., 2010). In these cases, agricultural water right holders often value water as not only the value of their agricultural production, but also a key representation of their identity and way of life, leading environmental water buyers to pay a premium on this price.

To examine the premium placed on water moving from agriculture to the environment, the median inflation adjusted price per committed acre-foot from 1987 – 2009 was examined across 11 western states for agriculture-to-agriculture leases and for agriculture-to-environment leases (Figure 4). The median price across all of the states reveals that the prices for agriculture-to-agriculture water transfers are typically lower than prices for agriculture-to-environment transfers. Results of a Mann-Whitney U test reveal that there is a difference in the median agriculture-to-agriculture (median = 11.27, n = 268) and median agriculture to environment (median = 26.48, n = 219) inflation adjusted price per committed acre-foot ($W = 24937.5$, $p < 0.01$).

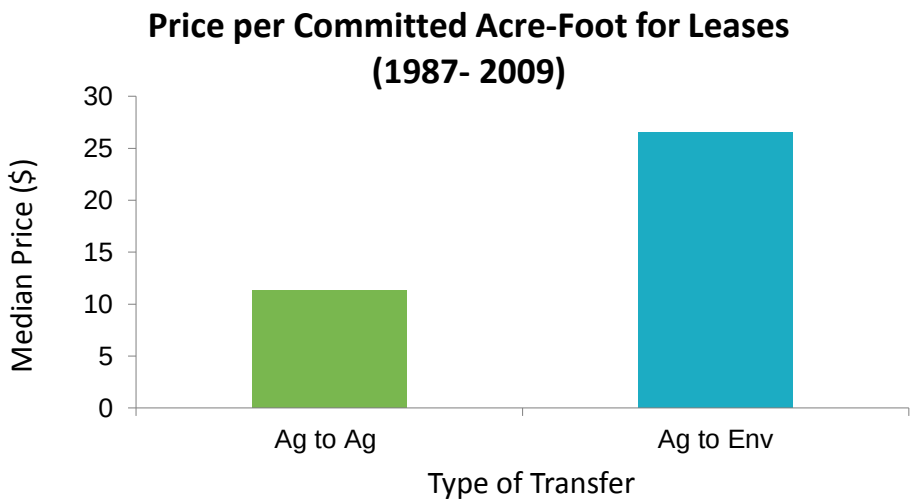

Figure 4. Median inflation adjusted price per acre-foot (1987 - 2009). Median price ($) for Agriculture to Agriculture (Ag to Ag, green bar) and Agriculture to Environment (Ag to Env, blue bar) transactions across 11 Western United States (AZ, CA, CO, ID , NM, NV, MT, TX, UT, WA, and WY). Data from the *Water Strategist* and the *Water Intelligence Monthly*.

In *Quantified: Redefining Conservation for the Next Economy*, The Freshwater Trust President, Joe Whitworth, states that the quantification of environmental benefits, such as flow restoration, can lead to a systematic metric for calculating environmental water funders ecological return per financial input. Assuming this systematic metric were put in place, environmental water buyers would be in a position where they can demonstrate the ecological value of a unit of water spatially and temporally, providing a concrete and transparent value from which to negotiate with water right holders. Further, restoration funding would be directed to where it can have the highest ecological impact, assuming environmental water funders are ultimately aiming to buy ecological outcomes. Prices for environmental water

should be based on the ecological outcome they provide, and environmental water buyers should be transparent about this valuation so that they will have a concrete point from which to negotiate, minimizing transaction costs associated with negotiations.

D. High transaction costs dampen the growth of environmental water markets.

One of the assumptions for the economic theory of optimal allocation through a competitive market is that transaction costs are low (Aylward et al., 2010). While environmental water markets have the potential to redistribute water to higher valued uses, these markets are often burdened with high transaction costs for a variety of reasons. From the standpoint of the environmental water buyer, transaction costs largely result from the following: transaction planning, identification of sellers, administrative and legal review, due diligence ensuring the legality and appropriateness of water rights, water use accounting, and compliance monitoring and enforcement (Garrick, 2013). A list of 14 tasks involved with administering the 2015 Dungeness Dry-Year Reverse Auction Leasing Program, administered through the Washington Water Trust, were categorized into the transaction cost categories of searching for, negotiation, and monitoring & implementing transactions. In a reverse auction format, this program leases water for the final month of the irrigation season, engaging in forbearance agreements with landowners for them to fallow their fields. This analysis reveals that for this program, the majority of transaction costs were the result of searching for and negotiating transactions (Figure 5, Appendix B).

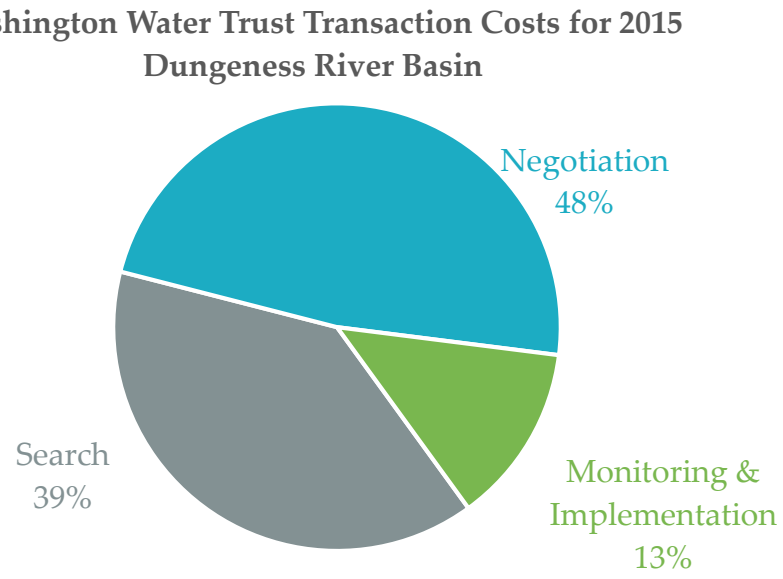

Figure 5. Percentage of transaction costs of the Washington Water Trust by type for the 2015 Dungeness Reverse Auction Program. Source: Program task details provided by the Washington Water Trust.

The lease duration, magnitude, legal status, and other components of a lease or leasing program can all affect the relative magnitude of transaction costs. Search transaction costs associated with general leases, which are not part of a systematic drought year leasing program, are relatively high, since water right holders are committing to longer term. Further, for general leases over a widespread area, monitoring costs are likely a much higher portion of transactions costs compared with the Dungeness Dry Year Leasing Program, where the program was only focused on one river.

The impact of transaction costs on program success, however, is not straightforward. While transaction costs can be relatively high, the funding and staffing of environmental water buyers, can overcome many of these transaction costs. Therefore, while high transaction costs are not preferred, their existence does not necessarily forecast low program success (Garrick & Aylward, 2012). Transaction costs vary not only between states but also within states, suggesting that while the legal enabling conditions do have an impact on the ability to create water transactions, institutional capacity may play a larger role (Garrick & Aylward, 2012). It should be noted that institutional capacity can have a feedback loop with policy conditions, through information gathering and lobbying encouraging policy enactments to strengthen market-enabling legislation (Garrick et al., 2013). These

institutional transition activities work to decrease or stabilize transaction costs over time. The Oregon Water Resource Department's (OWRD) expedited short-term review process provides an example of the success institutional transition activities can achieve. By communicating with OWRD, environmental water buyers were successful in expediting the review process for short-term lease approvals, reducing the process to 30 to 40 days (Oregon's Flow Restoration Toolbox). This expedited review process has been successful in decreasing transaction costs for environmental water buyers and increasing the number of environmental flow leases in Oregon. Overall, it has been recommended that CBWTP adapt funding to accommodate the high transaction costs associated with environmental flow transactions (Hardner & Gullison, 2007).

VII. KEY STRATEGIC TAKEAWAYS FROM INTERVIEW FINDINGS

Interviews with environmental water buyers have informed our understanding of key strategies currently employed. These interviews illuminate key growth areas for expanding environmental water markets into new areas and enabling the efficient transfer of water to environmental uses.

A. Understanding seller needs and operations leads to mutually beneficial approaches.

Water rights holders are more receptive to environmental water buyers who are part of their communities and help to identify creative projects that provide benefits to both parties. In order to make this possible for environmental water buyers, regulations must allow for a flexible toolbox and funding must not be constrained to narrow uses. As Tony Malmberg from the Freshwater Trust discusses, the more you can know about their [water right holders] operation, the more you can help them to use water as a tool for crops and for making money (Personal Interview, Tony Malmberg, 2015). An environmental water buyer can be a broker between environmental water funders and water rights holders, aiming to understand landowner needs and communicating available funding opportunities. This allows the water right holder to identify what works best for them while building trust (Personal Interview, Mike Jolliffe, 2015).

These partnerships and mutually beneficial projects vary, dependent on irrigators' operations and needs. Rotation schemes, such as split season use and conservation projects, keep farms in operation while returning water to streams where and when it is needed. As discussed by The Nature Conservancy's Robert Wigington, one strategy that gives environmental water buyers flexibility and security is purchasing land and leasing it to farmers, which keeps land in production but limits water use (Personal Interview, Robert Wigington, 2015). The strategy of aligning with the seller and finding mutually beneficial agreements that keep agricultural communities intact was discussed by 14 of our other interviewees.

B. Focused development and effective pilot projects are crucial for pushing enabling policy conditions.

There is a feedback loop between lawmakers and environmental water buyers. Lawmakers give tools to environmental water buyers, who use these tools to conduct pilot projects that provide proof of concept. This prompts lawmakers to provide more tools, which continues the cycle. Laura Ziemer from Trout Unlimited's Western Water and Habitat Program (TU) is focused on projects that illustrate concepts and needs to policy makers. In one fast-growing area of Montana where Ziemer works, the Gallatin Valley, a wealthy and powerful development lobby coupled with high rates of population growth are the main threats to the valley's agricultural community. Part of the TU mission is to keep agriculture intact while working collaboratively towards aquatic stewardship. TU's negotiation of agreements such as split season leases makes this possible. These leases continue irrigation during the high-water, first-half of the irrigation season, and dedicate to instream flows the water right during the second, dry half of the irrigation season. The use of such split-season leases of agricultural water rights allow both agriculture and ecosystems to benefit, and provide another source of income to irrigators who otherwise might allow their land to be developed (Personal interview, Laura Ziemer, 2015). By proving their projects can work in certain areas, TU can more effectively educate policymakers and push for new statutes or regulations that provide more conservation tools, and for policies that would allow current tools to work more smoothly. The general strategy of proving concepts to illustrate the need for change to policy makers was explicitly discussed by 5 of our other interviewees.

C. Environmental water buyers should not spread resources too thin when expanding into new areas.

For the many environmental water buyers that operate on a statewide scale or even larger, balancing resources between expansions into new basins and maintaining existing programs is a key consideration. One strategy employed in expanding operations is to concentrate resources towards areas to generate momentum and facilitate a baseline of transactions that can demonstrate success to other potential lessees. From here, a project manager will stay on to oversee operations and continue building relationships and facilitating transactions, while more people and resources are focused on building programs in new basins. This approach, referred

to by Mike Jolliffe as the "bobsled approach", is illustrated by The Freshwater Trust, who are focused on 3 particular basins despite having established water markets and continuing programs across much of Oregon (Personal Interview, Mike Jolliffe, 2015). Focusing resources towards identifying and conducting pilot projects in a new basin is important as a means of entering new potential market areas, and a means of initiating communication and building relationships with key community members and district managers. This approach, as opposed to spreading resources thin throughout a large area, is thought by some to be more impactful. This general strategy was discussed by 2 of our other interviewees.

D. Drought response is a useful approach in many scenarios, but should not distract from long-term goals.

In many places, large gaps between target flow levels and existing flows are an issue every summer, not just during droughts. With this in mind, many environmental water buyers and funders do not see the point in adjusting operations or being reactive to drought conditions, since their goal is to bring more water to the environment in the long run through consistent leases, sales, and conservation projects. As Amy Campbell from the Shasta Water Transactions Program puts it: "moving conservation forward is a marathon, not a sprint" (Personal Interview, Amy Campbell, 2015). Short-term transactions, such as dry year leases, are a good means of introducing people to the idea of living without their water, potentially leading to longer-term transactions. However, if too much focus is placed on short-term projects, gains from permanent water right transactions could be reduced, impacting the market longevity (Personal Interview, David Yardas, 2015).

Drought response programs are appropriate and can be preferable when target streams or rivers are only low enough to cause ecological damage during dry years, contrasted with a river reach that is over allocated to the point where it very frequently runs dry leading to ecological degradation. Further, when the permanent buy out of water rights for environmental flow is politically not an option, drought response programs might be the only option. When drought response is a preferred strategy, it is important to have funding and tools that are sufficiently flexible for working on short time scales. Plans for drought should ideally take place prior to drought scenarios, since being reactive to drought often does not leave sufficient time for planning leasing operations. Drought responses can place increased stress on institutional capacity; often requiring increased operational hours at the expense of progressing long-term projects. If a number of transactions could be prepared and

negotiated prior to drought scenarios as option contracts (contracts that can be executed if and when droughts occur), drought would cause less stress on institutional capacity (Personal Interview, Zach Smith, 2015). Drought response was discussed with all of our interviewees with few exceptions. There is general consensus that drought response is important and appropriate in specific situations, but not at the expense of a long-term focus. It is generally agreed upon that drought can be a good policy opportunity and can spur conversation and concern from landowners, which can be beneficial in the long run.

E. The organization administering the environmental market impacts market engagement.

The main argument against government or regulator administration of any water market is that a water right can be exposed to unwanted scrutiny and even relinquishment, which is a barrier to entering the market (Young et. al., 2016). Illustrating this point in regard to environmental water markets, surveys conducted regarding the 2007 reverse auction in the Yakima Basin, albeit with a small sample size, suggest that the Department of Ecology, the auction administrator and also the water rights regulator in Washington, is simply not trusted. It was revealed that water rights holders were unclear of what the real agenda behind the auction was (Rux, 2007).

In contrast, a nonprofit organization or for-profit business can serve as a gatekeeper between water right holders and regulators. A third party that is not required to report any illegal findings to regulators can be more effective, where individuals feel more comfortable proposing transfers. This would, in theory, increase the willingness of individuals to propose transactions and ask for their water right to be appraised without the threat of being punished. However, there is a difference between the for-profit businesses and non-profit organizations in what their real or perceived motives are in the eyes of water rights holders.

The motivation of nonprofit organizations can seem suspect to water right holders, if their primary motive is not to make a profit, but rather achieve conservation outcomes (Personal Interview, Laura Ziemer, 2015). Water right holders were asked to describe characteristics of an entity that they would be more responsive to. Unanimously, a “disinterested organization that would allow sellers and buyers to

establish a fair price" was the preference, which ruled out the local water trust and pointed to the local Reclamation District as the organization of choice (Rux, 2007). The reality for environmental water buyers is that most basins do not have a central market facilitator, so they often function as the administrator and the buyer. Businesses are perceived as transparent in their effort to make a profit. The following commonly cited barriers to participation in the Request for Water program, administered by the nonprofit Colorado Water Trust, were concerns over detailed water portfolio reviews, losing water rights, and enforcement of intended water use. These barriers show that perceptions of market administrators impact market participation. (OMNI Institute, 2013).

VIII. RECOMMENDATIONS AND CONCLUSION

It is a dynamic time for water management in the western United States, where the need to more smoothly reallocate water to higher value uses becomes more apparent as supplies dwindle and demand rises. The widening gap between supply and demand may be met with increased water transactions. The key strategies identified in our research and interviews that will lead to the expansion of environmental water markets are:

- **Understanding seller needs and learning about their operations leads to identifying mutually beneficial approaches**
- **The organization administering the environmental market impacts market engagement**
- **Water valuation should be transparent and be based on ecological outcomes**
- **Environmental water buyers should not spread resources too thin when expanding into new areas**
- **Environmental water buyers should utilize diverse funding sources to allow flexibility in identifying mutually beneficial projects**
- **Drought response is a useful approach in many scenarios, but should not distract from long term goals**
- **Focused development and effective pilot projects are crucial for pushing enabling policy conditions**

The environmental water market movement has been spearheaded by a dedicated and forward-looking group of individuals with a wide breadth of expertise and knowledge. As a result of working in a new field with new tools and strategies evolving over time, environmental water buyers are constantly trying new tools and experimenting with what works. Now that they have exercised many of them, the next step is to make them more routine, where instead of a new experiment every time, programs and tools can be broken down into a series of replicable steps (Personal Interview, Amy Beatie, 2015).

Over time, successful environmental water buyers will slowly see lower transaction costs as their operations become more routine (Garrick, 2013). With the amount of dewatered rivers in the western United States, environmental water buyers must consider the strategies discussed above and continue to learn and adapt to evolving

circumstances to rewater ecosystems and rebalance the allocation of water resources towards the environment.

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X. APPENDICES

Appendix A – Interview Questions

State Official Interview Questions

1) Does your [agency] have a mission to restore instream flows?

2) What organizations and individuals do you primarily interact with to achieve goals related to instream flows?

3) How do your goals/interactions/actions change during drought years?

4) What legislation confines the work that you do with instream flow? Are there any non-legislative confinements you must work within?

5) What institutional politics confine the work that you do with instream flow?

6) What types of interactions do you have with water rights holders in general?

7) What's your biggest challenge in communication and trust building with water rights holders?

8) How receptive are agricultural producers/water rights holders to instream flow transactions?

9) How large of a geographic area do you work in?

10) Do you primarily lease water rights or purchase them? What are the pros and cons?

11) What types of hurdles/obstacles do you have to overcome to be successful in water rights transactions?

12) What sort of parameters do you base your water transactions on?

13) How do you build/maintain relationships with entities you purchase/lease water from?

14) What could make the water right leasing/purchasing process easier for you?

Water Rights Holders Questions

1) What challenges do you face managing water supplies? (Technology, Political, Economic)

2) What are your long term and short term goals?

3) Do droughts impact your production? What steps do you take in reaction? (Switch crop types, fallowing fields, reducing water use, etc.)

4) What is your opinion on water rights transactions?

5) Do you have experience with water rights transactions? (Buy or Sell, Leasing)

6) In what situations would you be willing to participate in a water rights market?

7) What are your general sentiments towards environmental transfers?

8) What about technological 'trading' (build a better flow gate to trade for reduced water use)?

9) Have you been contacted by water trusts/organizations? How did they approach you? What would you have been more receptive to?

10) Which groups would you work with? What obstacles would have to be overcome for you to be willing to participate/continue to participate in water rights transactions?

11) What do you feel about the overall water efficiency of your operations?

12) Are there any barriers to implementing water efficiency technologies/practices?

13) What haven't I asked you that you think would be beneficial in discussing water transactions?

Environmental Water Buyers Questions

1) What organizations and individuals do you primarily interact with to achieve your organization's goals? (State agencies, other NGO's)

2) What types of interactions do you have with water rights holders in general, and which sectors do you primarily transact with?

3) Are there challenges in communication and trust building with water rights holders?

4) How receptive are water rights holders to your overall organization goals?

5) How many geographic areas do you work in? How large are the geographic areas in which you work?

6) How do you decide where to focus your operations?

7) How often is your institution involved in water transaction? Does this look drastically different on wet versus dry years?

8) How important are water transactions to the goals of your organization? Is your organization involved with river restoration beyond instream flow?

9) Does your organization have any specific future goals to expand the volume or number of water transactions within the basins you already work? Into new basins?

10) How do your donors' expectations impact your goals and practices?

11) Do you primarily lease water rights or purchase them? What are the pros and cons?

12) What types of hurdles/obstacles do you have to overcome to be successful in water rights transactions?

13) Do you have issues navigating through wet and dry cycles? Through funding cycles? With a fixed size business.

14) Do you see any solutions to these problems, regardless of costs; scale; or feasibility?

15) Who do you think we should talk to next?

16) What should we have asked you?

Appendix B – Transaction Cost Data

From The Freshwater Trust, we have finer scale transaction costs for their overall statewide operations in terms of hours spent on certain parts of the process and employee salary. We have these finer scale transaction costs from Washington Water Trust as well, specifically for their 2015 and 2009 dry year leasing program (Table B1). We then converted all of our transaction cost information from these forms into the same units as our pricing information, where leasing price information is presented as average dollar per acre-foot acquired, average search transaction cost per acre-foot, average negotiation transaction cost per acre-foot, and average monitoring and implementation transaction costs per acre-foot. Proportions of overall costs are in regard to actual acquisitions versus various transaction costs were calculated

Table B 1. Washington Water Trust Transaction costs for the 2015 Dungeness Dry-Year Leasing Program and 2015 Reverse Auction:

Transaction Cost Category	Transaction Cost Category Task	Total Hours	% of Total Time
Search	Fundraising and Grant Writing	25	6.0
Search	Planning and strategizing for auction	30	
Search	Marketing Campaign	30	7.2
Search	Send out offer forms	30	7.2
Search	Landowner Outreach	45	10.8
Negotiation	Process Offers Received	60	14.5
Negotiation	Due diligence	45	10.8
Negotiation	Draft and sign contracts	60	14.5
Negotiation	Mapping for contracts	35	8.4
Monitoring and Implementation	Fill out lease application	0	0.0

Monitoring and Implementation	Get signature on lease application	0	0.0
Monitoring and Implementation	Visual Monitoring 3 times	35	8.4
Monitoring and Implementation	Prepare invoice, issue checks	10	2.4
Monitoring and Implementation	Phone call and follow up survey to participants	10	2.4
	Total	**415**	

Appendix C - Streamflow Targets

Streamflow Targets in Specific Basins

As an example, streamflow targets are set in the Upper Yampa in Colorado from November through February and February through August to meet the needs of various endangered species. According to the Management Plan for Endangered Fishes in the Upper Yampa Conservancy District, the base flow target from November through February was set at 124 cfs and the baseflow target February through August was set at 93 cfs (Management Plan, 2004). The baseflow from November through February in 2004 was set at 124 cfs to account for uncertainty in flow needs (a 30% buffer added to the 93 cfs) during these months, confirming the uncertainty associated with determining streamflow needs. These streamflow targets from the Management Plan were combined with estimated streamflow targets from the Colorado Water Trust. Seen in Figure C1 the estimated streamflow (green-line) does not reach the targeted streamflow (blue-line) during any of the months. Water rights were obtained in the Upper Yampa Conservancy District and streamflow was estimated after these rights were added in Figure C2. The results of these graphs show that the estimated streamflow (red-line) does not reach the targeted streamflow (blue-line) for a large portion of the time, except during the late summer months, suggesting that water can be added to a stream even if estimates suggest that a stream will not be meet instream flow targets during a large portion of the time. There may be a tradeoff between adding in some water to increase streamflow and not reaching targeted streamflow and adding in no water.

Alternatively, if trusts cannot purchase enough water rights to reach streamflow targets then there may be no purpose in purchasing any water. This may be a factor of the initial amount of water that is instream and the gap between the estimated streamflow after a transaction and the instream flow target. Determining if the amount of water added to the stream will have an impact on endangered species is an important factor to consider when purchasing water, but incremental additions of water may still have an impact.

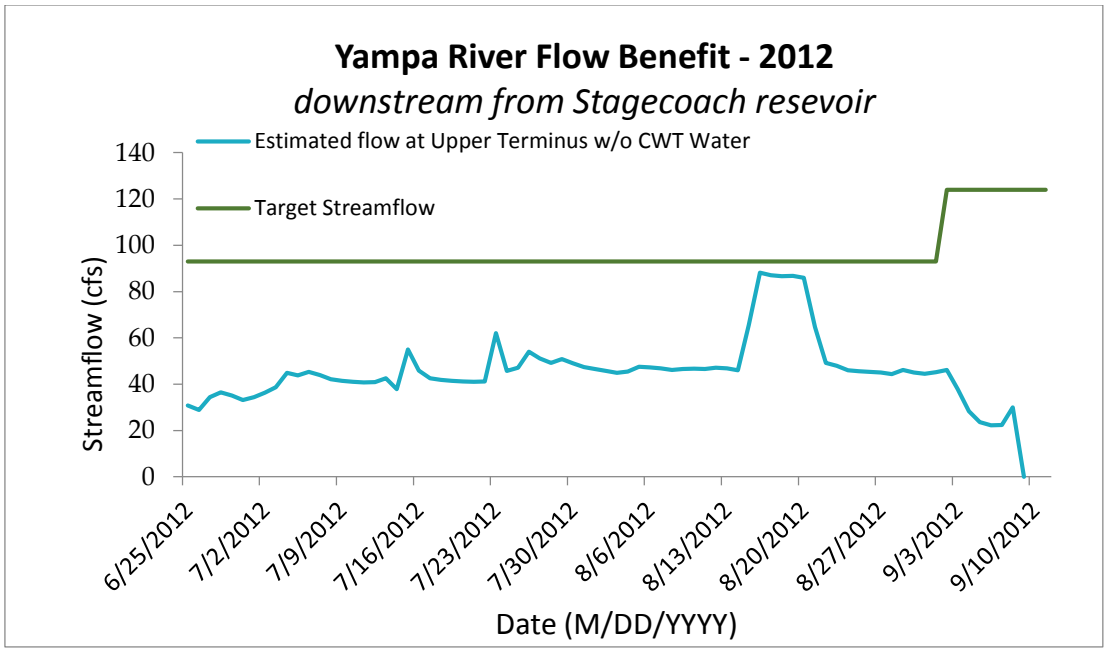

Figure C 1. Estimated and targeted streamflow at the Upper Terminus downstream from Stagecoach reservoir from 6/25/2012 to 9/10/2012. Estimated streamflow (green-line) and targeted streamflow (blue- line) at the Upper Terminus in Colorado in cubic feet per second (cfs). Data from http://www.coloradowatertrust.org/our-work/projects/stagecoach-reservoir-yampa-river

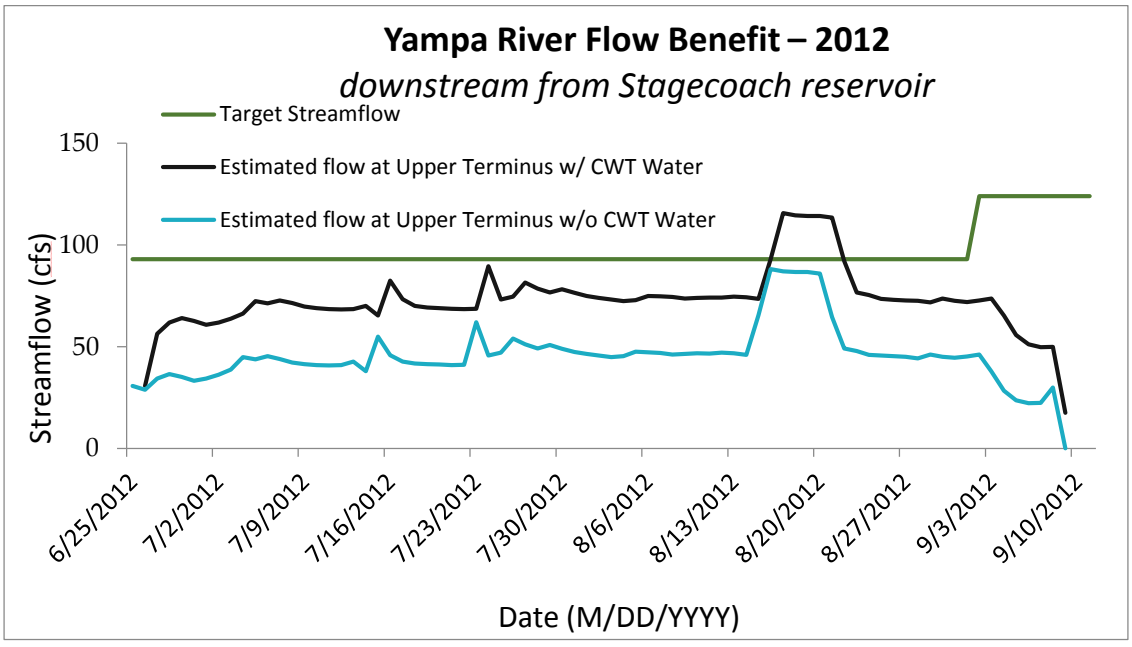

Figure C 2. Estimated streamflow w/ CWT water (red-line), estimated streamflow w/o CWT water (green-line) and targeted streamflow (blue-line) at the Upper Terminus downstream from the Stagecoach Reservoir in Colorado in cfs (cfs). Data from http://www.coloradowatertrust.org/our-work/projects/stagecoach-reservoir-yampa-river

Appendix D – Funding

The following are examples of programs in which regulatory drivers catalyzes funding for environmental water acquisitions:

Nevada Terminal Lakes, Nevada.

Neighboring Walker and Summit Lakes experienced decreasing water levels which resulted in the ESA listing of a native fish species. The Farm Security and Rural Investment Act of 2002 provided the Bureau of Reclamation with $200 million to address water levels and associated issues at Pyramid, Summit, and Walker Lakes but explicitly prohibited the use of funds for purchasing or leasing water rights. (Farm Security and Rural Investment Act of 2002, Sec. 2507 (b).) The next year, this limitation was overturned and $2.5 million was allocated for the acquisition of water rights through the State of Nevada (Energy and Water Development Appropriations Act, Section 217 (1)). In 2009, Public Law 111-85 enacted National Fish and Wildlife (NFWF) to oversee the Walker Basin Restoration Program, including $25 million for the creation and management of a 3-year water lease demonstration program (Program; Public).

Deschutes River Basin, Oregon.

The Oregon Resource Conservation Act of 1996 addressed several land and water issues in Oregon, in particular the protection of the Opal creek area (Benson, 2012). The Act recognized the Deschutes River Basin Working Group, which consisted of representatives from the following interests: private, tribal, federal, state, and county or city government levels, to "propose ecological restoration projects [...] based on a consensus of the Working Group" (Oregon Resource Conservation Act of 1996). The Act also tasked the Bureau of Reclamation with paying up to 50 percent of the projects, up to $1,000,000 annually from 1997 through 2001. The Act instructs the Working Group to "give priority to voluntary market-based economic incentives for ecosystem restoration including, but not limited to, water leases and purchases" (Oregon Resource Conservation Act of 1996).

Big Hole River, Montana.

In 2004, the combination of low flows and high water temperatures threatened the population of ESA-listed arctic grayling, causing irrigators to seek assistance from the Montana office of the United States Department of Agriculture (USDA) Natural Resources Conservation Services (NRCS) (Benson, 2012). In order to prevent new regulations, the NRCS utilized the Farm Bill's Environmental Quality Incentives

Program (EQIP) to pay irrigators to forego the use of their water rights (Food Security Act of 1985, 16 U.S.C. § 3839aa (1)–(2) (2006); Benson, 2012).

Colorado Water Conservation Board.

In 2002, the Colorado Water Conservation Board's (CWCB) role was expanded to allow for acquisition of water rights and use of appropriated funds (COLO. REV. STAT. § 37-92-102(3)).. Without specifically designated funds, the CWCB acquired no water rights in the first few years following the enactment of the statute. A provision in the 2008 House Bill 08-1346, appropriated $1 million per year to the CWCB "to pay for the costs of acquiring water, water rights, and increase interest in water for instream flow use," placing higher priority to the acquisition of rights (Colo. H.B. 08-1346 § 27-28). The following year, CWCB was authorized to receive up to $500,000 of annual revenue from habitat stamps, provided the previously appropriated $1 million had been used entirely (COLO. REV. STAT. § 33-4-102.7(1.5))

Columbia Basin Water Transaction Program (CBWTP)

The Congressional passing of the Pacific Northwest Electric Power Planning and Conservation Act in 1980 authorized the creation of the Northwest Power and Conservation Council (NW Council) "to protect, mitigate and enhance fish and wildlife of the Columbia River Basin that have been affected by the construction and operation of hydroelectric dams," among other roles (NPCC - Columbia River Basin: Fish and Wildlife Program; Pacific Northwest Electric Power Planning and Conservation Act). In 2000, two salmon recovery reports called for the operator of the hydroelectric dams, Bonneville Power Administration (BPA), to establish a water acquisition program in the Columbia Basin (Benson, 2012). The NMFS report found "that operation of the federal dams would jeopardize the continued existence of salmon and steelhead runs listed under ESA" and suggested establishing a water brokerage as reasonable and prudent action to address tributary flow problems (Benson, 2012; National Marine Fisheries Service, 2000). BPA agreed to the suggestions and in 2002 authorized the National Fish and Wildlife Foundation (NFWF) to implement the Columbia Basin Water Transaction Program. Individual water transactions are not conducted by NFWF but only by local and state nonprofit or government entities designated as Qualified Local Entities, with funding coming from hydroelectric revenues from BPA (CBWTP - The Program).