MANAGING WATER RESOURCES IN THE YAKIMA RIVER BASIN: AN ANALYSIS OF WASHINGTON WATER RIGHTS AND THEIR INFLUENCE ON IRRIGATED FARMLAND

by

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ABSTRACT

MANAGING WATER RESOURCES IN THE YAKIMA RIVER BASIN:
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Agricultural lands in Washington make up over 15 million acres and play a vital role in the State's economic viability (Washington State Department of Agriculture, 2014). Most of Washington's farmland is located in the eastern portion of the state, which also has the most arid climate. Consequently, irrigated water is one resource that is imperative to keep farms on the east side of the Washington operating successfully. One area in particular that is reliant upon surface water to irrigate its farmland is the Yakima River Basin. The convergence of western water law, as embodied in Washington water rights with irrigated water used for agriculture in the Yakima Basin, creates complex factors that the region is continuously trying to resolve. Moreover, all of these issues come at a time when climate change is a growing factor that adds additional challenges to the components of water rights, water management and water allocation. To better understand how Washington water rights influence irrigated farmland in the Yakima Basin, I conducted interviews with 7 major stakeholders in the area. The questions formulated for the thesis were developed to better understand the opinions and professional knowledge about water resource management-related issues in the Yakima Basin from individuals in the governmental and non-governmental sectors. The results I received from the 7 subjects interviewed from 5 different organizations laid the groundwork for the direction in which all individuals in the Basin involved with water resource management and irrigation ought to move. This study points out many of the similarities and differences various groups of stakeholders have in the Basin. These similarities are an important driver when it comes to making logical and progressive improvements and plans for the Basin's future. One thing that 6 out of 7 interview subjects could agree on is that the Basin is experiencing a persistent trend in warming. In fact, all 7 subjects agreed that the Basin is experiencing a loss in snowpack, and provided their own ideas on how to implement best management practices with respect to a less reliable water source.

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Acknowledgements

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I would also like to thank all of the people who participated in the interview process. Your expert opinions and insight contributed greatly to my research. The interviews that you all participated in helped to create new findings and a foundation for a path forward regarding many of the issues around water resource management in the Yakima River Basin. I am confident that all of you will continue your hard work and dedication in your respective fields to make the region a great place for years to come.

CHAPTER 1: Introduction

Background Information

Agricultural lands in Washington make up over 15 million acres and play a vital role in the State's economic viability (Washington State Department of Agriculture, 2014). Washington is known for its apple industry, which yields 70 percent of U.S. production, but also consists of 37,249 total farms that produce a wide variety of other crops (Washington State Department of Agriculture, 2014). Most of Washington's farmland is located in the eastern portion of the state. The three main surface water sources for eastern Washington are the Columbia River at Grand Coulee, lower Snake River, and the Yakima River watersheds (Washington State University, 2014). As a result of large-scale farming operations, the ecological services and vitality of this region's rivers and tributaries have been largely influenced by widespread irrigation. Furthermore, the Cascade Mountain Range creates a rain shadow effect that directs most of the moisture from the atmosphere onto the west side of State (Shepherd, 2002). This leaves the east side of the State with ample amounts of sunshine, but very little rainfall. Consequently, irrigated water is one resource that is imperative to keep farms on the east side of the Cascades operating successfully.

One area in particular that is reliant upon surface water to irrigate its farmland is the Yakima River Basin. The Yakima River is located in south-central Washington, and begins by the crest of the Cascade Mountain Range between Snoqualmie Pass and Mt. Daniel (Mack, 2013). The Yakima River runs southeasterly for 215 miles until it meets with the Columbia River near Richland, Washington (Mack, 2013). During its flow to Richland, the river drains an area of over 6,000 square miles, while being fed by seven

major tributaries and numerous smaller creeks and springs that allow the river to produce an annual discharge of approximately 3,700 cubic feet per second (cfs), as seen in **(Figure 1)** (Mack, 2013).

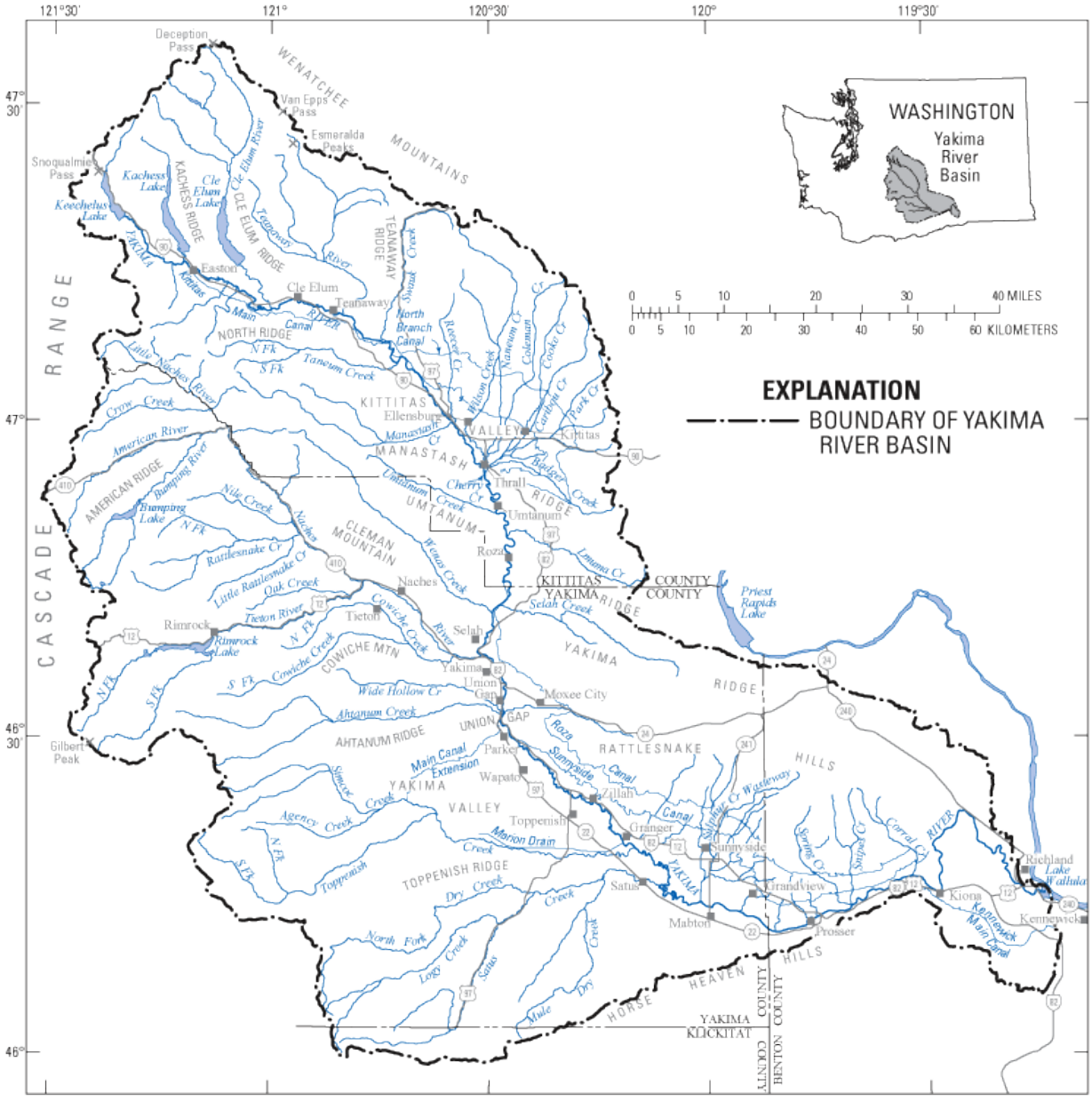

Figure 1. The Yakima River, its tributaries and the boundary of the Yakima Basin (U.S. Geological Survey, 2013).

A decline in water availability in the Yakima Basin can be attributed to a number of factors. Extensive irrigation, combined with the cycles of drought and low snowpack which are expected to worsen due to climate change, have made irrigated agricultural issues much more persistent; primarily in more arid regions like the Yakima Basin. This presents a widespread problem since 75 percent of the State's irrigation comes from surface water sources (Washington State University, 2014). Yakima Basin is mostly dependent upon extensive surface water irrigation practices. Because of the Yakima Basin's dry climate and large-scale irrigated croplands, this area faces serious concerns around water rights, water allocation and water resource management. Additionally, the growing demand for irrigated water from the Yakima Basin is influencing the spawning and lifecycles of salmon in its rivers and tributaries (Washington State Department of Agriculture, 2014).

The convergence of western water law, as embodied in Washington water rights with irrigated water used for agriculture in the Yakima Basin, creates complex factors that the region is continuously trying to resolve. Moreover, all of these issues come at a time when climate change is a growing factor that adds additional challenges to the components of water rights, water management and water allocation. One major disturbance from climate change to the Yakima Basin is that the winter snowpack in the mountain headwaters is decreasing because of an increase in air temperature, and a precipitation shift from snow to rain (Elsner, 2010). This weather-related change creates less runoff to supply the Yakima River and its tributaries with water throughout the spring and summer months (Elsner, 2010). A dwindling water supply threatens the

Yakima Basin's ecological systems and the economic way of life for many individuals who depend on its water for irrigation.

Western water law and Washington water rights, coupled with weather-related variables, sets limits on the quantity of water delivered to irrigators within the Yakima Basin. Issues around water rights dates back to the 19th Century before Washington had even established its statehood. Water rights holders, in many cases, have had to prove their traditional water rights through an adjudication process. Washington State Department of Ecology (Ecology) is the primary agency tasked to administer a complex system of senior and junior water rights within the Yakima Basin. This administrative process has created some level of distrust among some of the water rights holders. A number of water rights in Yakima Basin have been owned by families for several generations. Water rights holders can be very protective over their water resources and, at times, cautious of government intrusion. At the same time, senior water rights users can become frustrated and rely on Ecology to intervene if, for instance, a junior user impinges on a senior user's water supply. Therefore, to be able to understand these matters fully, it is essential to know the circumstances of all of the related stakeholders involved in water resource management in the Yakima Basin. To get a better understanding of these matters, interviews will be conducted to explore the decision making process among subject matter experts involved in the Basin's resource management. These interviews will also help to draw attention to any issues between the Basin's water rights holders and the various groups involved with water resource management.

The Interview Process

To better understand how Washington water rights influence irrigated farmland in the Yakima Basin, I conducted interviews with major stakeholders in the area. I developed a series of 8 questions that were asked to a total of 7 people; three individuals affiliated with Washington State Department of Ecology, a water law attorney with over 20 years of experience working in Washington, a private consultant working in the Yakima Basin, a representative from an irrigation district in the region, and a representative from a non-profit organization that represents farmers in Washington.

The questions formulated for the thesis were developed to better understand the opinions and professional knowledge about water resource management-related issues in the Yakima Basin from individuals in the governmental and non-governmental sectors. Specifically, each person interviewed was asked about their individual understanding of Yakima Basin's water laws and policies, any potential environmental impacts from these water laws, any climate change-related concerns in the Basin, and suggestions as to how water laws could be improved upon. Additionally, the questions asked during the interview process were intended to provide a comprehensive foundation with respect to Yakima Basin's historical information, as well as any contemporary or future plans viewed by the interviewee as either successful or unsuccessful for managing the Basin's water resources. The information and data obtained through the interviews is an important step for understanding the past, present and future problems around water resource management in the Basin.

CHAPTER 2: Literature Review

This chapter looks at several areas of study that play an important role in understanding the current state of water management and irrigation in the Yakima Basin. A look into Washington's water law history, current and anticipated issues around water rights in the Basin, various private and state run programs available to water users, and a closer look into water conservation efforts will all be discussed in this section. And finally, this chapter will conclude by explaining the research that was conducted to gather new information about this topic, as well as those areas that were not included in the research and would require further analysis.

A History of Washington Water Law and Rights

Washington water law and water rights are a defining set of laws that determines how a water rights user can legally use their irrigated water. Water is a shared natural resource in Washington, and is therefore not owned by any individual, group, or business residing in the state. Thus, a comprehensive set of laws is necessary so that the state's water resources can be put to use in the most economical, ecological and socially viable way.

Water rights in Washington have a long history that stretches back to the mining and settlement days of the 19th century. It is important to first define what a water right is to be able to interpret the laws that govern and support it. A water right is defined as: "A

right to a beneficial use[1] of a reasonable quantity of public water for beneficial purpose during a certain period of time occurring at a certain place" (Washington State Department of Ecology, 2014). In Washington, there have been two different periods for establishing water rights; before and after the implementation of water codes (Washington State Department of Ecology, 2014). Before the implementation of water codes, water rights were established mostly by pioneers looking to farm, mine and log. During this time, water rights could be determined in two ways; first, "if a person owned land adjacent to a stream or lake, he or she also automatically became an owner of riparian water rights. (Washington State Department of Ecology, 2014)" The other way for those who wanted to divert water from its original source and transport it to their land was to "simply post notice on a tree and/or record notice with the county and proceed to divert the water and put it to beneficial use on the land" (Washington State Department of Ecology, 2014). This way of obtaining a water right is called appropriation and is the foundation of Washington's prior appropriation system[2].

In 1917, the Washington Water Code created a centralized water rights administration system, and declared that the prior appropriation doctrine was the newest method for determining surface water rights (Mack, 2013). Things changed completely for water rights with the adoption of water codes in 1917 for surface water, and then in 1945 for groundwater. Now, in order to establish a water right, one must first file an application for a permit with Washington State Department of Ecology (Ecology)

[1]According to RCW 90.14.031 under Washington State law, "beneficial use" shall include, but not be limited to, use for domestic water, irrigation, fish, shellfish, game and other aquatic life, municipal, recreation, industrial water, generation of electric power, and navigation (Washington State Legislature, 1969).

[2] In dealing with water rights, the prior appropriation doctrine states that water rights are determined by priority of beneficial use. This means that the first person to use water or divert water for a beneficial use or purpose can acquire individual rights to the water (Cornell University Law School, 2015).

(Washington State Department of Ecology, 2014). An application must show that water will be put to full beneficial use before Ecology will issue a water right. Once the water rights is considered "perfected" Ecology will provide the applicant with a water right certificate for the quantity of water, and other essential requirements that are presented on the permit. Furthermore, water is considered a public resource and is collectively owned by all people of the state. Therefore, when you acquire a water right you do not secure ownership of the water; instead, you obtain the right to use water according to the terms and conditions of the water right you have been approved for by Ecology (Washington State Department of Ecology, 2014). Any water rights established before 1917, or a groundwater right that was established before 1945, must be represented by a water right claim (Washington State Department of Ecology, 2014). Initial water rights that occurred prior to the water codes have limited written or paper confirmation, so the state legislature has permitted people with such rights to file a claim for their right with Ecology (Washington State Department of Ecology, 2014).

Typically, water rights are divided into two main types; surface water rights and groundwater rights. Water rights fall under the surface category if water is diverted from a river, stream, lake, or spring; whereas groundwater rights are classified as the right to pump water from a well (Washington State Department of Ecology, 2014). Both surface and groundwater rights are distinctly established by the elements of a water right and any special requirements documented on water right documents. For instance, some of the elements in a water right may include "where you can take water [point of diversion, point of withdrawal], at what rate you can take water [instantaneous quantity], how much water you can use in total each year [annual quantity], what you can use the water for

[purpose of use], where you can use it [place of use], and when you can use it [season of use]" (Washington State Department of Ecology, 2014). With that being said, the elements of water rights are always grounded upon state law and interpreted by a number of organizational, governmental and case law models to sustain the rights of land owners, as well as the rights for many entities involved in managing water resources. Each water right is specific to a location, source, use, amount and other parameters.

One important tributary to the Yakima River, Ahtanum Creek, is where some of the earliest agriculture diversions in the basin took place. These diversions continued to expand to other areas of the Basin through the 1800's as agricultural land and a private ditch system were developed (Mack, 2013). It was once widely believed among early settlers and pioneers that water was an unlimited resource. However, particularly in the Yakima Basin, this has not been the case for many years. In fact, by 1905 the Bureau of Reclamation stated that there were too many claims and not enough water available in the region's rivers and streams to provide for all of the demand (Washington State Department of Ecology, 2014).

Strains on water availability for irrigation in the Yakima Basin have also been influenced by growth in residential construction and a rise in the state's population. Concerns around managing both the state and Yakima Basin water resources must include plans and strategies that address unavoidable population growth into the 21st century. An increase in population will ultimately place more demand on water resources for agricultural, residential and industrial uses. The number of people living in Washington between 1950 and 2000 grew from 2.4 million to 5.9 million, and is expected to reach 7.4 million by 2020 (Washington State Department of Ecology, 2014).

This growth rate is not exclusive to the Puget Sound region. From 2000 to 2008 eastern Washington had three out of the five fastest growing counties in the state, which included Franklin County experiencing a 42 percent population increase (Washington State Department of Ecology, 2014). Issues concerning population growth, coupled with climate change, are going to cause significant challenges to the future of managing the state's water resources. It is important to manage water resources responsibly by learning from the past, and being able to apply those lessons learned toward a responsible management plan for the future.

Yakima River Water Rights

Washington water rights govern Irrigated water in the Yakima Basin. Ecology is in charge of managing and enforcing water law statewide. It is up to Ecology to determine if water is being used beneficially under western water law's prior appropriation doctrine. Furthermore, Ecology must be able to make sure that water is not being wasted. This responsibility falls under the relinquishment law, or "use it or lose it" law. This law states that if a water rights holder does not use all or a portion of their water right for a period of five years or more, then, under most situations, that water right will be lost (Washington State Department of Ecology, 2006). Under western water law, the prior appropriation doctrine establishes water right ownership based on the order in which land owners applied for water use (Water Resources Program, 2006). According to this doctrine, the individual that first makes beneficial use of water has a right to future use of that water that is superior to users later in time (Water Resources Program, 2006).

The prior appropriation doctrine consists of two main principles that determine how water is used. The first principle states that it is mandatory for water rights holders to make beneficial use of their water; otherwise, they will lose their water right (Hillman, 2012). According to the law, beneficial use is defined as the application of water for any "non-wasteful" purpose (Water Resources Program, 2006). Beneficial uses of water that are considered non-wasteful include irrigation, mining and industrial application, stock watering, domestic and municipal use, and other non-wasteful economic activities (Castle, 2008). In recent years, the definition of beneficial use has broadened and now includes environmental dust control and snowmaking, among others (Castle, 2008). It is important to keep in mind that an appropriator holding a water right may remove the water from its source and put it into beneficial use, but only from the specified place of withdrawal and place of use determined under the terms of their water right. This also means that a water rights holder can move irrigated water from the Yakima River under specific seasonal or monthly amounts that are also determined by their water right, as long as the water is being used for a non-wasteful purpose.

The second principle is the relinquishment, or "use it or lose it", statute. This portion of the law states that if water is not used by a water rights holder for five or more consecutive years, the water right is lost (Water Resources Program, 2006). Water, as an individual resource, is not owned in Washington by a specific governmental agency, private entity, or any individual rights holder. However, the right to use water is held by the owner of the land to which it is attached. This ownership of the water right is the part that can be relinquished by the State if it is not being used in accordance with Washington water law. This is because water belongs to everyone in the state and, if not

used, it is subject to relinquishment and reallocation to other areas or users in need. The passage of the relinquishment statute in 1967 by the state legislature was meant to ensure that, "Washington's limited water resources are put to maximum beneficial use for all Washington's citizens" (Washington State Department of Ecology, 2006). However, there is what is known as "sufficient causes" to explain non-use to avoid relinquishment of an individual's water right. This responsibility to prove a sufficient cause for non-use is solely reliant on the water right holder. Sufficient causes include: water unavailability, military duty, legal proceedings, special federal or state programs, or irrigation specific causes like varying weather conditions (Washington State Legislature, 1967).

As more and more land in the Yakima Basin was converted to farmland in the early 20th century, a fear of over-allocation among water users and government entities reached a critical point by the 1940's (Hillman, 2012). A 1945 Consent Decree formed an unconventional water rights structure in the Basin. The decree was issued out of a civil action by a Federal District Court Judgment between Kittitas Reclamation District v. Sunnyside Valley Irrigation District (Garrity, 2012). Essentially, the decree defines the quantities of water which irrigation districts are entitled to in the Yakima Basin (Garrity, 2012). In accordance with the 1945 Consent Decree, Bureau of Reclamation decides the Total Water Supply Available (TWSA) every year (Garrity, 2012) The decree has established two types of water rights: non-proratable (senior) and proratable (junior) (Hillman, 2012). Senior water rights holder claims are guaranteed because they are the ones who filed first, whereas junior water rights holders are provided with what is left of the total water supply after senior water rights holders have been served (Hillman, 2012). For example, a senior water right owner can request regulation of junior users so that the

senior user receives the full amount of their right. In the past senior rights holders generally did not have much concern about their water supplies because they had never been shorted. Yet, the biggest and most economically productive water districts in the Basin depend on proratable rights (Garrity, 2012).

Proration never became much of an issue until the regionally historic drought in 1977. This extraordinary drought caused serous water shortages for the entire region, and resulted in substantial issues around proration (Garrity, 2012). Since the 1977 drought, there have been seven years where proratable rights holders received less than 70% of their water, which irrigators in the Basin see as a very grim economic trend (Garrity, 2012).

Sustainability and the Future of Yakima River Flow

A chief area of concern lies within the sustainability and instream[3] flow rates of the Yakima River. Often times the term "sustainability" can be broad and unclear. In regards to this study, sustainability will be defined in the context of sustainable development for irrigation distribution methods, water resources allocation and the conservation of instream ecological functions in the Yakima Basin. Therefore, sustainability in the basin means, "Any development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987).

[3] "A specific stream flow level (measured in cubic feet per second, cfs) at a specific location on a given stream. Instream flow is a range (a "regime"), usually changing month-to-month, instead of a single number. It is a water right to protect a quantity of stream flows for instream resources" (Washington State Department of Ecology, 2014).

Ecological strains caused by irrigation on the Yakima River depend on how much surface water is diverted from the river's instream flows. An over allocation of water to irrigated lands can cause a significant decrease in flow rates, as well as strains on the ecological function of the river from changes in water availability. One of the main challenges for maintaining sustainable streamflow is the western water law's prior appropriation doctrine. When water was initially allocated to a user there was little concern for long-term sustainability, and virtually no worry for the value of either environmental or economic instream uses. This is because beneficial use typically consisted of offstream practices, so any amount of water that was not used outside of the river channel was considered wasted (Hillman, 2012).

One key argument around instream flow rates is the subject of manufactured and natural capital. Manufactured capital consists of man-made resources that are used to produce other goods and services (Comolli, 2006). In respect to the Yakima Basin, manufactured capital refers to the use of river water to irrigate agricultural lands. There are some who believe that manufactured capital cannot take the place of natural capital[4], and that maintaining natural capital should be a main area of focus. This view is typically supported by those who favor a strong sustainability principle (Hillman, 2012). In addition to providing resources for production, supporters of strong sustainability recognize three other functions of natural capital: 1) assimilating wastes; 2) sustaining ecosystem health and function; and 3) providing non-use values (Ekins et al., 2003). In order to maintain the current level of natural capital in the river, advocates for strong

[4] "Natural capital is at least partly non-interchangeable with human-made capital, and, therefore, at least part of natural resources should be saved in the long run, as nothing human-made can replace the benefits we get from these natural resources" (Mircea, 2013).

sustainability believe that manufactured capital cannot perform the three aforementioned services; therefore, natural capital must be conserved for future generations to keep river conditions and ecological services at their current levels.

One key argument in favor of the natural capital viewpoint is that in many years the region has received less snow melt in the spring due to a lack of snowfall in the winter, and warming temperatures from climate change that increase evaporation rates of surface water (Elsner, 2010). In Washington, April 1st snow water equivalent (SWE), as shown in **(Figure 2)**, is expected to decrease by an average of approximately "27-29% across the State by the 2020s, 37-44% by the 2040s and 53-65% by the 2080s" based on the average effects of all climate models (Elsner, 2010). This anticipated shortage in river water would cause a significant amount of disagreement between those in favor of a natural capital model and instream uses, and those who depend on the manufactured capital methods to irrigated their crops for economic reasons.

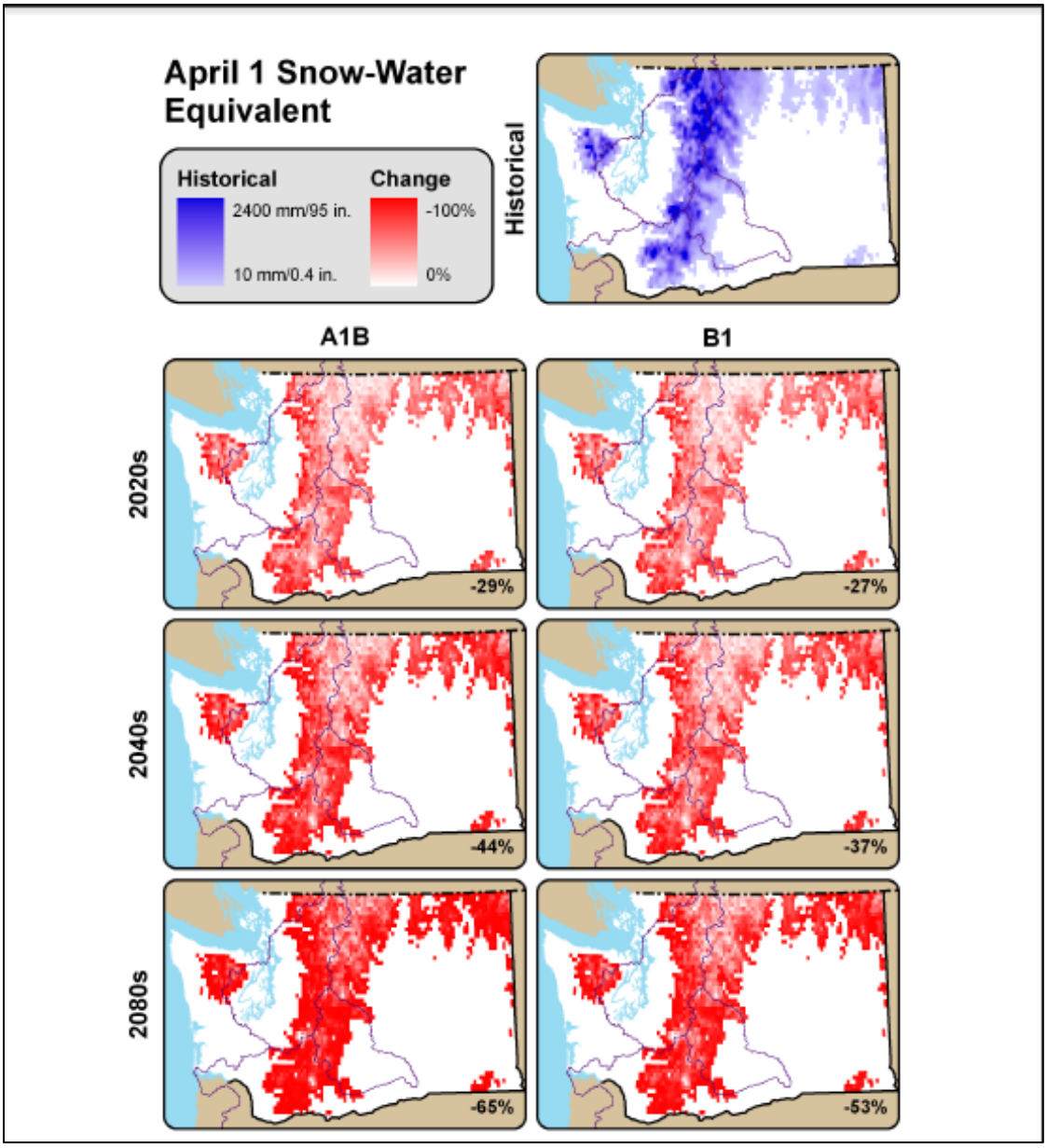

Figure 2. Projected April 1st snow water equivalent (SWE) for the 2020s, 2040s and 2080s (according to the A1B and SRES scenarios by the VIC model). Percentage change values represent spatially averaged April 1st SWE across Washington State (Elsner, 2010).

Irrigation Practices, Water Quality and Efficiency in the Yakima Basin

There are great opportunities for water conservation in the Yakima basin. In 1994, Congress passed the Yakima River Basin Water Enhancement Project (YRBWEP) to take on water related issues (Columbia Institute for Water Policy, 2007). YRBWEP's Basin Conservation Program financed the creation of water conservation plans for the majority of irrigation districts in the Yakima Basin. According to the Columbia Institute for Water Policy, three modern studies have looked at the potential of water conservation opportunites, and they concluded that the expected requirement for supplemental water supply in the Yakima Basin could indeed be fulfilled through water conservation.

The Lower Yakima River Basin is known as one of the most highly irrigated areas in the United States (Washington State Conservation Commission, 2014). The processes involved with heavy irrigated farmlands often times creates serious concerns with water quality due to increased runoff from agricultural fields covered with fertilizers and loose sediments. A 1974 study done for Ecology acknowledged Sulphur Creek sub-basin as having the greatest irrigation water quality problems of any sub-basin in the Yakima Basin (Washington State Conservation Commission, 2014). In the 1994 irrigation season, it was found that, "110 tons per day of total suspended solids were discharged into the Yakima River (equivalent to 14 dump truck loads), and 31.9% of all sources of suspended solids were coming from the Sulphur Creek Drain" (Washington State Conservation Commission, 2014).

Prior to the 1994 findings, the South Yakima Conservation District (SYCD) headed a Model Implementation Project from 1977-1982 as a way to improve irrigation

practices in the Sulphur Creek sub-basin (Washington State Conservation Commission, 2014). By 1996, SYCD got funding to start the Sulphur Creek Best Management Practices (BMP) Implementation Project (Washington State Conservation Commission, 2014). For this project, SYCD signed up 30 landowners to participate in the project, and they funded 10 conversion projects from rill irrigation[5] to sprinkler irrigation that benefitted over 600 acres.

In 2000, SYCD began looking at the accomplishments of the BMPs that landowners had implemented. Water quality samples were collected three days per week during the irrigation season from mid-April to mid-October (Washington State Conservation Commission, 2014). Data were collected on several water quality parameters, consisting of "discharge, turbidity, suspended solids, Kjeldahl nitrogen[6], phosphorous, temperature, pH, conductivity, and dissolved oxygen" (Washington State Conservation Commission, 2014). The assessment of the data showed that landowners had improved water quality considerably by adopting BMPs inn the two sub-basins: "Total Suspended Solids (TSS) decreased by 56%, Total Phosphorous (TP) decreased by 32%, and Total Kjeldahl Nitrogen (TKN) decreased by 117%. In sub-basin 10, TSS decreased by 86%, TP decreased by 69%, and TKN decreased by 45%" (Washington State Conservation Commission, 2014). These improvements carried on for the next few years, because by 2003, discharge from Sulphur Creek Drain averaged 17 tons per day, which was a decrease of 93 tons per day that took place in less than ten year time period (Washington State Conservation Commission, 2014). Therefore, it is evident that

[5] Rill irrigation, sometimes known as furrow irrigation, is when water is applied to row crops in small ditches or channels between the rows made by tillage implements (Washington State University, 2015).
[6] Kjeldahl nitrogen consists of ammonia, organic and reduced nitrogen (United States Environmental Protection Agency, 2013).

landowner participation is a key piece to the success of Yakima Basin's overall water quality impvrovements.

In terms of irrigation productivity, there are a number of improvements and adjustments that can be used. For example, technological innovation may consist of increasing efficiency of irrigation methods, conservation, and water recycling. In the Yakima Basin there has been an effort to use these methods to reduce the amount of water distributed offstream. In 2002, one study estimated that 14 irrigation districts in the Yakima Basin could save up to 540,000 acre-feet of water at a cost of about $400 million (Columbia Institute for Water Policy, 2007). The study also found that an additional 95,000 to 178,000 acre-feet of water could be saved through on-farm efficiency programs (Columbia Institute for Water Policy, 2007). However, there has been a lack of action associated with the efficiency and conservation programs among the Yakima Basin. This is because most Yakima Basin water conservation projects remain under-funded and largely unimplemented (Columbia Institute for Water Policy, 2007).

The Role of Water Trusts

Water trusts are private, nonprofit organizations that obtain water rights in order to improve instream flow for conservation purposes (King, 2004). Riverine habitat and species often suffer in arid regions like the Yakima Basin due to over appropriation of water for consumptive uses[7]. With these issues in mind, water trusts rely upon water

[7] "The consumptive and nonconsumptive classifications of water are important when assessing the quantity of water allocated. Water used consumptively diminishes the source and is not available for other uses; whereas nonconsumptive water use does not diminish the source or impair future water use.

market[8] transactions to acquire and transfer water rights to instream uses (King, 2004). Water trusts are evolving as a useful tool for protecting instream flows. Additionally, these organizations are supporting water conservation methods that improve the habitat of fisheries, water quality, habitat, and recreation (King, 2004).

Comtemporary environmental concerns are often handled through market-based approaches. Water trusts are among those market-based approaches, and have proven to be significant and innovative answers for water-related issues in the Yakima Basin, like reallocation (King, 2004). Water trusts have been implemented in the western United States for a number of reasons. Generally because this region is comprised of arid climate conditions, and its rivers are used for intensive irrigation and hydropower. There has been some disagreement among water rights holders and water resource management organizations, like Ecology, as to whether or not a water rights holder has "ownership" over water. But, as Washington's water law points out, citizens are only allowed the *right* to use it in accordance with the individual water right they have been granted.

Washington Water Trust (WWT) is one such organization that has been working with landowners since their establishment in 1998. WWT works with water rights holders on how to use water more efficiently and put unused water into a trust, which adds to instream flows. WWT describes their organization as a "neutral, nonregulatory nonprofit, dedicated to improving and protecting stream flows and water quality throughout Washington state." WWT uses voluntary, market-based transactions and cooperative

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Consumptive water use causes diminishment of the source at the point of appropriation" (Adelsman, 1991).

[8] "In a smoothly functioning competitive water market, price is uniquely determined by convergence of buyers' and sellers' marginal values. In actuality, a negotiated price will lie between the buyers' maximum willingness to pay for units of water exchanged and the minimum amount the seller is willing to accept in payment for water transferred" (Saliba, 1987).

partnerships between water rights holders to establish solutions around issues related to agriculture, fish, business, and wildlife (Washington Water Trust, 2015). Despite many years of practice, water trusts are still faced with ongoing challenges. The concept of water trusts is still new to some water rights holders, and remains as a somewhat rare player in the Yakima Basin.

Trust Water Rights, Water Banking and Water Acquistion Programs

The Washington State Trust Water Rights program offers an approach to lawfully hold water rights for future uses without the water right being relinquished (Washington State Department of Ecology, 2014). The Trust Water Rights Program for Yakima Basin was established through legislation in 1989, followed by a statewide water trust that began in 1991 (Washington State Department of Ecology, 2014). The purpose of water held in trust is to increase groundwater and instream flow levels, among other other beneficial uses like water conservation and efficient water allocation. The program operates on a temorary or permanent basis, and the rights of the holder stay protected the entire time of their participation (Washington State Department of Ecology, 2014). The Trust Water Rights Program was put into place to provide these transactions to irrigators with the idea in mind to open up markets for water rights, and increase instream flows (Hillman, 2012).

A water bank is defined as “an institutional mechanism used to facilitate the legal transfer and market exchange of various types of surface, groundwater and storage entitlements” (Washington Water Trust, 2015). Essentially, a water bank helps move

water rights from one user to another user. As **(Figure 3)** shows, a water bank works through leasing water from those willing to sell, and then maintains, reallocates and exchanges water rights on behalf of agreeable purchasers (Washington Water Trust, 2015). Not all water banks are designed the same because they depend on the specific watershed and local water resource needs of the particular region they were created to assist. Modifications and reallocations to water rights have been taking place between users for decades in Washington (Washington Water Trust, 2015). However, water banks are a way to officially transfer water rights between multiple buyers and sellers.

Figure 3. The typical functions of a water bank (Washington Water Trust, 2015).

In 2003, the State created the Washington Water Acquisition Program as a way to increase participation in water trust programs (Hillman, 2012). The 2003 acquisition program establishes a framework outlining various options that could be used to increase instream flows and make the voluntary water rights transactions more efficient. The acquisition does this by buying up senior water rights and essentially changing them to instream flow rights. The acquisition program was also used as an effort to increase streamflow in the upper and lower Yakima Basins, which had been deemed "fish critical" for salmon populations (Hillman, 2012). See **(Figure 4)** for a map of the fish critical areas. Despite its implementation, and extensive assessments, the accomplishments of the acquisition program in the Yakima Basin have not fully achieved expectations (Lovrich, et al., 2004). The acquisition program's lack of success can be attributed to a number of variables, but the primary reason for its nonsuccess stems from farmers' mistrust of Ecology and suspicion that leased water rights will never be returned (Hillman, 2012).

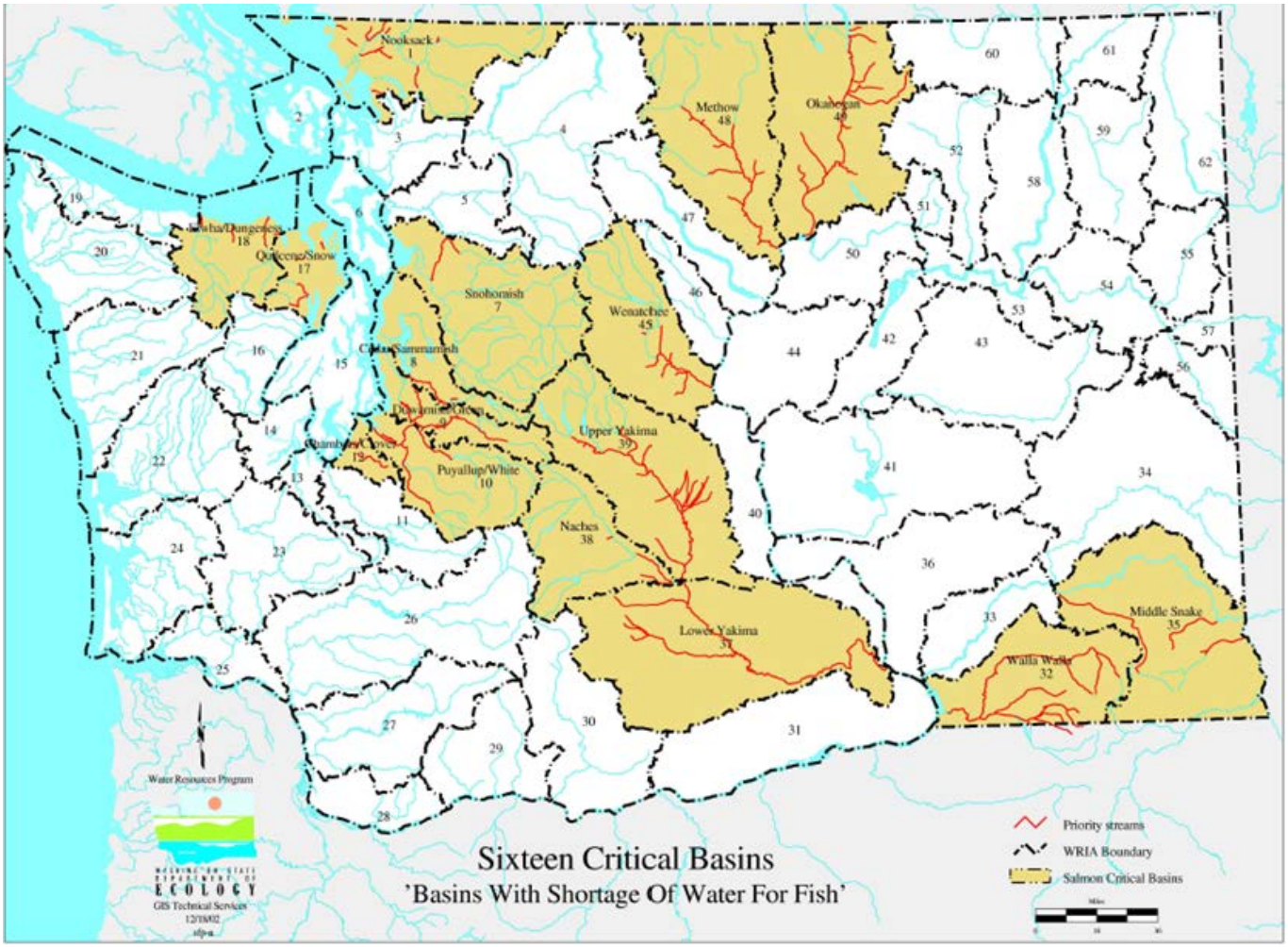

Figure 4. "Sixteen Critical Basins" with areas having a shortage of water for fish (Washington State Department of Ecology, 2014). Salmon critical areas are highlighted in light brown.

Water trust programs will not solve all of the allocation problems in the Yakima Basin. In addition to these trust issues, there are some known loopholes in water markets. For instance, individuals upstream could create an economic externality for those located downstream by taking advantage of their own location on the river and exploiting the actual water market demand (Hillman, 2012). Some of the concerns around water trusts and water banking will be directly addressed in the interview, and will be discussed in further detail in the Results and Discussion portion of the thesis.

Is Water Conservation the Key to an Unreliable Water Supply?

Water Conservation has been a key focus among many groups in the Yakima Basin. For many, conservation seems to be the most logical and immediate change that water users in the Basin can do as a way to use water efficiently. Ideas and concerns related to water conservation are not exclusive to the Yakima Basin. Basins around the country, with similar climate conditions and water demands, are facing comparable dilemmas when it comes to water conservation efforts. Some states, like New Mexico and California, have been developing management strategies for irrigated water in basins that require heavy irrigation like the Yakima. So, the question is, "Is water conservation actually the most direct practice for using irrigated water resourcefully and sustainably?"

Common problems around water have afflicted large areas of the country. Issues like climate change, water supply limits and continued population growth have intensified concerns around irrigated agriculture, and caused a re-examination of broader water conservation efforts. Many of these water conservation efforts have taken place in

the agricultural sector because irrigated agriculture is the world's largest water user (Ward, 2008). Much of the effort around water conservation and agriculture has been established through government policy measures. These measures are commonly believed to make more water available for cities and the environment (Ward, 2008). Even though there is a large belief that water conservation is the answer to sustaining irrigated agriculture, there still remains a lack of conclusive studies to test this hypothesis.

One of the great political and scientific tasks of the 21st century is the ability to increase the world's food supply to provide for a global population that will reach 10 billion or more people, while also facing challenges brought on by climate change (Ward, 2008). With these challenges also comes the ability to balance water quality and quantity which are imperative to sustain both healthy ecosystems and successful economies. Water used for agricultural irrigation is a necessity in many areas where food is grown. This is often the case because much of the food grown is in arid environments, or where growing conditions require large amounts of water for successful crop growth. However, the earth's natural ecosystems have evolved through numerous centuries of adaptation and balance provided by stream discharge, precipitation, and evaporation patterns of the hydrologic cycle. Therefore, many current and unforeseen challenges brought on by variations in the hydrologic cycle to climate, weather, and land-use change will have vast and multifaceted effects on economic and ecological systems (Ward, 2008).

Already in the United States many areas are faced with insufficient water supplies to meet their urban, environmental, and agricultural needs. In California, the entire state has felt the effects of extreme drought for the past several years. Snowfall supplies about 70 percent of California's annual precipitation (NASA, 2015). This snow, mostly in the

Sierra Nevada range, melts in the spring and early summer, which then provides surface water and reservoir recharge to meet the state's demands in the spring, summer, and fall. However, in the Tuolumne River Basin in the Sierra Nevada, scientists working with NASA's Airborne Snow Observatory (ASO) found the snowpack there contained just 40 percent as much water in 2015 as it did at its peak level in 2014, which had already been recorded as one of the two driest years in California's history (NASA, 2015). The ASO team quantified the first springtime acquisition of 2015, and discovered that the total volume of water contained in the basin on March 25, 2015 was 74,000 acre-feet, or 24 billion gallons (NASA, 2015). When compared to that same week in 2014, the snow total was 179,000 acre-feet (NASA, 2015). Images taken by NASA's ASO which shows the annual change in snowpack between March 2014 and March 2015 for California's Tuolumne River Basin can be seen in **(Figure 5)**.

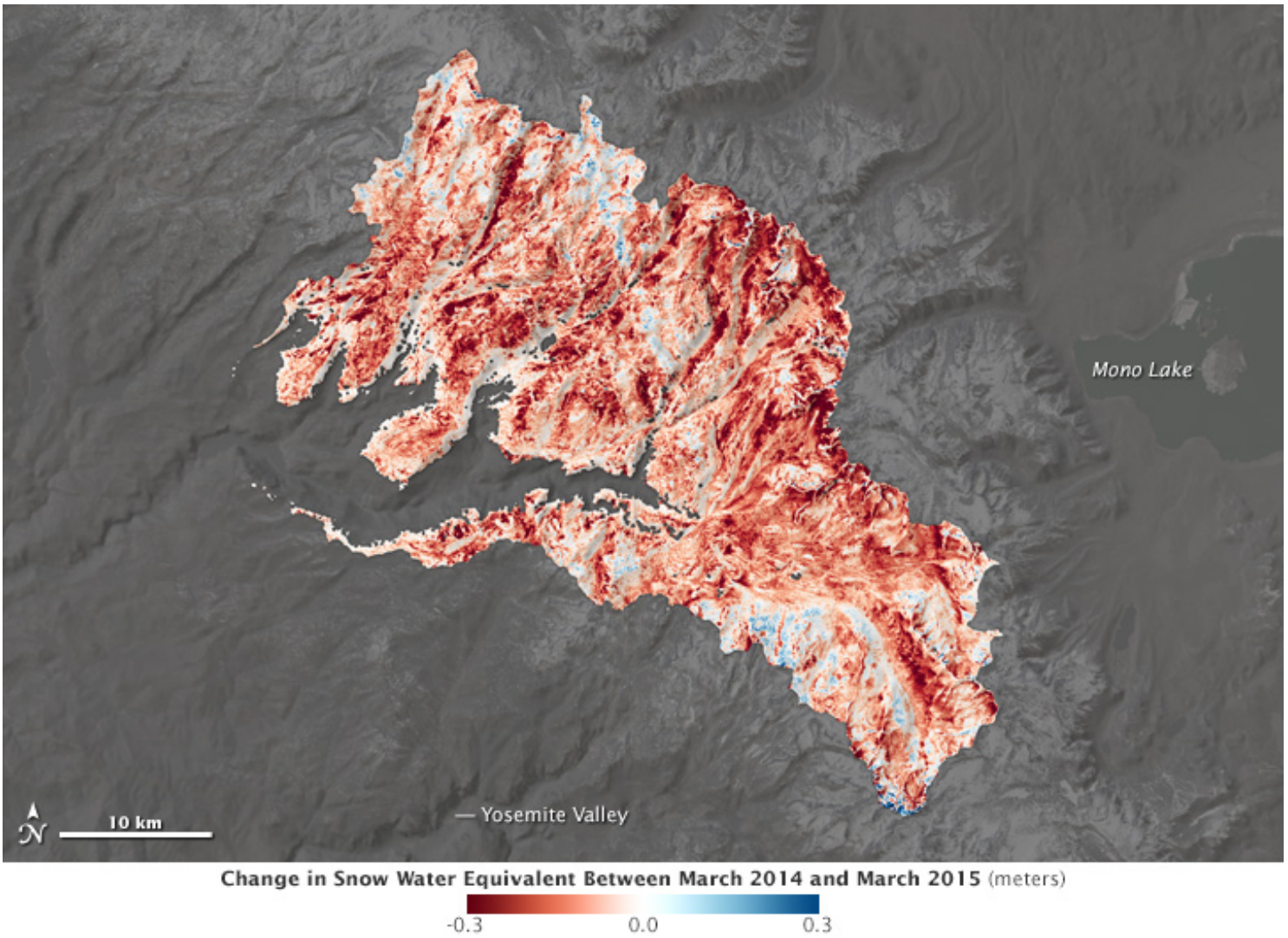

Figure 5. The snow-water equivalent (SWE) in the Tuolumne River Basin from late March 2015 versus late March 2014. Snow-water equivalent is a measure of the total volume of water in the snowpack. Red areas had significantly less water in March 2015, while blue areas had more (NASA, 2015).

As a result of California's serious drought conditions, conservation policies and state mandates have been implemented. Governor Edmund G. Brown Jr. has, for the first time in California's history, directed the State Water Resources Control Board to implement mandatory water reductions in cities and towns across California with a goal to decrease water usage by 25 percent (State of California, 2015). It is estimated that this savings amounts to approximately 1.5 million acre-feet of water over the next nine months (State of California, 2015). The Governor has also indicated that the state will:

> "Replace 50 million square feet of lawns throughout the state with drought tolerant landscaping in partnership with local governments; direct the creation of a temporary, statewide consumer rebate program to replace old appliances with more water and energy efficient models; require campuses, golf courses, cemeteries and other large landscapes to make significant cuts in water use; and prohibit new homes and developments from irrigating with potable water unless water-efficient drip irrigation systems are used, and ban watering of ornamental grass on public street medians" (State of California, 2015).

California's agricultural water users, many of whom have faced serious concerns from drought conditions, have had to significantly reduce water allocations to hundreds of thousands of acres, and layoff thousands of farmworkers (State of California, 2015). Under the newly enforced state mandates, agricultural water users will have to report more water use information to state regulators, which will increase the state's enforcement ability against illegal diversions, water waste, and other uses that have been deemed unreasonable under current state water laws (State of California, 2015). In addition to the agricultural mandates, the Governor's changes toughen standards for

"agricultural Water Management Plans submitted by large agriculture water districts and requires small agriculture water districts to develop similar plans" (State of California, 2015). According to the state, these new plans will help to make sure that agricultural communities are prepared in the event that the drought extends into 2016.

In many drought ridden areas of the U.S., extreme and severe drought conditions have been deemed as the "new normal" (New Scientist, 2014). California and its 38 million residents are not the only ones to feel the effects of drought in the U.S. Areas in the Southwest region of the U.S. have been exploring new ways to conserve irrigated water used for agriculture. In one related study, results were presented from an integrated basin-scale analysis connecting biophysical, hydrologic, agronomic, economic, policy, and institutional dimensions of the Upper Rio Grande Basin (Ward, 2008). The study also examined a number of different water conservation policies and their influence on water designated for irrigation and conservation practices. Contrary to common beliefs, the results of the study show that water conservation subsidies are not likely to reduce water use in many river basin environments (Ward, 2008).

There are different ways to measure the amount of water used versus the amount of water that is returned back to the river, or to another water source such as groundwater reservoirs. Evapotranspiration (ET)[9] from the watershed's surface is the reduction or loss of water from a hydrologic basin related to plant water use. Water that is not consumed during ET is water that is diverted from its source by way of canal, pipe, or other means,

[9] For this study, efficiency is the ratio of water depleted by plant evapotranspiration (ET) to water diverted from the stream. ET is the consumed fraction of water diverted. As technologies or management practices are adopted that bring the ratio closer to 1, irrigation efficiency increases. Much of the study focused on what happened to the nonconsumed fraction of water (Ward, 2008).

and returns via surface runoff or through deep percolation into the basin from which it was withdrawn (Ward, 2008). This returned water can then be available to other water users at new locations and times. Therefore, it is understood through this cycle of return and reused water that one water user's inefficiency can serve as the source of another user's water supply. Just how percolation from the Yakima River, along with all of the water used by the Basin's irrigators, helps to recharge the groundwater to much of the region's residential and municipal water supplies. One way this groundwater recharging process is being minimized is through a widely accepted method known as drip irrigation, and is used primarily for water conservation. Drip irrigation allows for exact application of irrigated water into the root zones of plants. This method results in little to no runoff, or deep percolation for return to other water users (Ward, 2008).

According to the Upper Rio Grande Basin study, a linear relationship is common between ET and crop yield over a diverse assortment of crops and water applications (Ward, 2008) As a result "irrigation technologies that apply water at optimal times and locations in plant root zones increase crop consumptive use of water and crop yield as irrigation efficiency increases" (Ward, 2008). Essentially what this means is that when yield goes up, ET usually rises. In **(Figure 6)** both crop yield and gross revenue increases due to efficient irrigation systems minimizing the diverted water from streams (Ward, 2008). For the farmer, efficient irrigation systems may increase crop yield and raise their income per unit of land as long as the cost of installation, cost and returns of production, and the price of water does not negatively offset the initial investment. So, from an economic point of view the new water conservation technologies can be a positive transformation for their operation. However, overall consumptive use of water at the

basin-level can increase as a result of large-scale water conservation practices. In this study, stakeholders in the Yakima Basin will address concerns around overuse and conservation of irrigated water, and how it effects water supply and water storage concerns for the region.

	Water applied*		ET*		Deep percolation*		Price		Yield, quantity/acre†		Production cost (0% capital drip irrigation subsidy), $/acre/year		Production cost (100% capital drip irrigation subsidy), $/acre/year‡	
Crop	Flood	Drip	Flood	Drip	Flood	Drip	$/Unit	Yield units	Flood	Drip	Flood	Drip	Flood	Drip
Alfalfa	5.0	2.7	2.2	2.7	2.9	0.0	130.00	Tons	8.0	10.0	884	1,357	884	993
Pima cotton	2.8	1.5	1.2	1.5	1.6	0.0	1.05	Lbs	750.0	937.5	979	1,324	979	960
Upland cotton	2.8	1.5	1.2	1.5	1.6	0.0	0.75	Lbs	1,000.0	1250.0	1027	1,261	1027	897
Spring lettuce	2.5	1.4	1.1	1.4	1.4	0.0	5.84	Cartons	475.0	593.8	3001	4,398	3,001	4,034
Fall lettuce	3.3	1.8	1.4	1.8	1.9	0.0	6.23	Cartons	500.0	625.0	2,638	3,971	2,638	3,606
Fall onions	4.7	2.5	2.0	2.5	2.7	0.0	6.63	Sacks	1,200.0	1500.0	5,762	8,848	5,762	8,484
Midseason onions	4.0	2.9	2.3	2.9	1.7	0.0	6.38	Sacks	675.0	843.8	3,722	5,708	3,722	5,344
Spring onions	4.8	3.4	2.7	3.4	2.0	0.0	6.43	Sacks	825.0	1031.3	4,455	6,871	4,455	6,506
Grain sorghum	2.0	1.1	0.9	1.1	1.1	0.0	3.70	Cwt	40.0	50.0	615	728	615	364
Wheat	2.5	1.4	1.1	1.4	1.4	0.0	3.75	Cwt	92.0	115.0	718	929	718	565
Green chile	4.6	2.5	2.0	2.5	2.6	0.0	285.00	Tons	11.0	13.8	2,275	3,356	2,275	2,992
Red chile	5.0	2.7	2.2	2.7	2.9	0.0	0.72	Lbs	3,500.0	4,375.0	2,004	2,851	2,004	2,486
Pecans	6.0	3.2	2.6	3.2	3.4	0.0	2.28	Lbs	1,158.1	1,447.7	1,731	3,114	1,731	2,750

Figure 6. Crop water use, price, yield, and cost per acre, Lower Rio Grande, NM, 2006.

*Acre-feet per acre per year. +Each crop is specified to have a linear relationship between water use (ET) and crop yield across irrigation technologies.

Concluding Statement

Over the years, a steady increase in agricultural lands in the Yakima River Basin has created several complex issues around individual water rights and practical water resource management. A lack of instream flows has generated additional concern around the environmental and ecological vitality of the Yakima River, its aquatic wildlife and the surrounding riverine ecosystems. All of these factors come at a time when climate change is beginning to alter snowpack levels in the Cascade Mountain range, which is Yakima River's main water source, as well as increase in average annual temperatures across the Basin (Elsner, 2010).

It is evident that existing ways of allocating water need to be changed so that economic efficiency and ecological sustainability is applied to the area. Existing strategies for water allocation are not meeting economic or ecological efficiency standards; nor will the current strategies be a reasonable approach for a viable plan in the future. The status quo for water resource management in the Yakima Basin puts human and nonhuman players at a disadvantage when it comes to economic, social, cultural, environmental, and ecological improvements.

In order to address these inefficiencies, a reallocation of water rights may be necessary (Hillman, 2012). Despite sluggish adoption in many cases, larger establishments of trust water rights, water banking, and water acquisition programs have proved to be a practical approach when used to encourage the transactions of voluntary water rights. These programs would provide senior water rights holders the ability to increase instream flow rates and provide much needed water to those junior rights holders

in need of additional water resources, all while avoiding the fear of relinquishment. The expansion of beneficial use requirements would increase the amount of unused water back into the Yakima River, and create a more efficient economic and ecological system for both human and nonhuman systems.

Achieving positive change in the Yakima Basin that would benefit all of its stakeholders will also require involvement from all of those individuals and organizations. To achieve an inclusive study for all those invested in the Basin's water resources, it is ideal to interview both subject matter experts and water users. However, this study focused on interviews with only experts because other stakeholders in the Basin were unable to be reached, or did not respond to my requests for an interview. A more comprehensive study on this subject would include water users and tribal members in the Yakima Basin. Further discussion about the preliminary nature and potential for a more in-depth analysis of this topic will be addressed in the final conclusion section of this paper.

Experts included employees from Washington Department of Ecology, private sector individuals with experience in this topic (e.g. consultants, irrigation district representatives, and people in the non-profit sector), and one attorney who specializes in Washington water law. It is essential to gain the perspective of these various experts so that a broad spectrum of data and a well-rounded analysis can be applied to the thesis research. Responses to interview questions regarding the topics and concerns mentioned in this paper provides an importing starting point for understanding how to manage water resources and irrigated farmland in the Yakima Basin. The evidence gathered from the Yakima Basin may also be applied to other basins that are struggling with managing

irrigated water. This evidence can be used as a tool to further aid in developing water resource management plans that provide economic, environmental, social, and cultural stability in these complex, yet extremely important areas of the country.

Chapter 3: Methods

How Interview Subjects Were Designated

The purpose of my thesis research was to determine how western water law and Washington State water rights (i.e. prior appropriation doctrine and relinquishment statute) has influenced irrigation practices for irrigated farms in the Yakima River Basin. I was also interested in how various experts on water resource management and agriculture in the Yakima River Basin make decisions about the irrigation process.

Description of Subjects Used and How They Were Selected

Subject matter experts involved in the interview process consisted of employees from Washington Department of Ecology, private sector individuals with experience in this topic (e.g. consultants, irrigation district representatives, and people in the non-profit sector), and an attorney who specializes in Washington water law. There were three employees from Ecology, three representatives from the private sector, and one water law attorney. The responses provided through my interviews, along with my individual findings through the literature, provided a representative sample from subject matter experts regarding Yakima Basin's water resource practices and irrigated water use, along with the water laws and rights that impact them.

The recruitment of human subjects for my proposed study was carried out via e-mail, phone contact, or in-person meetings. The subject matter experts in my study were contacted based on their professional, educational and direct experience with the topics closely surrounding Yakima Basin water issues. In each group of subject matter experts

a high-level of expertise, experience, and knowledge regarding were important criteria for inclusion.

Interview Methods

The material collected from the interviews was the core material for my final thesis research paper. All of the information obtained through the interviews was used in agreement with The Evergreen State College's Human Subjects Review process. No names of the human subjects were displayed, or suggested in any way in the final paper. All of the subjects were aware that their participation in the interview process was completely voluntary, and that they would not be provided compensation of any kind for their contribution. Subjects were also informed that they could refuse to answer any question, or stop their participation in the interview completely at any time without facing any negative consequences. Additionally, access to my thesis paper was made available to the interviewed subjects, upon request, and any outside parties through The Evergreen State College's online library, as well as a hard copy located in the Evergreen library's archival section.

Subjects involved in the interview process consented to a 30-minute phone interview that was audio-recorded and transcribed. Responses from the interviews may have been reported in the final thesis paper, but the identity and any personal classifying evidence was not included. Additional measures were taken to protect the subjects from personal privacy and digital security risks; all of the recordings and transcriptions from the interviews were saved and secured by password on my personal computer. None of

the information was ever saved, or viewed, on a public computer so that all of the responses and answers from the interviews could be kept completely confidential. At times, some or all of the interview information was shared with my faculty reader, Dr. Kevin Francis. All digital information and data gathered from the interview process was appropriately deleted, and all paper copies of the transcribed interviews were properly discarded upon completion of my thesis research to uphold the anonymity of the interview subjects.

Interview Questions

Questions for all subject matter experts:

1. What is your understanding of the "use it or lose it" clause and how it effects irrigation in the Yakima River Basin?
2. What is working with current water law in the Yakima Basin?
3. What is not working with current water law in the Yakima Basin?
4. If you could reform the law in any way, what would you do?
5. Do you think current allocation methods promote or harm the river's natural ecosystem?
6. How do you see climate change effecting water reliability?
7. Do you think that climate change will cause a recurrent decline in snowpack and cause earlier snowmelt?

8. How should western water law respond to climate change projections?

*All groups received the same questions and in the same order.

Chapter 4: Results and Discussion

Question 1:

"What is your understanding of the 'use it or lose it clause' and how it affects irrigation in the Yakima River Basin?"

During the interviews, the three employees from Washington Department of Ecology responded similarly about this particular question. In fact, all three subjects state that the use it or lose it clause causes a "waste of water", and also makes water users to want to hold onto unused water so not to suffer relinquishment of their water right. There were not any notable differences in the responses to Question 1 from the three Ecology subjects.

The private sector group of subjects had slight variations in their response to Question 1. two out of three subjects believed that the use it or lose it clause causes a "disincentive to conserve water"; whereas one out of three did not comment at all in regards to how the use it or lose it clause affects irrigation in the Yakima River Basin, but only stated their understanding of its definition.

The water law attorney stated that the use it or lose it clause does indeed cause some water users, who are concerned about the potential for relinquishment, to "do what they can to use their full allocation of water under their water right – even if the demand is not there in terms of what they really need to irrigate their crops." However, the attorney also indicated that there are water users who, "understand the relinquishment

law better and it's not as simple as 'use it or lose it' because there are exceptions to relinquishment."

In terms of the definition of the use it or lose it clause, responses to Question 1 seemed fairly standard across all 7 individuals interviewed. Some responses had more legal knowledge and detail in their answers, but overall, every subject had an accurate understanding of what the use it or lose it clause actually is. However, it was the second part of the question that produced varying responses when the subjects were asked to state "how it affects irrigation" in the Basin. All three subjects from Ecology, as well as the water law attorney, had the same response. That the use it or lose it clause does, in their experience, cause a waste in water among water users so that they do not have to worry about the potential for relinquishment. The only group that had variation in their responses was the private sector. This was due to the fact that one person in this group did not provide their opinion as to how the use it or lose it clause affects irrigation in the basin, but only their understanding of its definition.

Question 2:

"What *is* working with current water law in the Yakima Basin?"

Two out of three individuals from Ecology believed that water banking and free/private enterprise solutions for water banking programs were among the things working with current water law in the Basin. Yet, there were other differences in opinion between the three subjects in Ecology on this particular question. One out of three mentioned that the trust water rights program was working. One out of three thought that

water banking was the “only way to move forward into the future with regard to providing water for currently unmet needs” in the Basin, and should actually be broadened to other areas; including the entire western United States. And only one out of three said that federal funding from the Bureau of Reclamation was a good thing for the Basin and water conservation efforts.

The private sector group had a wide range of response regarding Question 2. None of the three subjects had similar views as to what is working with current water law in the Basin. Instead, one out of three said that the, “Columbia River program, as a whole, was working.” One out of three believed that the Yakima River Basin Water Enhancement Project was working well to promote more water storage capacity. One individual, from a consulting firm, believed that a, “Robust conservation focus both in terms of motivation and political will” were great things happening under current laws. The consultant also listed a number of encouraging things that were taking place around current water law in the Basin: “A diverse group of local stakeholders that weigh in on everything from individual water right changes, to new water banks being formed, to larger policy questions about the Yakima Integrated Plan.”

The water law attorney believed that, in terms of surface water, things are working very well with current water law in the basin. The subject went on to say that this is mostly because water rights have been adjudicated throughout the Basin. The subject elaborated about the improvements made through the adjudication process because of adjudicated water rights: “We have a good transfer market for water rights in the Yakima Basin. We’ve got a pretty free market where folks who are junior [water

rights holders] and want to purchase senior rights are able to do that, and you have a transfer system through the Yakima County superior court."

Things that are working well with current water law in the Yakima Basin resulted in a number of different responses. Few responses across all 7 subjects showed similar opinions as to what they thought was currently working under the current water laws. Only two out of three Ecology subjects displayed some similarities as to what they thought was working. However, there was a connection between the consultant from the private sector group and these two employees from Ecology. These three subjects all agreed that water banks and the free enterprise system is one thing that is currently working under the Basin's current water laws. The remainder of the responses to Question 2 resulted in broad opinions and varying responses as to what was currently working.

Question 3:

"What *is not* working with current water law in the Yakima Basin?"

Ecology did not have any similarities in their responses to this question. Each individual had their own views as to what was not working with laws in the Basin. Their responses varied from a backlog of pending applications for water rights, a lack of water right usage by junior water rights holders, a lack of confidence in the Trust Water Rights program, and that the current laws do not have enough flexibility in them. With respect to the lack of confidence in the Trust Water Rights program, one Ecology employee believes that Ecology must, "Do a better job of letting people know about the state trust

water right program by getting them familiar and comfortable (with the program)." Additionally, a second Ecology employee believes that current water laws are not working for the environmental and endangered species side of things. The second employee pointed out that, "Just because you have endangered species, it kind of tells you that (current laws) are not working." The second employee went on to describe how all of the pieces are just not there yet in order for water law in the Basin to work for all of the parties involved.

The private sector group had no similarities in their response to Question 3. Each person had a different opinion as to what was not working with current water law in the Basin. The difference in their answers ranged from one person saying there is a lack of storage capacity for the basin, to a second saying that senior water right holders have no incentive at all to conserve water under the current water laws. A third person in the group said that the regulatory pressure in the basin has, "Set the cost of water much higher relative to the rest of the state – sometimes ten times or thirty times as expensive."

The water law attorney believes that the biggest challenge around current water law in the basin relates to groundwater. This is because, "In 1977, when the Acquavella case was started, a decision was made to only adjudicate the surface water rights and not the groundwater rights." The attorney went on to explain that back in 1977 there was not a great understanding of the connection, or "hydro continuity", between groundwater and surface water. "There wasn't an understanding that groundwater use could affect the rivers due to the connection – and that ultimately that connection would be so important that groundwater use can actually cause impairment by reducing [water] supply to senior water right holders." Another problem area brought up by the attorney was that

justifications in relinquishment do not cover water rights users who may want to shift to a less water-intensive crop. For example, a grower might decide that they want to shift from a water-intensive crop like apples, to a less water-intensive crop like wine grapes by putting in a vineyard and taking out an orchard. According to the attorney, “They could be prone to relinquishment if they ever wanted to go back to apples, and that may be a hindrance to them economically.” Therefore, the attorney believes that this is one problem area in the Basin that needs to be dealt with.

Question 3 provided the interview subjects with a chance to express what they felt was not working under current water law in the Basin. There was a great deal of variation among responses in all of the three groups. One trend that did in fact stand out was the correlation between each group’s responses, and how it directly related to their particular field or profession. For example, Ecology only mentioned things like the Trust Water Rights Program and a backlog in pending water rights applications. Other examples in the private sector group included too much regulatory pressure and a lack of storage capacity for water. It is not surprising that each group talked exclusively about issues that relate directly to their field or profession because these are their respective areas of expertise and professional work.

However, as one Ecology employee pointed out when explaining the issues around current law and endangered species in the Basin, “All of the pieces are just not there yet in order for water law in the Basin to work for all of the parties involved.” If this statement is true, or even partially true, then it would makes sense for subjects from each group to thoroughly understand the opinions and suggestions from all parties involved. This would not only provide insight into how other organizations, irrigation districts,

consulting firms, non-profits, and law practices make decisions, but it would also allow real dialogue among all of the interested parties. All interested parties must understand what is not working under current water law for every group and person involved so that all of these same people can make reasonable compromises and plans among one another to sustain the Basins water resources for years to come.

Question 4:

"If you could reform the law in any way, what would you do?"

The purpose of Question 4 was to gather the opinion from all three groups as to how they would reform water law in the Yakima Basin. There were some similarities in responses from the Ecology employees. Two out of three said water laws should have more direct connection with land use and property laws. One employee expanded on their belief of connecting water and land use laws by saying, "I would like to have more tools to do more with the way we manage land, in conjunction with the way we manage water, to benefit fish and to actually get better results in these basins where we spent millions of dollars to get water in streams." There was also a very notable change suggested by a second Ecology employee. This second employee said, "I would close the entire Yakima Basin to all new surface water and groundwater permits." The second employee explained that by closing the Basin it would, "Make the determination there is no new

surface or no groundwater available that's not already appropriated." Other notable responses from each of the Ecology employees were to give domestic water users priority over irrigation use, do more with instream use for fish populations, create a "really robust water court, water trust, and water banking system", and add a higher water fee so that the money can be "given back to the state to be used for the common good of everybody."

The private sector group also showed some similarities in their responses for Question 4. Three out of three believed that relinquishment, or the "use it or lose it" clause, should be changed in some way. Two out of three said that they think relinquishment should be abolished all together. The person representing the irrigation district suggested changing the time period that water users have to use their full water right before it is relinquished by the state from 5 to 10 years. This person believed that changing the relinquishment time from the current 5 year rule to 10 years would place fewer burdens on the water user to use more water than they need to. The consultant said to change the statute by, "Designating relinquished water for specific purpose." One example given was, "Relinquished water returns to the state or even to counties instead of the state with a specified purpose. For example, one third of the water could be designated to instream flow and two thirds of the water that was relinquished could be designated to some specific out of stream use such as exempt well mitigation." The consultant expanded on the idea by describing how the state legislator adopted a similar plan back in 2006. This plan created the office of the Columbia River which in the consultant's words, "Develops new water supplies and then allocates that water; two-thirds for out of stream uses and then one-third for instream uses."

The water law attorney had several suggestions as to how the water laws should be reformed in the Basin. The first change was to add some sort of exception from relinquishment for changes in crop regimes. One example provided was, “If it’s worth their [water users] while economically to go from apples to grapes, and to use less water, to not have to fear that they won’t be able to and increase their water duty again to grow apples 40 years from now, if apples are a better economic way to go than going with a lower water duty crop like grapes.” The attorney went on to describe that essentially what this would do is give water users the flexibility to change their crop regimes to save water, and gain economic benefit at the same time. This change would also allow the water user to switch back to their original crop years down the line if it is in their economic interests – without facing any penalty or resistance to make this change.

Another reform suggested by the attorney, which was actually a change in the current law system itself, was to add the groundwater right holders to the adjudication process. This is because there is a, “Mismatch of groundwater versus surface water. You’ve got surface water rights adjudicated with lots of clarity; and then we have less clarity with the groundwater rights and especially the permit exempt wells.” According to the attorney, reform is already taking place in some areas of the Basin – like Kittitas County. Under Kittitas’ land regulations, people who want to construct new homes are required to “buy new shares of mitigation water out of the mitigation bank to ensure that they’re not going to cause impairment for the senior water rights holders.”

Question 4 resulted in several different responses from each group. While there were some similarities among people in the same group, there were not many connections between the different groups. One thing that is worth pointing out is some of the drastic

changes some of the subjects believe should happen to current water laws. For instance, one employee from Ecology wants to cut off all new ground and surface water permits in the Basin. Two people from the private sector group want to do away with relinquishment all together. There are viable arguments both for and against each of these suggestions made by the two groups. However, it seems as though any sweeping changes to water laws, especially in a short period of time, encounter public resistance, years of bureaucratic procedures, and several legislative sessions. This has been true for over a century, and the struggle for water laws and rights have always been a part of Washington's history. As one person pointed out in the interview process, western water laws and Washington water rights span back so far that it is hard to make big changes to a system that has been in place for such a long period of time.

Question 5:

"Do you think current allocation methods promote or harm the river's natural ecosystem?"

Question 5 addressed environmental impacts to the river's natural ecosystem caused by current allocation methods. Individuals from Ecology held very similar views about this question. Two out of three said that the current allocation methods definitely harm the river's natural ecosystem; whereas only one Ecology employee said it actually promotes and harms. This person expanded on their view that allocation methods promote and harm by saying, "The allocation system that was put in place 100 years ago hurts the river's ecosystem, because you could only protect a water right." They believed

that the newer allocation methods are working to promote the river's natural ecosystem because it takes a closer look at water availability and does more with managing relinquishment.

However, all 3 employees with Ecology believed that their agency, along with other organizations and groups in the Basin, have been working continuously to mitigate any harm that irrigation puts on the river's natural ecosystem. One person said that Ecology and other interested parties have been working on this particular issue for over 30 years now. "We are working in every way we can think of. We're trying to do things like restore the river's natural floodplain by setting levees back further away from the riverbanks than they are currently." Other projects pointed out by this employee that is being worked on by Ecology include fish passages, fish ladder improvements, and "all sorts of things to improve and restore flows to the streams." A second employee with Ecology has seen improvements to promote the river's natural ecosystem in the last 5 or 10 years. This second employee explained these improvements by saying, "We've found ways to be more creative and to partner with folks to get more bang for our buck in terms of benefitting river ecosystems."

In the private sector, two out of three people thought that the current allocation methods do not harm the river's natural ecosystem. The consultant said that the current allocation methods are largely protective and promote the river's natural ecosystem. This consultant said this is because, "Essentially no water is allocated under the current water regime. New water rights have not really been issued in any basin with any respect within the last 20 years." The individual representing the irrigation district said it depends on what your baseline is in terms of what the river's natural ecosystem really is. "If your

baseline is before there were European settlement actions here in the mid-1800s, then the natural ecosystem is very different than it was then." Therefore, the irrigation district representative believes that the current allocation methods promote the river's natural ecosystem in regards to today's standards. This individual also believed that much of the river's environmental advancements have been hindered by activist groups. This person said that some of the activists like to use pictures of the Sunnyside Dam in the early 1900s and the 1977 drought when there was virtually no water flowing over it to misrepresent the river's present conditions. "I'm pretty grateful", the irrigation district representative added with respect to the river's old management practices, "that the river isn't operated like that anymore."

On the other hand, the person from the non-profit organization believed that the current allocation methods are neutral when it comes to harming the river's natural ecosystem. This is because, "Today's environmental standards are pretty stringent. So, in the past maybe water rights were issued when there wasn't enough water in the basin, but we haven't found that very often. So I don't think it's harmful to the environment." This person also added that any environmental harm to the river is neutralized because of the fact that there are hardly any new water rights issued as a result of the strict environmental standards.

The water law attorney thinks that the current allocation methods both promote and harm the river's natural ecosystem. According to the attorney, there are certain things that the court system has established that provides some "basic level of protection of the natural ecosystem." However, the attorney explained, "If you talk to somebody from the Yakima Nation, or if you talk to somebody from the environmental group that's involved

with issues out in the Yakima Basin, you may hear dissatisfaction that it's not enough." The attorney also thinks that the allocation methods work better in river's main-stem more than its tributaries. This is because the, "Allocation system isn't as well developed in the tributaries, where even though there's supposed to be a certain amount of basic water left in the tributaries for fish since the Bureau of Reclamation isn't supplying water." The attorney goes on to say how it's more of a free-for-all in tributaries; so, anytime you have a dry year things can become basically waterless in some of those tributaries.

Question 5 was centered on current allocation methods and how they affect the Yakima River's natural ecosystem. This question was intended to gain a better understanding of the environmental implications that irrigation has on the river, and how each person interviewed felt about how allocated water influences the river's natural state. The three employees from Ecology all felt that the current allocation methods, in some way, harmed the river's natural ecosystem. Only one of them thought that the current methods also promoted the river's natural state in some way. The water law attorney also held the same view that the current allocation methods do both harm and good to the river.

However, when compared to the private sector group, all three subjects agreed that the current allocation methods do not harm the river's natural ecosystem. All of their reasons were different, and the non-profit representative thought that it neither harms nor promotes, but that it has a neutral effect. The responses to Question 5 are very unique to the individual interest groups. It appears as though their opinions are again mostly influenced by their own area of expertise. Each group and person involved in the

interview had logical approaches in their answers to Question 5, but there is a gap that has developed with regard to how current allocation methods influence the river's natural ecosystem. These clear differences that have developed in each group's beliefs may have been influenced from years of work in their own professional fields.

As previously discussed for Question 3, it would be helpful to bring together both facts and expert opinions from each group to make sound conclusions about how current allocation methods are influencing the river's natural ecosystem. Scientific consensus, business expertise, social justice, and economic success are all important factors to take into account from all interested parties when making decisions about the river's natural ecosystem.

Question 6:

"How do you see climate change affecting water reliability?"

Question 6 moved away from the legal and policy-related questions, and focused more on the effects of climate change. There were many similarities among the Ecology group. Three out of three strongly believed that climate change will have negative impacts on water reliability; as one individual put it: "Drastically. Devastatingly. We're seeing it this year. Since I'm not an 80-year-old farmer I don't have the long-range personal experience, but in the experience I do have I would say that it's going to have a huge, huge effect." A second employee with Ecology believed strongly that climate change will have negative impacts on water reliability. This second employee stated, "My strong opinion is that we're going to see reduced water reliability as a result of climate

change." The third employee in the Ecology group believed that climate change will cause "a lot less certainty, and a lot more years that are going to be short supply" when it comes to water reliability.

There were a few other notable opinions from the Ecology group. One person thinks that warmer temperatures brought on by climate change means longer growing seasons. So, consequently more water will be needed to fulfill the irrigation demands for the longer growing periods, which will contribute to a less reliable water supply. Another individual believed that an increase in urban demand, because of a hotter, dryer climate, will diminish the supply for areas, like the Yakima Basin, who are reliant upon irrigation.

In the private sector, there was quite a bit of variation among their responses. The irrigation district representative said there will be a need for more water storage because a warming climate will bring rain instead of snow as winter precipitation. This would result in a faster snow melt, and, ultimately, a different flow regime that results in an early spring runoff which creates the argument for more water storage capacity in order for irrigation supply to last through the summer months. The consultant believed that water reliability will be impacted because a warmer climate will likely make curtailment increase. The consultant added, "the data suggests that there will be a shift in supply from summer to spring, with an increase in frequency and most of our curtailment problems are in July, August, and September." This means that a decrease in water reliability, and a reduction in water supply, will put increased strains on the water users, and eventually restrict their use in accordance with that season's water availability. Interestingly, the non-profit representative denied the science around climate change all together, and instead referred to changes in the earth's climate as "climate variability." This individual

said that climate variability "relates to the scientific notion of the 500-year heating and cooling cycles we go through." Therefore, the non-profit representative's solution to climate variability is that water sharing methods and practices must take place during times of drought in the climate variability cycle.

The water law attorney was convinced that climate change is affecting water reliability, and believes in the predictions from climatologists that it will negatively affect water reliability. According to the attorney, "in the last 20 years I've been in this business, so to speak, the general trend appears to be that snowpack is getting reduced, that we're seeing either more precipitation as rain, or we're seeing more rain on snow events, where we'll have snowpack and then we'll get a rainstorm which actually causes snow melt much earlier than we usually have it during the spring." The attorney then pointed out that there are some necessary actions and projects taking place in the Yakima Basin to try and mitigate changes brought on by climate change. One thing mentioned was the Yakima Basin Integrated Water Resource Management Plan (YBIP). The attorney believes that the plan is important because, "It's something where the irrigators, the Yakima Nation, and some parts of the environmental community, have all come together to develop a win-win type of program." This plan involves water reservoir projects for storage, as well as habitat projects that will bring all of the interests in the Basin together.

Question 6 generated some compelling responses among the subjects. It was interesting to see how transitioning from law and policy-related questions, to a more emotionally-charged topic like climate change influenced each person's response. Often today issues and concerns around climate change are swayed by economic, political,

social, or otherwise non-scientific views. This is because the science behind climate change can often times be dissuaded or influenced by non-scientific factors. Economic, political and social interests are just a few of the persuading causes that may otherwise alter the scientific consensus in favor of a planet that is warming as a result of anthropogenic causes.

Question 7:

"Do you think that climate change will cause a recurrent decline in snowpack and cause earlier snowmelt?"

Opinions from Ecology were all very similar. Three out of three believed that climate change will indeed cause a recurrent decline in snowpack and cause earlier snowmelt. Three out of three Ecology employees also thought climate change will cause the Basin to have more rain, rather than snow, as winter precipitation. One employee from Ecology also points out that an increase in winter heat wave events could "wipe out the snowpack", and may be a sign of common things to come.

There was a variation among the responses in the private sector group. Both the irrigation district representative and the non-profit organization representative believe climate change is not going to cause a recurrent decline in snowpack. However, the consultant said that all of the current projections suggest a continuing decline in snowpack. One thing to note is that the non-profit representative believes that we are making a transition from a warming to a cooling cycle in what was referred to earlier as

"climate variability." Therefore, this person believes that presently temperatures in the Basin are not on the path to increase.

The water law attorney's view on how climate change will impact snowpack in the Yakima Basin is primarily influenced by reading reports from both credentialed scientists and faculty at the University of Washington's climate center. And so, according to what the attorney has observed for about the last 20 years, and read from scientific reports, it seems as though climate change will cause a recurrent decline in the Basin's snowpack and cause earlier snowmelt. The attorney elaborates on this viewpoint, and says whether or not it is related to human induced carbon emissions is not as important as the fact that it will negatively affect the Basin's overall water reliability.

Question 7 was also related to how climate change will influence the Basin; in particular, the amount of snowpack in its surrounding mountains. When formulating thoughts and opinions about this question, it was important to understand the basis of each person's perspective. Some of the interview subjects had a fairly well-versed scientific background; either through their education and or their professional status. For instance, some of the interviewees may not have been scientists by training, but they have worked directly with scientists in their professional careers and this is where much of their understanding and beliefs around climate science was generated. Another example of this is how the water law attorney and private consultant both developed their opinions on the matter from scientific reports and projections developed by climate scientists. Therefore, individuals interviewed who were not scientists or from the scientific community developed their understanding of whether or not climate change will

influence the Basin's snowpack from a source outside of their traditional area of expertise.

However, the irrigation district representative and the non-profit representative both had opinions about the question that were not in line with scientific consensus. The irrigation district representative said, "In the last 10 or 15 years there seems to be a whole lot of crying that the temperature is going up and you see people jump on any individual data point on both sides." Whereas the non-profit representative believes that any changes in the Basin's climate is caused by what he calls "climate variability", and describes it as "a natural variation in the earth's heating and cooling cycles." The non-profit and irrigation district representatives did not sate specifically where their scientific knowledge around climate change came from.

Question 8:

"How should western water law respond to climate change projections?"

Question 8 was a way for subjects to bring together their views on both the water laws and climate change, and apply them to areas like the Yakima River Basin. The broad nature of this question left most of the subjects with varying opinions and suggestions. However, three out of three Ecology employees all agreed that more "flexibility" is needed within current western water laws. There were informative ideas from two of the Ecology employees. One employee suggested extending the irrigation season. This person believes that a water user should be able to, "apply to Ecology to take an irrigation water right that the season of use is defined as April 1st to October 31st, and

expand that from March 15th to October 10th." A second Ecology employee thinks that western water law should address the "death of stationarity." As this person points out, much of the laws are founded on the principle of climate stationarity – meaning that you can predict the climate's future from its past. However, with climate change increasing variability in things like temperature and precipitation patterns in the Basin, the second Ecology employee thinks new laws should be established to deal with extremes and regular events of unpredictability.

The private sector group had different opinions about Question 8. The non-profit organization representative said that climate science is "not sound science" because it only looks at a very short period in the "temperature column data." Therefore, this person's view on how western water law and policy should respond is based on data from "300 to 500 year swings" in climate variability as a way to test the "veracity" of modern-day climate science. The consultant believes that incentivizing water storage, both surface and subsurface, for the Basin is a way in which western law should respond. The consultant elaborated on this idea by saying, "Most of the climate change projections I've seen from climate impact groups suggest that in the next 100 years or so water supply and association of water year is probably neutral to even positive by a few percent. The problem is that it's going to come earlier and flashier." Therefore, based on this view there would be a need to capture and store both surface and subsurface water in order to put it to beneficial use during months of irrigation in the Basin. The irrigation district representative thinks that the law does not necessarily need to change, but that the relinquishment statute does. "There's a very broad definition of beneficial use." The irrigation district representative goes on to say how the range of interpretation of the

statute creates ambiguity among water users, and ultimately overuse and water wasting in the Basin.

The water law attorney stated that this is one of the toughest questions out there in terms of merging the issues around climate change and western water laws. The attorney thinks that western water law does not currently work well in regards to fairness. The attorney believes that the "first in time, first in right", or what is legally known as the prior appropriation doctrine, does not allocate water fairly among all water rights holders, especially in times of regular water shortages within the Basin. Therefore, as the attorney points out, it would not be fair to only allocate full water rights to senior water rights holders, while all other water users suffer the full brunt of a less reliable water source from the river and its tributaries. So, the attorney believes that "sharing the pain" of less water reliability in the Basin should be reanalyzed to provide more equality in terms of water use among all water rights holders. Furthermore, the attorney thinks that western water law should promote projects like the YBIP, and provide comprehensive programs that will benefit water supply for irrigators, water for fish habitat, and help encourage environmental values all at the same time.

Each subject provided their input as to how western water law should deal with the effects of climate change. Ecology employees all agreed that more flexibility is needed in the laws so that adjustments can be made to deal with the disturbances from climate change. There were many suggestions from all of the individuals interviewed on how western water law should address a changing climate, and each suggestion had a practical approach regarding their own approach to handling a changing climate; regardless of whether or not they thought it was climate change, or some other weather-

related phenomena causing water-related issues in the Basin. Some of the suggestions were drastic changes to the law, while others were seemingly minor modifications to the current system – like creating ways that would allow the law to promote projects like the YBIP to all of the parties involved in the Basin, and making comprehensive water resource programs available to irrigators.

By and large, it seemed as though all of the individuals interviewed could find common ground on several of the interview questions. While there were plenty of differences among each person, there were also many similarities; even among the diverse professions which maintain very different goals and interests. Comparable stances on things like more flexibility in water laws and increased water storage projects are very agreeable matters among all of the individuals interviewed. Projects already in place that aim towards these common goals, like the YBIP and various other collaborative programs, are all positive steps forward to bring together the many parties involved in the Yakima Basin's water resources and irrigation projects. I am hopeful that the hard work and commitment each of the subjects I interviewed exhibited will result in a successful and sustainable Basin for the coming years.

Chapter 5: Concluding Thoughts and Statement

The interview responses reinforced some of the common issues around water resources and how laws and policies influence those resources in the Yakima Basin. The commonalities among the responses to the interview questions shed light on the fact that different people from different organizations can agree on several of the issues. However, the variation in responses also illuminates the fact that there is still much work to be done with respect to finding the common good for all of the interested parties in the Basin.

Some of the broader agreements among the groups around water resources in the Basin are important pieces of data that should be used to make effective changes. Parallels that were proven through the interview process are a way to gather common interests around complex issues, and use them as the framework to create more dialogue among the interested parties for both immediate and future changes for the Basin. A logical approach to take on multifaceted concerns regarding the Yakima Basin and its water resources should initially be founded upon areas of agreement and compromise. From there, areas of disagreement must be sorted out through a series of give and take proposals and scenarios. Often times, matters where numerous parties disagree can create an extensive negotiation process. Nonetheless, this is where leaders from the private and public sectors must converge to move in the direction of compromise. Not every group involved in the Yakima Basin will get everything they want in the negation process. In fact, when it comes to managing such a valuable natural resource like water, especially in an arid environment like the Yakima Basin, most people involved will not get everything that they want.

The Basin's managerial and professional groups must be responsible leaders and able to adapt to the environmental and socioeconomic changes of the 21st century. These adaptations must then be used to influence outdated and imbalanced water laws that are no longer consistent with today's needs. One relevant example of adapting to outdated water laws is how new water laws and plans can adapt to the changing climate. So, when decisions are made among various parties in the Basin around climate change and how it will influence the area, scientific facts must prevail. When scientific evidence, rather than emotional or political opinions, influence the way decisions are made on a scientifically-based topic it creates a solid foundation that all groups in the Basin can use. Thus, creating a well-informed and common starting point that will benefit every interest that relies upon the Basin's water supplies.

With that being said, the results I received from the 7 subjects interviewed from 5 different organizations laid the groundwork for the direction in which all individuals in the Basin involved with water resource management and irrigation ought to move. Many of the differences that people get caught up on, such as whether or not climate change is a human-induced occurrence, are often irrelevant at the present time when it comes to making logical and progressive improvements and plans for the Basin's future. In fact, one thing that 6 out of 7 interview subjects could agree on is that the Basin is experiencing a persistent trend in warming. In fact, all 7 subjects agreed that the Basin is experiencing a loss in snowpack, and provided their own ideas on how to implement best management practices with respect to a less reliable water source. Even though many of their ideas varied in regards to a best management strategy for the Basin, it is still true that all 7 subjects had the idea in mind that the Basin does in fact need a number of

different water resource plans and projects to cope with a changing climate – regardless of its cause.

There are some important factors to recognize with respect to the overall scope and range of data collected for this thesis research. First, there were several other groups contacted that would have been categorized as "subject matter experts" and included as part of the interview process. However, these groups either refused to take part in an interview, or did not respond to my requests at all. Interviews from a larger collection of groups involved in the Yakima Basin would have increased the sample size of subject matter experts, provided a more detailed analysis of the questions asked, and helped to identify any further issues taking place with respect to managing the Basin's water resources. Additional groups of subject matter experts that were contacted consisted of members from the Yakama Nation, The Bureau of Land Management, United States Bureau of Reclamation, several attorneys that specialized in Washington water law, university faculty and researchers from universities located in Washington, and other irrigation districts in the Yakima Basin region.

Also, there was an attempt through several organizations to reach out to water users, both junior and senior, so that their perceptions around the topics discussed could be included into the thesis research. However, I did not receive a response from any of the water users that were contacted. The nonparticipation from water users resulted in lack of information from their perspective around water laws and whether or not climate change has had, or will have, any impact on their individual water rights. Opinions from subject matter experts provide great insight into what kinds of issues need to be acknowledged in the Basin; however, an understanding provided by actual water users

would provide necessary and more complete information for the topics addressed in this thesis.

The findings in this thesis project is intended to create practical guidance with regards to current and future plans for the Basin's water resources. However, it is important to recognize that the limited scope and small sample size in the research provides only a solid preliminary foundation for further research on this topic. A topic of this magnitude requires a much larger sample size that includes, but is not limited to, all of the aforementioned groups and individuals who did not participate in the interview process. Additionally, more interview questions must be asked with respect to water conservation, water usage, and crop-related questions targeted directly towards water users.

The Yakima Basin is expected to experience yet another water shortfall during the 2015 irrigation season. According to scientists, in the 21st Century the Yakima Basin will, "Transition to earlier and reduced spring snowmelt as the century progresses, which results in increased curtailment of water deliveries, especially to junior water rights holders. (Vano, 2007)" There are numerous sources, reports, scientific journal articles, and books about this topic that all agree that climate change will be the cause of warming temperatures for the region, and result in a recurrent decline in the Basin's snowpack.

While there are some plans and projects already in place to minimize the impacts of this year's limited water supply, there is still a great deal of uncertainty among the Basin's water users, water resource managers and all of the individuals that work diligently to maintain this precious resource. With warming temperatures, a projected

increase in less reliable water resources, and the unforeseen consequences of climate change, it is my hope that sensibility, responsible leadership, and the dedication of all of the people in the Yakima Basin will be able to establish the model for how basins everywhere can create a sustainable future for all of its inhabitants for many years to come.

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