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Title: Characterizing Adaptive Governance Capacity: A Case Study of the Willamette River Basin.

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The Willamette River Basin supports 70% of Oregon's population and contains the richest native fish fauna in the state, (Hulse, Gregory, & Baker, 2002). The Basin is facing changes that stress its water management regimes. Is the Basin's water management regime able to adapt in the face of these changes? Climate models project increasing air temperature, greater variability and intensity in winter rainstorm events, and decreased low elevation snowpack in the Basin (Sproles et al. 2012). Environmental streamflow requirements for federally listed fish species and municipal and agricultural water demand have closed several watersheds to new surface water allocations and reduced reliability of supplies. Sustainable water resources management requires networks of water managers who practice adaptive management by continually monitoring, assessing, and improving management procedures and outcomes. This requires adaptive governance capacity, which is "the ability of a resource governance system to first alter processes and if required transform structural elements to better cope with experienced or expected changes in the societal and natural environment,"
(Pahl-Wostl et al., 2010, 572). To characterize adaptive governance capacity, a questionnaire was sent to 119 water managers at the basin scale and within three selected watersheds examining four key elements of adaptive governance capacity: social capital; human, financial, and physical capital; management tools and strategies; and governance strength (Pakenham-Stevenson, 2017). The availability of water for appropriation of new surface water rights was used to identify three watersheds that spanned low (McKenzie River), medium (North Santiam River), and high (Middle Fork Willamette River) levels of water availability. Questionnaire

results suggest high levels of reciprocity, awareness of impacts, and trust in watershed councils across selected watershed and at the Basin level. The strength of networks among water managers was high at the watershed level. Trust in water managers was low at the Basin level and the availability of adequate financial capital was at the Basin level and across selected watersheds. Water managers also did not believe their stakeholder group can adapt to changes in supply and demand. Trust in specific stakeholder groups varied widely across watersheds, highlighting unique characteristics and networks at the watershed level. To further understand the barriers and opportunities for adaptive governance in the Basin, semi-structured interviews were conducted with 17 key water managers. Interviews highlighted uncertainty created by minimum perennial stream flows, challenges sharing information between federal, state, and local levels, and reduced financial capacity. Interviewees highlighted several organizations that are leading the way in adaptive water resources management and enhancing adaptive governance capacity at the local and state levels. To adapt to likely changes in supply and demand the water management regime will require trust building among specific stakeholder groups, increased network strength at the basin-level, and increased financial capacity.

Characterizing Adaptive Governance Capacity:
A Case Study of the Willamette River Basin

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CHAPTER 1. INTRODUCTION

Water management in the Willamette Basin is currently in a period of change. The U.S. Army Corps of Engineers (USACE) and the Oregon Water Resources Department (OWRD) are implementing a study to examine the effects of reallocating the 1.6 million acre-feet of water stored behind 13 reservoirs in the Willamette Basin (OWRD, n.d.), the USACE is managing flows in accordance with a federal law under a 2008 Biological Opinion (BiOp) for the Upper Willamette Basin, and a pilot reallocation has already begun through a U.S. Bureau of Reclamation (USBR) water right transfer to allow 437 acre-feet of stored water in two Willamette Project reservoirs to be used for municipal and industrial use for the first time (OWRD, 2016). Finally, the State of Oregon is rolling out its new Integrated Water Resources Management Strategy with a new focus on drought mitigation and response. This research will examine the barriers to adaptive governance capacity and opportunities for adaptive governance capacity within the Willamette Basin and within three nested units of analysis: the North Santiam, McKenzie, and Middle Fork Willamette watersheds. Adaptive governance capacity is "the ability of a resource governance system to first alter processes and if required transform structural elements in order to better cope with experienced or expected changes in the societal and natural environment" (Pahl-Wostl et al., 2010, 572). In other words, adaptive governance capacity is the ability of a management regime to restructure in response to endogenous or exogenous stresses to the social or ecological system. This research aims to characterize adaptive governance capacity in the Willamette Basin, quantify adaptive governance capacity using a replicable method, and identify opportunities and barriers to collaboration to inform policy and community planning.

The Willamette Basin's water resources are managed for many uses, including flood control, recreation, endangered species, municipal supply, irrigation, wild and scenic character. The large geographic scope of the basin and the USACE's dam management in combination with the diversity of stakeholders make the management of the Willamette Basin's water supply what scholars have called a "wicked problem." Scholars have identified "wicked problems," as unique management challenges because they are unstructured, cross-cutting (across stakeholders and perspectives), and relentless (Weber & Khademian 2008, 336). Wicked problems are relentless because once they are resolved, new problems inevitably appear. The wicked nature of water management in the Willamette Basin offers an opportunity to examine two important questions that impinge on the long-term effectiveness of the new system. First, given that collaborative problem solving arrangements are a good fit for coping with and making progress against wicked problems (Weber and Khademian 2008; Weber, Lach and Steel, 2017), will the agencies, institutions, and stakeholders together have the necessary collaborative capacity to manage the new system successfully over the long term?

Second, precisely because major changes to any system may cause disruption and instability in institutions, rules, practices, and relationships among key stakeholders, the question of adaptive governance capacity arises. Put differently, high adaptive governance capacity increases the likelihood of successful system change that overcomes the disruption and instability, while low adaptive governance capacity promises the opposite. The question of adaptive governance capacity in basin-wide systems of water management is important from the perspective of climate change and the expectations of significant population increases in the Willamette Valley in coming decades. By definition, these added stressors on the existing water system, with its heavy historical emphasis on agricultural uses, will require greater adaptive governance capacity in order to absorb and incorporate the climate change and population dynamics. Finally, evaluating adaptive governance capacity can help stakeholders "identify which approaches are appropriate in different circumstances" and provide policymakers with "informed evaluations that help them formulate appropriate rules and regulations," (Conley & Moote, 2003, 373). Understanding which management tools are being implemented or neglected within the basin, as well as taking a barometer of the strength of the social network can help identify opportunities for managers to improve adaptive governance capacity. Identifying gaps in information and knowledge sharing efforts may help avoid future conflict among stakeholder groups.

Oregon State University has launched a study of the Willamette Basin, called the Willamette Water 2100 Study (WW2100), to model the effects of climate and population changes on the hydrology, land use, water use, reservoir operations, agricultural demand, and instream temperatures within the sub-basins and along the main-stem of the Willamette River (Willamette Water 2100, n.d.). Only preliminary legal research has been integrated into the model, but further research is anticipated to examine the "preferred legal and policy approaches that will most likely achieve the desired outcomes" (Amos, 2014, 22), including understanding the intersection of state and federal law and opportunities for managers to exercise discretion. Once complete, this legal research will clarify the legal boundaries of management tools within the basin, however the research does not address the governance capacity of the current water management regime to implement diverse management tools, engage stakeholders, and employ human, financial, and physical capital to adapt to changes in climate and population.

The Willamette River Basin, a tributary to the Columbia River, supports 70% of Oregon's population and contains the richest native fish fauna in the state (Hulse, Gregory, & Baker, 2002). The Willamette Basin is facing changes that stress its existing water management regimes. Climate models project greater variability and intensity in winter rainstorm events and decreased snowpack at low elevations in the Willamette Basin (Sproles et al. 2012). Environmental flow requirements for federally listed fish species coupled with increasing municipal and agricultural water demand have closed several watersheds to new surface water allocations, and reduced reliability of supplies. Is the basin vulnerable in the face of these changes?

It is now generally accepted that long-term, sustainable water resources management requires networks of water managers who practice adaptive management by continually monitoring, assessing, and improving management procedures and outcomes. To characterize and to assess adaptive governance capacity in the Willamette Basin, this research surveys over 100 water managers at the basin-wide scale and the watershed level. As step one, a questionnaire examines four key elements of adaptive governance capacity: 1) social capital, 2) human, financial, and physical capital, 3) management tools and strategies, and 4) governance strength. A second level of inquiry focuses specifically on three watersheds within the Basin that have varying levels of water available for appropriation of new surface water rights. The three watersheds are the North Santiam River (medium), McKenzie River (low scarcity), and Middle Fork Willamette River (high). Semi-structured interviews were conducted with key managers in these watersheds to further identify barriers to and opportunities for adaptive governance. Respondents included experts involved in managing water on a basin-wide scale and those managing on a watershed-level within the selected watersheds.

1.1 Study area description

1.1.1 Landscape uses and water demands in the Willamette Basin

The Calapooia, Luckiamute, Yamhill, and Clackamas Tribes have inhabited the WRB for about 10,000 years. The Kalapuya managed the valley floor with frequent fire to sustain oak savannah and game species. EuroAmerican settlement increased as settled agriculture replaced hunting and trapping, bringing in 175,000 people by 1880 (Dearborn & Duclos). By the 1850's much of the population of the tribes was reduced due to small pox. By 1940's, urban dwellings had already begun to surpass rural dwellings and the percentage of land use in development is projected to increase 54% by 2050 (Oregon Office of Economic Analysis, 2011). Today, Oregon's three largest population centers, Portland, Salem, and Eugene-Springfield, are located in the Willamette Basin. These new uses of water, including irrigation and municipal uses, have increased alongside population growth and Euro-American settlement in the Willamette Basin.

In 2015, Oregon's total water demand was 8,425,000 TAF, including 14% municipal and industrial demands and 86% agricultural demands (OWRD, 2015). The Willamette Basin produces 45% of Oregon's agriculture, however agricultural lands are projected to decrease by 8% by 2100 (Jaeger et al., 2017). Municipal and Industrial demand are projected to increase 20% by 2050 statewide, with significant increases in Marion and Lane Counties, where North Fork Santiam and Middle Fork Willamette are respectively located.

According to a Statewide Water Needs Assessment prepared for the Oregon Water Resources Department, (HDR Engineering, Inc., 2008), Oregon's water demand is anticipated to increase by 1.8 million acre feet by the year 2050. As new demands arise, resilient management that accounts for the anticipated and impacts of climate change in supply and uncertainty of supply is increasingly important. However, policy and regulations are often based on assumptions of "stationarity" that are challenged by climate change (Milly et al. 2008). Stationarity is "the idea that natural systems fluctuate within an unchanging envelope of variability" (Milly et al. 2008, 573). While Oregon water law has adapted over time (Bateman, 2014) and water management in the is American West has been called a "compelling story of active adaptation," (McKinney and Thorson 2015, 679), system stresses of population growth and climate change will require multi-level water management regimes to adapt to increasing uncertainty and manage for a margin of safety in new ways.

1.1.2 Ecological system: biotic and abiotic components in the Willamette Basin

At the time that Euro-American settlers arrived in Oregon, the Willamette Valley was dominated by black douglas fir, Oregon ash, cottonwood, alders, big leaf maple, several species of oak, and western red cedar. The river margin was dominated by riparian mixed hardwood and conifer forests, with some areas managed by the tribes, who used fire as a management tool to promote bottomland prairie grass. Over 97% of this prairie grassland has been lost (Gregory et al., 2002). Open savannas and understory in the foothill has become dominated by douglas fir forests. Today, Approximately 75% of the basin is forested, with 64% zoned for exclusive forest use under Oregon's land use planning laws (Payne & Goicochea Duclos, 2002). Ownership of the forest is distributed among private landowners (61%), federal government, (38%), state government (1%), and Native Americans (0.2%) (Payne & Goicochea Duclos, 2002). Finally, it is important to acknowledge that 96% of riparian forests in the Willamette Basin are along small streams (Gregory et al., 2002).

The biotic components of the Willamette River Basin that receives the most attention, due to both legal and cultural factors, are endangered salmon and chinook fish. A Biological Status Review completed by USFWS in 2005 found that Upper Willamette River Chinook Salmon were likely to become endangered. The report identified "only one remaining naturally producing population in this Endangered Species Unit: the spring-run Chinook in the McKenzie River," and identified dams as a habitat blockage (Willamette Riverkeeper, 2007). In 1999, USFWS listed Upper Willamette River Chinook and the Lower Columbia River Chinook Salmon and Steelhead as threatened and designated critical habitat for the Upper Willamette River Chinook Salmon (Willamette Riverkeeper, 2007). Critical habitat was designated for Upper Willamette River steelhead in 2000 and 2005. Additional species listings include Columbia River Bull Trout (1998) and Oregon Chub (1993). The 2008 BiOp issued by NMFS and FWS found that the risk of extinction for Upper Willamette River Chinook over the next 100 years is high. The North and South Fork Santiam River, South Fork McKenzie, and Middle Fork Willamette River are the "only areas still accessible to Chinook for spawning, incubation, and early rearing," (NOAA, 2008, 12).

1.1.3 Water resource characteristics

Water availability in the Willamette Basin is shaped by historic climate and current climate and topography. Between 15,500 to 13,000 years ago, there were over 40 episodic floods (the Missoula floods), which shaped the valley with rich sediment. The Willamette Valley itself is characterized by rich, arable land, while the eastern portion of the Basin is comprised of the Cascade Mountain Range, the tallest of these mountains being Mt. Jefferson, reaching10,495 ft. Eruptions from Cascade volcanoes have formed the Columbia River Basalt Group, an aquifer which underlies the northern 2/3 of the Basin. On the eastern side of the basin, snowfall in high Cascades and some permanent glaciers contribute to groundwater re-charge, cool waters, and mixed rain and snow-dependent streams. Snowpack provides approximately 10% of stored water in the Willamette Project Reservoirs (OWRD, n.d.). In contrast, there is little snow accumulation on the western side of the basin, where the tallest peak, Mary's Peak, reaches 4,097 feet. Rivers on the western side of the basin in the coast range tend to have higher flow in the winter months due to runoff and lower flow and warmer temperatures in the summer months. Overall, Willamette Basin climate is controlled by continental influences, which lead to cold, wet winters and warm, dry summers. Summer rainfall is only 5% of annual average total and the Basin receives rainfall from December through February.

1.1.4 Degree of human influence in the Basin

The Willamette Basin is a highly human-modified system, due to flood control dams and revetments, agriculture, forest management practices, and urban development in the river floodplain. Dams in the Willamette River Basin alter the natural hydrograph by decreasing peak flows during the winter and increasing summer low flows (Hulse, Gregory, & Baker, 2002). During the period of reservoir construction (1945-1968), the river flowed above the vegetated line (bankfull) for an average of 14 days in a year. After 1968, flow greater than bankfull occurred an average of only 8 days per year (Gregory et al., 2002). Dams and revetments have also altered channel complexity, floodplain function, and total river area, reducing alcoves (which are important habitat for aquatic species) by 57.7% and total river length by 25.8% between 1895 and 1995 (Gregory et al. 2002). The lower reach of the channel, which runs through basalt, has not experienced significant geomorphic changes in the past century, however the middle reach has changed some and the upper reach of the channel, which was historically more braided, has changed significantly. The loss of islands, sloughs, and alcoves results in loss of habitat diversity in temperature, depth, velocity, sediment, and riparian ecosystems (Gregory et al., 2002).

Over 90% of wetlands and grasslands in the Basin have been converted to farmland and urban areas, reducing habitat for native species such as the western pond turtle and Oregon spotted frog (White & Baker, 2002). Reduction in wetlands and grasslands is due to both urban and agricultural influences from impermeable pavement and drain tiling, a practice used in agricultural land management to direct excess water off of farmland. Roads alone occupy 3.8 miles of every square mile of land in the Basin (Payne, Goicochea, & Duclow, 2002). Also, the near eradication of beaver in the landscape by the 1830's changed the hydrology of the basin (Bransomb & Richmond, 2002). As a result of these landscape changes, 1,400 miles of stream in the Basin do not meet water quality standards.

In addition to human influences on river morphology, over half of the Willamette Project Dams block salmon and steelhead passage; these include Blue River, Cougar, Dexter, Big Cliff, Detroit, Foster, and Green Peter Reservoirs (Myers et al., 2006). The last four of this list represent the most significant blockages for Steelhead species. NOAA outlines several ways the Willamette Project (including reservoirs, revetments, flood risk reduction, and contracting for stored water) harms salmon and chinook, among other species:

> The Willamette Project has adversely affected Upper Willamette River Chinook and steelhead by blocking access to a large amount of their historic habitat upstream of the dams and contributing to degradation of their remaining downstream habitat. The associated mitigation hatcheries that accompanied the dam building had an effect on the genetic diversity of Chinook populations in the Willamette basin. Other factors in the decline of Willamette salmon and steelhead include habitat degradation by others, hatchery effects, and harvest. (NOAA, 20012).

Landscape changes and natural climate variability lead to environmental hazards in the Willamette Basin, including floods, droughts, forest fires, landslides, forest fires, and earth quakes. Recent floods in the Willamette River include the flood of 1964, which inundated 152,789 acres of land, and the flood of 1996, which inundated 194,533 acres. While these floods gained public attention, they are much smaller than floods that occurred previous to the dam construction era. In 1861, for example, the rate of flow reached 340,000 cubic feet per second at Albany, and inundated over 320,000 acres (Gregory et al., 2002).

1.1.5 Technical Infrastructure

Within the Willamette Basin, USACE owns and operates 13 dams, constructed between 1941 and 1969, which store 1.64 million acre feet of water for flood risk reduction, irrigation, recreation in the reservoirs, and hydropower. Eight of the 13 dams on in the Project have power generation capabilities and produce a total of 2,105 MW per year, which is marketed by Bonneville Power Administration (BPA) (NOAA, 2008). In addition to the flood control dams, the Willamette Project also includes 43 miles of revetments, which are levees and riprap that prevent the river from meandering and keep floodwaters away from property. Over 50% of the revetments in the Willamette Basin are owned by private landowners or urban centers, rather than USACE, for purposes of protecting agriculture and urban centers (Payne, 2002).

1.1.6 Federal laws affecting the Willamette Basin

The Endangered Species Act (ESA) is a formal, relatively rigid rule that has impacted management institutions in the Willamette Basin. Under Section 7 of the ESA, federal agencies are required to consult with U.S. Fish and Wildlife (USFWS) (for freshwater species), and with NMFS (for anadromous fish species) to determine whether listed species are present within their action area (16 U.S.C. § 1536, 1973). To do this the agency must look to the best available scientific and commercial data. When acting under ESA section 7 to assess the impacts of an agency action on listed species, federal agencies must consider the impacts of an agency action on the "action area," which includes "all areas to be affected directly or indirectly by the federal action" such as lands owned and managed by the agency (50 C.F.R. §402.02). After a Biological Assessment determines that an agency action is "likely to affect" a listed species, the listing agency has 90 days to issue a Biological Opinion, stating the effects of the action on the listed species and critical habitat, determining whether the action is "likely to jeopardize" the listed species, and stating reasonable and prudent alternatives the action agencies can take (16 U.S.C. § 1536, 1973). Finally, the ESA prohibits federal agencies from making an "irretrievable commitment of resources," before considering reasonable and prudent alternatives to their actions (16 U.S.C. §1536, 1973).

The complex legal infrastructure in the Willamette Basin creates overlapping institutions of water management. There is tension between rules in the Willamette Basin due to dual sovereignty and challenges of water accounting in a highly-managed system. There are overlapping roles of water management, and there are multiple mechanisms to promote instream flows, however legal protection for each of these mechanisms differs. Federal and state agencies have roles to manage water quantity and quality. Congress authorized construction of the Willamette Project in 1938 and shortly thereafter the Flood Control Act of 1944 authorized the USACE, led by the Secretary of the Army, to manage flood risk reduction throughout the U.S. and an era of dam construction swept across the nation. The Federal Water Projects Recreation Act of 1964 introduced recreation and fish and wildlife as federally authorized purposes for federal dams ([16 U.S.C 460(L)(12)- 460(L)(21)). The

USACE, in carrying out its goals, is authorized to store water behind dams to prevent flood stage below dams, and to release water when storage space is needed behind the dams for safety reasons. Releases from USACE dams are managed using a “rule curve,” which balances flood probability and storage. Reservoirs are drawn down to a minimum between December and late January and USACE uses the period between February and early May, when floods are less likely to occur, for conservation storage, gradually filling the reservoirs (NOAA, 2008). The USACE also has authority to issue permits to dredge and fill Waters of the United States under Section 404 of the Clean Water Act. This includes activities on wetlands that have a significant essential nexus to those waters (Ferry, 2016).

When Congress authorizes the construction of a USACE reservoir, it also designates uses for the stored water that are aligned with public interests. When the Willamette Project was constructed, the stored water was not allocated to specific uses, instead the stored water was allocated for “joint use,” or multipurpose uses (OWRD, n.d.). USACE can recommend changes to Congress regarding the operation of the reservoir or the allocation of stored water (OWRD, n.d.). Currently, stored water is only used for irrigation purposes. USACE has determined that 15% of the stored water in the Willamette Project (50,000 AF) could be reallocated for municipal and industrial uses without formal Congressional approval, provided USACE headquarters approves. For reallocations less than 499 AF, headquarters approval is not required (OWRD, n.d.). Reallocating stored water includes allocating the cost of constructing the reservoirs, which requires approval from Congress. Contracts to municipalities for stored water will be priced per acre foot, according to the proportion of storage acquired and the related proportion of the cost required to construct the project, and revenues will be returned to the U.S. Treasury (OWRD, n.d.) As was done in the pilot project, the USBR certificates need to be changed through a state transfer process to change the “character of use” of the stored water, but it is unlikely that the change of use can exceed the 95,000 AF cap on new contracts for agricultural use (NOAA, 2008). To do so may trigger OWRD to determine that the transfer injures current water rights holders. Also, this could be considered a “Regulatory Taking” under the 5th Amendment. The process of reallocation is also lengthy and costly for the USACE, which must prepare a report that includes updated information on supply and demand estimates, project data, and NEPA analysis (OWRD, n.d.). It is noteworthy that stored water does not need to be contracted by USBR and could be contracted directly through USACE and that reallocation is subject to NEPA and ESA laws. While an Environmental Impact Statement (EIS) was not completed for the pilot transfer, the USACE believes a larger transfer would require an EIS, (OWRD, n.d.). Additional consultation with USFWS and NMFS may be required because the 2007 Environmental Assessment did not include reallocation in the project operations.

USBR has constructed and now manages dams in the United States that provide stored water for irrigation purposes. USBR is the holder of two water right certificates awarded by OWRD (72755 and 72756) to a total of 1,640,100 AF of stored water behind USACE Willamette Project dams, constituting the total summer conservation storage. However, a total of only approximately 74,000 AF of stored water is contracted under USBR certificates (USBR, personal communication 4/21/17). Under the Water Resources Development Act of 1986, Congress authorized USBR to issue contracts for irrigation only.

1.1.7 State laws affecting the Willamette Basin

While federal flood management practices alter water quantity, states also have authority to manage water quantity. In Oregon, all water is publicly owned and managed by the Oregon Water Resources Department, which has authority to award usufructory rights to surface water and groundwater. Oregon passed its State Water Code in 1909, adopting the Doctrine of Prior Appropriations. The right to use water from a stream for beneficial use in Oregon is dependent on the time of the first application of the water to beneficial use, without waste. In Oregon, water users must have a water right to store water, and a secondary right to use stored water. If stored water is released without a water right from a reservoir, which is the case with unallocated stored water from the Willamette Project Reservoirs, water users can withdraw the released stored water as if it were “live flow.” OWRD cannot regulate water users who take life flow that is released from stored water if that stored water does not have an accompanying secondary water right.

The first in time, first in right principle allocates risk (reliability of water availability) among users based on priority date (Tarlock, 2001), allowing senior users the certainty that the amount of water that was available to them at the time their initial diversion was established will be available to them (Van de Wetering & Alder, 2000). The doctrine has been called adaptable because of recent laws that establish a formal system of applying for and transferring instream water rights as well as a program that incentivizes conservation measures (Bateman, 2014; McKinley & Thorson, 2015). However, the rigidity of the doctrine is apparent in the inefficiency of moving water between uses (Garrick & Aylward, 2012).

Oregon passed the Instream Water Right Act in 1987, which gave OWRD the statutory authority to protect instantaneous rates of streamflow from being diverted out of stream through an instream water right. Soon thereafter, the Oregon Department of Fish and Wildlife applied for instream water rights on streams throughout the state, and each was awarded a priority date of 1987 or later. These instream flow rights are usually junior to historic rights to divert water, which date back to the 1860's in Oregon. Thus, many instream water rights are not fulfilled and flow instream is less than the amount established in the instream flow certificates.

Before water rights could be legally protected instream, in 1952, OWRD established minimum perennial stream flows that provide flow targets for keeping water instream. Minimum perennial stream flows are not protected instream unless they have been converted into instream water rights, at which time they are given the priority date they were established. In the 1950's and 1960's, ODFW created minimum perennial stream flows as targets for supporting aquatic life. These flows have been converted into instream water right certificates, allowing them legal protection, in every basin except the Willamette Basin in most areas where the USACE operates (OAR 537.346). Once converted, these water rights will have a senior priority date to some existing water rights. Some minimum perennial stream flows list both stored water and "live flow" as their source, adding further complication to their conversion and accounting. Minimum perennial stream flows in the Willamette main stem, Middle Fork Willamette, Coast Fork Willamette, McKenzie River, Long Tom River, Santiam River, and the Tualatin River call upon both stored water and natural flow.

In 1970, the State authorized the protection of State Scenic Waterways (ORS 390.805 to 390.940), another mechanism to protect water instream. The first designations of State Scenic Waterways were made in the 1980s in the Chetco and Molalla basins. Another flow protection mechanism was developed more recently. In 2015, OWRD adopted a new statewide rule that gave the agency the authority to condition the portion of a municipal water right permit used after December 11, 2013 to leave additional water instream during times of low flow, based on recommendations from the Oregon Department of Fish and Wildlife (ODFW) (SB 712, 2015). These new "Fish Persistence Conditions" reduce the reliability of some municipal water right permits by requiring an ODFW review of municipal extensions for municipal water right permits awarded after a certain date. If use of the full rate allowed under the permit could harm the persistence of conditions required for fish survival, a portion of the permit's rate can be conditioned or reduced.

Another rule affecting water use are state administrative rules, which are developed for each river basin in Oregon. These rules establish beneficial uses, irrigation season length, and specific concerns and use restrictions within the basin. The Willamette Basin Rules direct OWRD to "protect undeveloped streams with instream values for public instream uses; seek a balance in the future appropriation of water between instream and out-of-stream uses on those streams already significantly developed for out-of-stream purpose; preserve opportunities for future economic development by reserving water for future use; minimize the likelihood of over-appropriation due to new uses; [and] manage stored waters which have been released for instream purposes to meet flow needs reflected in established instream water rights" (OAR 690-502-0020(1)(a, b, c, d, e)). These rules demonstrate the tension between water allocation for out-of-stream uses and instream needs.

1.1.8 Action Situation

In addition to changes in Oregon's water law, there have been several events in the Basin surrounding ESA species listing and the management of the Willamette Project Reservoirs (see Table 1). In 1997, steelhead, an anadromous salmonid species, was listed as endangered under the ESA and in 1999, chinook, another anadromous salmonid, was listed as threatened under the ESA. In the winter of 1999, discussions began between USACE and NMFS regarding the listings. The federal agencies involved in the Willamette Project (USACE, USBR, and BPA) initiated consultation with NMFS and USFWS, however the completion of consultation was delayed due to ongoing challenges involved with the Columbia River Power System (Amos, 2014).

In September 2007 Willamette Riverkeeper (Riverkeeper) and Northwest Environmental Defense Center (NEDC) filed a lawsuit against the USACE, the USBR, and BPA in the U.S. District Court for Oregon for alleged violations of the ESA (NOAA, 2008). After a settlement agreement with Riverkeeper and the NEDC, the action agencies were required to issue a BiOp by July 2008. On June 11, 2008, NMFS and FWS published a formal, combined BiOp outlining the effects of the Willamette Project on 13 listed species of salmon and steelhead as well as a distinct population segment of the North American green sturgeon and the Southern resident killer whale, which are also listed (NOAA, 2008, 1-3). The BiOp assesses three Federal Agency actions: USACE operation of the Willamette Project, Bonneville Power Administration power sales, and USBR contracts for stored water (for irrigation) in Willamette Project Reservoirs.

The BiOp determined that the Willamette Project is likely to jeopardize the continued existence of Upper Willamette River Chinook Salmon and Upper Willamette River Steelhead species and to adversely modify or destroy designated critical habitat and it concluded that the remaining 11 species are likely to be affected, but not jeopardized. When a "likely to jeopardize" opinion is reached in a BiOp, NMFS and/or FWS are required to provide the agency with reasonable and prudent alternatives. If these alternatives are followed, the federal agency is not liable for “take” of an endangered species. The BiOp also outlines several reasonable and prudent alternatives for the USACE to follow.

The BiOp requires USACE to maintain minimum authorized flows in the main stem Willamette (3,895 cfs from February to June and 2,990 cfs from July to November) which are measured at Albany (see Table 2). The BiOp also requires minimum and maximum flows on tributaries to the Willamette main stem (see Table 3). According to the BiOp, “when the water supply is inadequate to maintain both minimum flows and the scheduled rate of filling, maintaining instream flows…generally takes precedence,” (NOAA, 2008, 2-18). Also in response to the BiOp, NMFS and ODFW established a fish screen assessment process to ensure that USBR could verify contractor compliance with fish protection requirements (USBR, 2009).

USACE has federal obligations to prioritize the management of the reservoirs for flood risk reduction and listed species protection, however USACE has “a high degree of operational flexibility…in determining how to meet the [other] authorized purposes,” (Amos, 2014). Other uses of the Willamette Project include irrigation, hydropower, and recreation. An example of potential discretion the USACE has is the Rule Curve, which sets maximum reservoir fill targets during each month of the year. It is understood that it may be within USACE’s discretionary authority to change the Rule Cure without explicit congressional approval. However, the Rule Curve is an important element of flood risk reduction (and consequently protection of lives and property) and making any significant change would require that a report be sent to Congress from the Chief of Engineers of the U.S. Army (Amos, 2014).

USACE and OWRD are also currently implementing the Willamette Basin Review Feasibility Study to examine the effects of reallocating the stored water in the Willamette Project Reservoirs to new uses (OWRD, n.d.). The project began in 1996 to research the authority of USACE to reallocate stored water for municipal and industrial uses, but was delayed due to ESA Consultation. The official study has begun under the name, Willamette River Basin Review, and is a collaboration between OWRD, USACE, and ODA. In 2013, USBR and OWRD also began planning for a WATER-Smart Basin Study of the Willamette Basin to identify data gaps related to water demands in the basin to support the Willamette Basin Reservoir Study efforts, however the effort was not completed. The Willamette Basin Review Feasibility Study has continued, and it falls within the constraints of the USACE goal to reduce flood risk and provide environmental flows under the BiOp. Effectively, there will be no increase in the number of days the river is above bankfull, all contracts to stored water will be subject to environmental flows, and the study will not investigate new infrastructure or changes to the rule curve (OWRD, n.d.). New information produced by the study will include an evaluation of future climate change, impacts to recreation and hydropower, and overall cost effectiveness and financial feasibility (OWRD, n.d.). The draft recommended plan was completed for internal review in July 2017 and agency decisions are scheduled to be made by January 2018.

Management of the Willamette Project involves coordination among the USACE, the USBR, and OWRD. More recently, National Oceanic and Atmospheric Administration (NOAA) and ODFW have an increasingly important role in the management of the Willamette Project. According to the USACE, “the most significant adaptation to reservoir system operations has been the adoption of spring main stem flow targets. Since 2000, main stem Willamette Basin flows have been substantially higher during the spring migration periods for juvenile and adult spring Chinook salmon and winter steelhead,” (OWRD, n.d.). USACE uses about 536,700 acre-feet “during an average conservation season to maintain minimum reservoir releases and summer flows on the main stem at Albany and Salem,” (OWRD, n.d.). It is evident that the BiOp has caused some re-structuring and this research will examine the adaptive governance capacity of the new management regime.

Table 1. Major recent events in Willamette Basin

Date	Actor	Action
1990's	USACE	Begins study to reallocate stored water in the Willamette Project Reservoirs.
1999	NMFS	UWR chinook and steelhead federally listed as threatened; Critical habitat is designated.
1999	USACE	Reallocation study halted when chinook and steelhead are listed.
2000	NMFS, USSACE, and OWRD	Create plan for spring and early summer flow; New reservoir operations begin to meet main stem and tributary flow objectives for chinook and steelhead
April 2000	USACE	Submits Biological Assessment with project actions based on pre-listing of Chinook and Steelhead
October 2010	NMFS	Contacted Tribes and proposed to hold a meeting. CTWS, CTSI, CTGR attended meeting to discuss consultation process.
May 2002	USACE, USBR, and BPA	Submit amendment to Biological Assessment proposing to increase the volume of stored water that can be released from Willamette Project reservoirs for new USBR water service contracts
July 2003	NMFS	Submit revised BiOp to USACE, USBR, and BPA for review and comment
April 2004	NMFS	Provide preliminary revised draft reasonable and prudent alternatives
December 2004	USACE, USBR, and BPA	Submit comments on revised draft, expressing concerns
2005	USACE	New water temperature control facility constructed at Cougar Dam
September 2007	Willamette Riverkeeper and Environmental Defense Fund	File complaint and issue 60-Day notice of intent to sue Action Agencies under Section 7 and Section 9 of the ESA. Action Agencies and plaintiffs reach settlement agreement requiring BiOp to be issued by July 2008

Table 1. Major recent events in the Willamette Basin (continued)

January to April 2008	NMFS, USACE, USBR, BPA, and OWRD	Meet to discuss mechanisms to protect flows for fish that are released from Willamette Project reservoirs from out-of-stream diversion by holders of OR water rights for "live flow"
July 2008	NMFS and USFWS	BiOp issued with "jeopardy" statement that the proposed action is likely to jeopardize species and destroy habitat because of dams, revetments, and hatcheries. Incidental Take Statement issued through 2023. Requires USACE, USBR, and BPA to provide information to OWRD to help protect flows. WATER Study Team Formed.
2012	McKenzie River Flyfishers	Filed intent to sue ODFW for introducing hatchery fish in the Willamette, harming summer steelhead. Defendants win lawsuit.
September 2013	USBR	Creates draft Willamette Basin Plan of Study in hopes of pursuing a WaterSMART Basin Study in the Willamette.
2013	USBR	Discontinues Willamette Basin WaterSMART Study
2013	USACE and OWRD	Revived reallocation study.
May 2017	Riverkeeper and the Conservation Angler	Filed an intent to sue USACE for impacts of hatchery summer steelhead program.

*USBR wanted to add 10,000 AF of stored water available for contracts, totaling 95,000 AF.

Table 2. Main stem Willamette flow objectives (NOAA, 2008, 2-44)

Time Period	7-Day Moving Average[1] Minimum Flow at Salem (cfs)	Instantaneous Minimum Flow at Salem (cfs)	Minimum Flow at Albany (cfs) [2]
April 1 - 30	17,800	14,300	---
May 1 - 31	15,000	12,000	---
June 1 - 15	13,000	10,500	4,500
June 16 - 30	8,700	7,000	4,500
July 1 - 31	---	6,000	4,500
August 1 - 15	---	6,000	5,000
August 16 - 31	---	6,500	5,000
September 1 - 30	---	7,000	5,000
October 1 - 31	---	7,000	5,000

[1] An average of the mean daily flows in cubic feet per second (cfs) observed over the prior 7-day period.
[2] Generally, Congressionally authorized minimum flows (House Document 531). September flows were extended into October.

Table 3. Minimum and maximum tributary flow objectives below Willamette dams (NMFS, 2008, 2-44-46).

DAM	PERIOD	PRIMARY USE	MINIMUM FLOW (CFS) [1]	PERCENT OF TIME FLOW IS EQUALED OR EXCEEDED[4]	MAXIMUM FLOW (CFS) [2]	PERCENT OF TIME FLOW IS EQUALED OR EXCEEDED[4]
Hills Creek	Sep 1 - Jan 31	Migration &	400	99.9		
	Feb 1 - Aug 31	Rearing	400	99.9		
Fall Creek	Sep 1 - Oct 15	Chinook spawning	200	95	400 through Sep 30, when possible	25
	Oct 16 - Jan 31	Chinook	50 [3]	99.9		
	Feb 1 - Mar 31	Rearing	50	99.9		
	Apr 1 - May	Rearing	80	99.9		
	Jun 1 - Jun 30	Rearing/adult	80	99.9		
	Jul 1 - Aug 31	Rearing	80	95		
Dexter	Sep 1 - Oct 15	Chinook spawning	1200	99.9	3,500 through Sep 30, when possible	10
	Oct 16 - Jan 31	Chinook	1200 [3]	99.9		
	Feb 1 - June	Rearing	1200	99.9		
	Jul 1 - Aug 31	Rearing	1200	99.9		
Big Cliff	Sep 1 - Oct 15	Chinook spawning	1500	95	3,000 through Sep 30, when possible	5
	Oct 16 - Jan 31	Chinook	1200 [3]	98		
	Feb 1 - Mar 15	Rearing/adult	1000	99.9		
	Mar 16 - May	steelhead	1500	99.9	3,000	25
	Jun 1 – Jul 15	steelhead	1200 [3]	99.9		
	Jul 16 - Aug	Rearing	1000	99.9		
Foster	Sep 1 - Oct 15	Chinook spawning	1500	75	3,000 through Sep 30, when possible	1
	Oct 16 - Jan 31	Chinook	1100 [3]	80		
	Feb 1 - Mar 15	Rearing	800	95		
	Mar 16 - May	steelhead	1500	80	3,000	30
	May 16 - Jun	steelhead	1100 [3]	95		
	Jul 1 - Aug 31	Rearing	800	99		
Blue River	Sep 1 - Oct 15	Chinook spawning	50	99.9		
	Oct 16 - Jan 31	Chinook	50	99.9		
	Feb 1 - Aug 31	Rearing	50	99.9		
Cougar	Sep 1 - Oct 15	Chinook spawning	300	99.9	580 through Sep 30, when possible	60
	Oct 16 - Jan 31	Chinook	300	99.9		
	Feb 1 - May	Rearing	300	99.9		
	Jun 1 - Jun 30	Rearing/adult	400	99.9		
	Jul 1 - Jul 31	Rearing	300	99.9		
	Aug 1 - Aug	Rearing	300	99.9		

[1] When a reservoir is at or below minimum conservation pool elevation, the minimum outflow will equal inflow or the Congressionally authorized minimum flows, whichever is higher.
[2] Maximum flows are intended to minimize the potential for spawning to occur in stream areas that might subsequently be dewatered at the specified minimum flow during incubation.
[3] Incubation flows are intended to be no less than ½ the maximum 72-hour average discharge observed during the preceding spawning season. Efforts will be made to avoid prolonged releases in excess of the recommended maximum spawning season discharge to avoid spawning in areas that would require high incubation flows that would be difficult to achieve and maintain throughout the incubation period.
[4] Flow duration estimates are based on HEC-ResSim model output data for the BiOp operation. Period of Record of model data is Water Years 1936-2004.

CHAPTER 2: RESEARCH METHODOLOGY AND LITERATURE REVIEW

This research utilizes the case study method to examine adaptive governance capacity. Case study research investigates “a contemporary phenomenon (‘case’) in its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident,” (Yin, 2014, 2). This research also utilizes elements of the Management and Transition Framework (MTF) to structure an overview of the institutions and actors in the Willamette Project. MTF is “a flexible framework to analyze water management regimes and transition processes” (579), specifically multi-level governance structures. MTF is also an organizational tool for characterizing the human and environmental components of a water system and their attributes (Pahl-Wostl et al., 2010). Attributes of the system discussed in the site description for this research include the technical infrastructure in the water system, the ecological system, and legal institutions.

2.1 Definitions

Adaptive governance capacity is “the ability of a resource governance system to first alter processes and if required transform structural elements in order to better cope with experienced or expected changes in the societal and natural environment,” (Pahl-Wostl et al., 2010, 572). Adaptive management, which can be achieved when high adaptive governance capacity is harnessed, is “a systematic process for improving management policies and practices by systemic learning from the outcomes of implemented management strategies and by taking into account changes in external factors in a pro-active manner” (Pahl-Wostl et al. 2010).

This research uses the definition of scarcity created by the WW2100 team, which wrote that “water scarcity occurs when there is not an affordable, attainable, and reliable source of clean water when and where it is wanted or needed by humans and animals and plants currently and into the future (Morzillo, 2015). This definition complements the notion that “scarcity is fundamentally a normative, anthropocentric concept and thus, can and should be distinguished from the related, purely descriptive notion of water deficit,” (Jaeger et al., 2013, 4507).

2.2 Metrics

A questionnaire developed by Anna Pakenham-Stevens was used to quantify adaptive governance capacity. The questionnaire included four main concepts included in adaptive governance capacity 1) social capital, 2) human, financial and physical capital, 3) management tools and strategies, and 4) governance, and each measure was operationalized into several metrics. First, social capital was measured by strength of networks, trust among stakeholders, reciprocity among stakeholders, and level of conflict. The questionnaire measured the intensity of past conflict, including litigation (although litigation was not explicitly noted in the questionnaire), level of expected future conflict, and the effects of conflict on stakeholder groups. Human, financial and physical capital were measured by awareness of impacts of water use on other user groups, the availability of information about water use, and available knowledge and resources. The questionnaire listed water management tools that are most likely available to water managers in the western U.S., including instream transfers, reallocation of stored water, and water conservation (see Appendix C). Respondents were asked to identify whether they currently use each tool and whether voluntary or regulatory use of each tools was supported to capture the support for using legal authority to apply regulatory tools to improve water management. The questionnaire measured the strength of the stakeholder group's innovation, clarity of goals, and self-identified ability to adapt to management challenges. Finally, this study measured three concepts of government: authority, engagement, and leadership. Authority was measured by the jurisdictional authority to make decisions, which is a legal authority, engagement was measured by the opportunity to engage in water management decisions, and leadership was measured by the presence of a leader who is trusted and can bring diverse stakeholder groups together.

Each concept was quantified in the questionnaire on a five-point scale from (1) strongly disagree to (5) strongly agree. Trust was measured on a scale from (1) strongly distrust to (5) strongly trust. The questionnaire was then issued to "water policy actors" in three sub-basins, with differing levels of water scarcity, to examine whether water scarcity is related to adaptive governance capacity. A mean score of $\geq$

4.00 indicated strong in adaptive governance capacity and a means score of $\leq$ 3.00 indicated weak adaptive governance capacity. The term water policy actor referred to agencies, organizations, or individuals who have act within the water policy arena (see Table 4). This term was used to avoid the sometimes narrowly applied term "water manager." For example, Eugene Stakhiv (2008) defines water managers narrowly as individuals who implement policies, make strategic planning choices, and contributes to the management of operative water infrastructure. To provide reliable water services. While Stakhiv excludes policy analysts, researchers, and professors from the field of water management and focuses on water supply and treatment, the term "water policy actor" included these individuals as well as individuals involved in aquaculture, timber management, hydropower, and tribes. Respondents who completed the questionnaire were given the option to participate in a semi-structured interview, and additional respondents were identified via a snowball sampling approach.

To measure scarcity, OWRD's water availability database was used, which measures the amount of surface water available for future appropriation during each month of the year. This metric reflects both the current allocation of surface water to different uses, including instream flow, and legal infrastructure surrounding water rights in Oregon. OWRD uses the 80% exceedance rates to calculate whether water is available for new water rights. Thus, when water is available but not plentiful, new water rights may be conditioned. When water is not available, the Water Resources Department will deny applications for new water rights. Effectively, OWRD's water availability metric can "close" a basin to new water allocations, limiting the means available to users seeking access to water (Cooper, 2002).

The Oregon Water Resources Department measures Water Availability (WA) by subtracting existing storage (ST), out-of-stream consumptive uses (CU), and instream demands (IS) from the natural stream flow measurements (Cooper, 2002).

$$WA = Q_{NSF} - ST - CU - IS$$

To determine exceedance flows, the department uses measurements from existing stream gage records or from modeling. The Department accounts for consumptive use by “multiplying the maximum diversion rate allowed for the water right by a consumptive use coefficient,” (Cooper, 2002, 1). It is assumed that the portion of water that is not consumed is returned to the stream from which it was diverted. Instream water needs, including scenic waterway needs and instream water rights, diminish water availability upstream but not downstream from their designated point of “diversion,” (Cooper, 2002). Finally, water availability on the Willamette Basin Tributaries is limited by instream flow requirements in the main-stem Willamette River. The Columbia River Treaty establishes obligations for the United States to provide a minimum of 1,500 cfs at the mouth of the Willamette River (NOAA, 2008).

2.3 Site Selection

To address the impact of water scarcity on adaptive governance capacity, three sub-basins were identified: a high water scarcity sub-basin, a medium water scarcity sub-basin, and a low water scarcity sub-basin. These determinations were made using OWRD’s Water Availability Reporting System, which includes Water Availability Analyses for all major Willamette tributaries with federal dams. Water Availability is updated frequently and site selection was made using metrics as of 11/15/2016. Only sub-basins with federal dams were chosen, due to interest in the current Willamette Basin Review Study. Sub-basins with federal flood control dams were also considered because water storage capacity has a significant effect on local peak flows and summer water availability in the Basin, making the current management of the Willamette Project most critical in these sub-basins. Finally, it is important to note that OWRD’s Water Availability measure does not capture the full patchwork of federal laws, state laws, and administrative rules that impact water uses and water management within each sub-basin.

Figure 1. Sub-basins in the Willamette River Basin (Branscomb, Goicochea, & Richmond, 2002).

Figure 17. *WRB fifth field hydrologic units.*
(Not to scale)

2.3.1 Medium water scarcity: North Santiam Watershed

The North Santiam River Basin was selected as a medium water scarcity sub-basin. At the mouth of the North Santiam, there is no water available at the 80% exceedance level during the months of August, September, and October. Of the limiting watersheds in this sub-basin, there is no water availability above Trask Creek or above Morgan Creek from August-October. At the confluence of the North Santiam and the Santiam River, water is not available from August-October.

The North Santiam River is a 5th order stream and drains 777 square miles (Branscomb, Goicochea, & Richmond, 2002). The watershed has a total of 9 dams, (Payne, 2002), two of which are operated by USCE. Big Cliff Dam generated 46,352 megawatt hours of electricity in 1995. The dam does not receive any recreational visits and does not have a stated drawdown priority. Big Cliff is a re-regulation dam to provide uniform stream flow in the North Santiam. As a result, levels in Big Cliff Lake fluctuate as much as 24 feet daily. Detroit Reservoir stores a total of 455,100 acre feet at full pool. The dam includes two power generators that generated 393,539 million megawatt hours in 1995. The Reservoir has 7 public recreation areas and receives an average of 735,000 recreation visits a year. Due to the intense recreation pressure, USACE aims to keep lake levels high through Labor Day, making Detroit last in line for draw down priority. The dam is rarely drafted to augment instream flows on the main stem Willamette (OWRD, n.d.).

The Willamette Basin Program limits water use to domestic and livestock purposes on several tributaries to the North Santiam River, including "North Santiam River above USGS Gage 14181500; Mad Creek tributary to North Santiam River; Rock Creek tributary to North Santiam River [and] Stout Creek tributary to North Santiam River, (OAR 690-502-0110 (1) (b) (B) (xi, xii, xiii, ix)). The Program also limits the appropriation of new water rights, except for "domestic or livestock uses or waters to be legally stored or legally released from storage" on the following streams: "the North Santiam River or its tributaries above USGS Gage 14181500; the North Santiam River or its tributaries above USGS Gage 14183000; [and] the North Santiam River or its tributaries above USGS Gage 14184100. (OAR 690-502-0110 (2) (c, d, e)).

2.3.2 Low water scarcity: McKenzie River Watershed

The McKenzie River Basin was selected as a low water scarcity sub-basin because it has water available during all months of the year throughout the year. The limiting watersheds in this sub-basin all have water available throughout every month of the year. The McKenzie River is a 5th order stream and drains 1,338 square miles, (Branscomb, Goicochea, & Richmond, 2002). The river experiences highest flows in

February and is more snow-dominated than the North Santiam or the Middle Fork (Baker, Van Sickle, & White, 2002). The River experiences its lowest flows in late September, due to snow melt sustaining summer base-flow.

The McKenzie River has 9 dams (Payne, 2002), and two USACE operated dams. Blue River Dam which was constructed in 1969, is relatively new. The dam was constructed following the flood of 1964 for flood control and does not have any power generators. The dam stores 89,500 acre feet at full pool and receives 66,000 yearly recreation visits to the 1,240-acre lake. The dam is 3rd priority for draw down during the summer months. and Cougar Reservoir. Cougar dam is "the highest embankment dam ever built by the USACE," (OWRD, n.d.), at 452 feet tall. The dam stores 219,000 acre feet at full pool and has 2 power generators, which produced 172,171 MW hours in 1995. The 6 recreation areas receive similar visitation to Blue River (64,000) and the dam is also high drawdown priority (2nd only to Lookout Point).

The McKenzie River "from Clear Lake to Carmen Reservoir, from Tamolitch Falls to Trail Bridge Reservoir and from Trail Bridge Dam to Paradise Campground and the South Fork McKenzie River from the Three Sisters Wilderness boundary downstream to Cougar Reservoir and from Cougar Dam downstream to the confluence with the McKenzie River" are designated a state scenic waterways (OAR 690-502-0080 (1) (a, b)). Also, no appropriations of water "except for domestic or livestock uses or waters to be legally stored or legally released from storage" shall be made in "the South Fork McKenzie River or its tributaries above the South Fork McKenzie River…the Blue River or its tributaries above the Blue River…the McKenzie River or its tributaries above USGS State Engineer Gage 14162500…[or in] the McKenzie River or its tributaries above the intersection of the McKenzie River and Interstate Highway 5," (OAR 690-502-0080 (2) (a, b, c, d)).

2.3.3 High water scarcity: Middle Fork Willamette Watershed

The Middle Fork Willamette River was chosen as the high water scarcity sub-basin due to the availability of water only during the months of January and December. During all other months, there is a deficit of water available, suggesting that surface water has been over allocated in this sub-basin. The Middle Fork is a 5th order stream and drains 1,364 square miles, (Branscomb, Goicochea, & Richmond, 2002).

The Middle Fork has a total 8 dams (Payne, 2002) and 3 USACE dams. Lookout Point Dam stores a total of 455,800 acre feet of water at full pool and has 3 power generators that generated 297,325 million megawatt hours in 1995. The Dam has 6 public recreation areas and receives an average of 97,000 yearly recreation visits. Due to reduced recreation access and fluctuations in lake levels, Lookout Point is drafted first to meet flow requirements on the main stem Willamette. Oakridge hatchery and Dexter holding ponds, which are operated by ODFW, serve as mitigation for salmon spawning habitat due to the dam. Just 2.8 miles downstream of Lookout Point, Dexter dam serves as a re-regulating dam, but does not fluctuate as much as Big Cliff on the North Santiam, thus receives an average of 321,000 recreation visits per year. The dam also has one power generator, producing 87,797 million megawatts in 1995. Located on Fall Creek, a tributary to the Middle Fork Willamette, Fall Creek Dam stores 125,000 acre-feet at full pool and does not generate electricity. Because of moderate recreation (269,000 yearly visits), the dam is 5th for drawdown priority (OWRD, n.d.).

Only domestic and domestic commercial uses of water not to exceed .01 cfs are allowed on several streams in the Middle Fork watershed. These streams include "Fall Creek tributary to the Middle Fork of the Willamette River; Lost Creek tributary to the Middle Fork of the Willamette River," (OAR 690-502-0060 (1) (c) (A, B)). Also, uses are limited to "domestic, commercial use for customarily domestic purposes not to exceed 0.01 cfs, livestock, and public instream uses only" on the "Middle Fork of the Willamette River and tributaries above Dexter dam, (OAR 690-502-0060 (1)(d)). Water uses are also restricted to "domestic uses excluding irrigation of lawn and noncommercial garden, commercial use for customarily domestic purposes not to exceed 0.01 cfs, livestock and public instream uses" on "the waters of the natural lakes of the Middle Fork Willamette River sub-basin above 3,000 feet elevation," and no storage is allowed on these lakes, (OAR 690-502-0060 (1) (e)).

Finally, the Basin Program limits all new water uses on in the Middle Fork sub-basin to "domestic or livestock uses or waters to be legally stored or legally released from storage," in the "Middle Fork Willamette or its tributaries above the Willamette Middle Fork; Fall Creek or its tributaries above the Fall Creek; [and] the Willamette Middle Fork or its tributaries above the Willamette Middle Fork," (OAR 690-502-0060 (2)).

2.4 Sampling Procedures

This research used nonprobability sampling methods to identify water policy actors within each sub-basin. Nonprobability methods are appropriate for "labor-intensive, in-depth studies of a few cases," (Bernard, 2011). Research about adaptive water governance capacity includes understanding the specific challenges of water managers, which requires a small subset of the population who are expert informants on the issue. To identify these experts, this research uses purposive sampling (judgment sampling), an accepted method for intensive case studies for populations that are difficult to find.

To identify key water policy actors in the sub-basins, a list of stakeholder groups was compiled. Between three and five actors within each stakeholder group was identified. Watershed Councils, which are "locally organized, voluntary, non-regulatory groups established to improve the conditions of watersheds in their local area. Councils are required to represent the interests in the basin," (Oregon Revised Statutes 541.910). Each Watershed Council has a board of directors, which is representative of stakeholder interests in the watershed. Individuals on the board of directors for the Middle Fork Willamette Watershed Council, North Santiam Watershed Council, and McKenzie River Watershed Council were all sampled.

Leaders of interested parties who participated in Willamette Project reallocation discussions between 2011 and 2013 were also sampled. These interests included agriculture/irrigation, instream/environmental, cities/municipalities and federal and state agencies. Oregon Department of Agriculture, NRCS, and Irrigation District managers were sampled to represent agricultural interests. Soil and Water Conservation District managers within the sub-basins were also sampled. Finally, environmental groups were sampled by identifying local partners of larger regional and national environmental groups including Natural Resources Defense Council, Waterkeeper Alliance, Center for Biological Diversity, Water Watch of Oregon, and Oregon Wild.

Table 4. Stakeholder groups indicated on survey tool

Stakeholder groups
Municipal/potable water
Tribal
Irrigation
Environmental/conservation group
Watershed Council
Aquaculture
Recreation group
Timber industry
Hydroelectric
Scientist
Federal agency
State agency
County government
Local agency

2.5 Literature Review

In the past three decades, there has been an increasing focus on the governance arrangements that promote a sustainable ecological system and an acknowledgment of the feedback loops between human systems and environmental systems. In 1973, C.S. Hollings wrote his famous article, *Resilience and Stability of Ecological Systems*, which influenced a broad scope of literature and research on the importance of adaptation in managing for resilient environmental systems. At the same time, the adoption and practice of collaborative governance, as opposed to top-down, or hierarchical, government approaches, has been growing tremendously, especially with respect to environmental and natural resource issues and problems. It is these two literatures taken together that are instrumental in this research.

There are several key terms used in literature surrounding adaptive management, including Complex Adaptive Systems (Levin, 1998), Socio-Ecological Systems (Ostrom, 2009), Coupled Human-Natural Systems (Liu et al., 2007), and literature that explores the specific antecedents, elements, and outcomes of collaborative governance arrangements (Sirianni, 2009; Weber, 2010). This research does not differentiate between these terms, but acknowledges that ecological and human systems are inherently complex, interwoven, and interdependent.

Institutional adaptation is considered a necessary element of complex socio-ecological systems because it promotes the sustainability of ecological and social systems (Emerson & Gerlak, 2014). Adaptation has been defined by the World Commission on Environment and Development (1987) as meeting "the needs of the present without compromising the ability of future generations to meet their own needs." Adaptation is an active goal, and requires adaptive management, "a systematic process for improving management policies and practices by systemic learning from the outcomes of implemented management strategies and by taking into account changes in external factors in a pro-active manner," (Pahl-Wostl et al., 2010, 4).

Collaborative governance literature has also contributed to the understanding of the ability of multi-stakeholder groups to address complex natural resource governance issues and transition from conflict to cooperation. Collaborative governance is defined as "a governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage programs or assets" (Ansell and Gash 2007). Collaborative governance arrangements that fit this formal definition will not always be appropriate for every basin or watershed, but elements of collaborative governance have been identified as important for adaptive governance capacity[1].

This literature review will focus on the elements required for governance regimes to have a high capacity to practice adaptive management. This is called

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[1] It is worth noting that "baseline or mandatory participation upon which collaboration has spread was a result of litigation through participatory laws (Nie 2008, 144-148) and "despite the fact that most interests use the courts…there has been a concerted effort to frame conservationists as 'obstructionists' who serially abuse the judicial system." Collaboration does not occur in a vacuum, but rather within the larger regulatory framework, the weakening of which could "potentially undermine the usefulness and spread of collaboration in the future," (Nie 2008, 144-148).

"adaptive governance capacity," which refers to "the ability of a resource governance system to first alter processes and if required transform structural elements in order to better cope with experienced or expected changes in the societal or natural environment," (Pahl-Wostl, 2009, 572). The problem all too often, according to Pahl-Wostl et al. (2010), is that we design and employ "prediction and control regimes" that are "mechanistic and technocratic … [and replete with] strategies that neglect complexity and the human dimension" (571), which can and do lead to the failure of water management schemes.

Claudia Pahl-Wostl (2007), among others, argues that we need to change water management to incorporate human dimensions and increase adaptability and flexibility. This is supported by the assumption that the ability to predict ecosystem change is limited. Adaptive management requires "a sound understanding of what determines a basin's adaptive governance capacity," which is the focus of this study in the Willamette Basin. Folke et al. (2002) defines adaptive governance capacity as the "potential or capability of a system to adjust, via changes in its characteristics or behavior, so as to cope with novelty without losing options for the future," (52). Other definitions of adaptive governance capacity involve learning, flexibility to experiment, the willingness to adopt novel solutions, and the ability to cope with system stresses (Daniels & Walker 2001; Pahl-Wostl, 2009). This study focuses on four dimensions of adaptive governance capacity, 1) governance, 2) social capital, 3) human, financial and physical capital, and 4) management tools, which are addressed in the remainder of this literature review.

2.6 Social Capital

Relationships between individuals and stakeholder groups are important for information sharing, reducing transactional costs of collaboration, and building trust. Social capital can be defined as, "the value of trust generated by social networks to facilitate individual and group cooperation on shared interests and the organization of social institutions at different scales," (Brondizio, Ostrom, & Young, 2009, 255) and serves to "mediate the vertical interplay among institutional arrangements," (256). It is important to understand among which individuals and groups social capital is strong, however, as social capital can be created among a "limited networks of individuals or cliques that engage in mutual reciprocity at the expense of the larger group they are supposed to be serving," and "social capital at one level may enhance or retard social capital at another level," (264). This study focuses on networks, trust, reciprocity, and level and function of conflict as the key elements of social capital.

2.6.1 Networks

Adaptive water management regimes address management at multiple scales, which requires non-hierarchical institutional structures. Raul Lejano and Helen Ingram (2008) define social networks as "patterned relationships that bridge, cross, and blur organizational boundaries," (250). Additionally, decentralized control is important because it facilitates multi-level collaboration, flexible resource allocation to multiple users, and it means that "adaptation is not controlled by a central unit," (Pahl-Wostl, 2009, 53). Networks that are decentralized have the capacity to be accountable to a broad range of interests, and to demonstrate "a capacity for effective self-governance," (Weber, 2003, 14). The decentralized nature of networks also increases their diversity and their "potential for self-organization," (Pahl-Wostl, 2009, 53).

Networks increase monitoring and enforcement capacity and can solve conflicts and promote cooperation (Weber, 2003). They can be formally created, or may form over time, creating lasting resilience when formal structures break down (Lejano & Ingram, 2008). For networks to be resilient, members must have continued interaction; specifically face to face interactions add to the richness of experienced shared among network members, and knowledge sharing strengthens networks by making them "not merely teleological, but constitutional –they become part of how people understand themselves," (253). "Umbrella Groups" are groups that add cohesion to networks and can bring together multiple often competing interests (Ansell & Gash, 2008). Umbrella groups "often include community collaborations among their membership," which can lead to "complex hierarchies of collaboration with individuals and organizations sometimes appearing at more than one level," (Huxham & Vangan, 2000, 343).

Another complexity of individual involvement in networks concerns when staff are employed by the collaboration because "if they are formally employed by one of the member organizations, they may be subject to conflicting accountabilities to the employer and to the collaboration," (Huxham & Vangan, 2000, 347). Individuals involved in collaborative arrangements "sometimes clearly represent their organization and have its backing and resource to draw upon [but] in other situations organizations are relevant only to the extent that they allow the individuals to participate in a personal capacity," (Huxham, Vangan, & Eden, 2000, 342). This challenge is not always predictable because "the degree to which a whole organization is involved, rather than just an individual, generally varies from one member to another" (342).

2.6.2 Trust

Trust is one of the most difficult concepts to measure, yet one of the most important elements of collaboration (Stern & Coleman, 2014; Leach & Pelkey, 2001). Trust is commonly defined as "a psychological state in which one actor (the trustor) accepts some form of vulnerability based upon positive expectations of the intentions or behavior of another (the trustee), despite inherent uncertainties in that expectation," (Stern & Coleman, 2014, 118-119).

Commitment to collaborating creates trust in collaborative efforts through mutual recognition of interdependence, shared ownership of the process, and openness to exploring mutual gains, but this trust is partly endogenous to the collaborative process itself (Ansell & Gash, 2008). Another element of trust in collaborative arrangements is the inclusiveness of the arrangement because inclusion gives collaboration legitimacy in the public sector. "If a collaborative process is perceived to exclude relevant stakeholders, it may be viewed as illegitimate, a conclusion that will threaten its political viability" (Johnston et al. 2010, 700). However, inclusion is not simply a requirement that must be obtained, but a process that must be thoughtfully managed, taking into consideration varying degrees of participation. Overall, trust building can be a very time-consuming process (Ansell & Gash, 2008).

The development of trust can also be encouraged through institutional arrangements that create consensus power, which grants participants a "veto power over decisions…thereby increasing legitimacy, lowering implementation resistance, engendering self-enforcement, and respecting minority rights" (Weber 2003, 11). Studies on procedural justice have shown that trust in process affects the perceived fairness in outcomes, even when outcomes are not favorable, (Lind & Tyler, 1988; Leach & Sabatier, 2005). While consensus processes can be perceived as fair and can lead to increased support for decisions (Chamley, Long, & Lake, 2014), they can also lead to lowest common denominator solutions (Leach & Pelkey, 2001) and can be barriers to flexibility (Leach & Pelkey, 2001). Trust and procedural clarity can be enhanced by hiring a professional facilitator. This is preferable to "placing an agency expert in the role of facilitator, especially when he or she lacks the "time, neutrality, training, or experience" (Leach & Pelkey, 2001, 383). Most importantly, the decision-making process should be transparent and have clear ground rules and trust can be built by "early joint exploration of the overall value of collaboration," (Ansell & Gash, 2008, 561).

2.6.3 Reciprocity

Reciprocity is an element of trust and refers to the expectation that a favor will be returned. In a reciprocal relationship, energy that is invested in an interaction such as time, information, and resources will be returned. Reduced transaction costs for industry and agencies can serve as incentives for participating in collaborative governance (Weber, 2012) because in collaborative arrangements, reciprocity can improve the efficiency of natural resources management through sharing resources and in kind donations. For example, collaborative restoration efforts on Whychus Creek have harnessed resources from a local irrigation district, which reduced overall cost and strengthened relationships between irrigators and the local Watershed Council. Reciprocity can build social capital through investing in new opportunities with the potential for greater, long-term gains (Brondizio, Ostrom, & Young, 2009).

2.6.4 Conflict

Managing conflict is important for promoting collaborative learning (Daniels & Walker, 2001). History of past conflict or cooperation effects trust among stakeholders who come to the table to collaborate (Ansell & Gash, 2008). Specifically, a pre-history of conflict "is likely to express itself in low levels of trust, which in turn produce low levels of commitment, strategies of manipulation, and dishonest communication," (443). However, low to medium levels of conflict can encourage collaborative watershed partnerships (Leach & Pelkey, 2001). Some studies have found that "high conflict situations characterized by low trust [can] still be managed collaboratively if the stakeholders [are] highly interdependent" (Ansell & Gash 2008, 563; Ansell & Gash, 2008; Leach & Pelkey, 2001). For example, problem severity, the degree of "wickedness of the problem," and even the presence of a hurting stalemate can be antecedents to collaboration (Weber, 2003; Ansell & Gash, 2008). In the case of past conflict, trust building may be a focus of early collaborative efforts, (Ansell & Gash, 2008). On the other hand, history of collaboration "can create social capital and high levels of trust that produce a virtuous cycle of collaboration, (Ansell & Gash, 2008, 553). However, in the absence of shared goals, awareness of impacts, or a convening leader, conflict can occur even with strong social capital. For example, if stakeholder groups have strong social capital within their group but not across groups, they can mobilize to pursue opposing goals (Brondizio, Ostrom, & Young, 2009; Ansell & Gash, 2008). Thus, strong ideological differences can serve as an obstacle to collaboration (Ferranto et al. 2013).

2.7 Human, financial, and physical capital

Human, financial, and physical capital make up the intangible infrastructure of knowledge and skills as well as the tangible infrastructure, including water treatment plants, wastewater treatment plants, road culverts, fish passage structures, dams, etc. Knowledge and technical expertise allow new and existing technologies to be implemented and allow for the creation of new knowledge when people are equipped with research skills and access to information. Awareness of impacts is an element of human capital because it captures knowledge of complex natural and human systems.

For example, if an individual is not aware that groundwater and surface water are connected, he or she will be unable to understand that their individual well use may influences surface water users in a nearby stream. When water users and water managers have a limited knowledge of the system they are managing and the impacts their management decisions have on other resource users, management may become disjointed and moot. Finally, physical infrastructure is an important element of a system's vulnerability. If water managers do not have adequate infrastructure, they may not be able to adapt to increases in population or changes in water quality. Inadequate physical infrastructure can also harm aquatic species where fish passage structures are not present.

2.7.1 Awareness of Impacts

Awareness of biophysical impacts of management decisions is necessary for stakeholders to recognize their interdependence in the water management system (Pahl-Wostl, 2009) and is necessary for crafting policy that fits the social and ecological context. Successful adaptation requires that decision makers have information and understanding of potential future impacts of past and current decisions. For example, lack of awareness surrounding climate change led to policies that promoted technologies that exacerbated the problem (Polasky et al., 2007). To achieve awareness of impacts of policy and management decisions, the effects of management decisions must be monitored through space and time, with adequate baseline information about the social-ecological system. Monitoring should not be limited to natural systems, but should include reflecting on the effects of decision and policy impacts, measuring outcomes against goals, and adjusting policies and adapt management practices, promoting iterative learning (Polasky et al., 2007).

2.7.2 Information

Adaptive management requires both "qualitative and quantitative indicators of whole ecosystem states and ecosystem services," (55). Information about the ecological system should include knowledge of thresholds that inform monitoring and information should be at the appropriate scale and resolution (Karkkainen, 2002).

Local groups may have increased "capacity to generate fine-grained, high resolution information at more localized scales," which should be harnessed (Karkkainen, 2002, 21). Watershed partnerships emphasize "the importance of adequate scientific information or understanding…[and] effective communication or education among stakeholders or between the partnership and the general public," (Leach & Pelkey, 2001, 381). Adequate technical information also aids stakeholders in finding the best solutions (Ostrom, 1990).

Presence of sufficient data alone is not adequate; data must be shared openly, be accessible, and be viewed as legitimate to enhance trust among partners (Leach & Pelkey, 2001; Brondizio, Ostrom, & Young, 2009; Daniels & Walker, 2001). In hierarchical systems, information sharing is fragmented, creating gaps in understanding and the lack of integration of knowledge (Pahl-Wostl, 2009). To close these gaps and strengthen adaptive governance capacity, information must be shared and integrated, so new information gathering can focus on knowledge gaps. Monitoring programs that involve citizens can increase available information about the system as well as build social capital and increase understanding of the ecological system, (Chamley, Long, & Lake, 2014).

2.7.3 Human capital

Human capital is "the acquired knowledge and skills that an individual brings to an activity," (Brondizio, Ostrom, & Young, 2009, 260). Human capital is important in the context of social capital, which can increase human capital and bestow legitimacy upon individuals' knowledge. Social networks can increase human capital through knowledge sharing across groups of different types of individuals, exposure to new ideas, knowledge co-production, mediation, translation, and negotiation (Lejano & Ingram, 2008; Brondizio, Ostrom, & Young, 2009). However, "forms of knowledge valued at one level may not be recognized as legitimate at another level or by a different group," (Brondizio, Ostrom, & Young, 2001, 260). Short tenures and high turnovers, which can reduce an organization's human capital, have been identified as barriers to collaboration (Ferranto et al. 2013).

2.7.4 Financial capital

Financial capital is one of two (along with leadership, discussed below) most frequently cited factors for success in watershed partnerships (Leach & Pelkey, 2001). Collaboration can increase available financial funds, making goal implementation more feasible, (Rogers & Weber, 2010). Watershed partnerships identify several resources-related themes that are important for success, including "adequate time, support from the legislature, support from agency managers, cooperative and committed participants, adequate funding, and miscellaneous community resources (including wealth, a diversified economy, and an older, more experienced population)," (Leach & Pelkey, 2001, 382). Funding resources for collaborative efforts also need to be stable and promote adequate staffing (Chamley, Long, & Lake, 2014), and be flexible (Pahl-Wostl, 2009). When financial resources are "concentrated in structural protection (sunk costs)," change in the water management system is difficult or impossible. Thus, adaptation is aided by diversified financial resources that use "a broad set of private and public financial instruments," (Pahl-Wostl, 2009, 55).

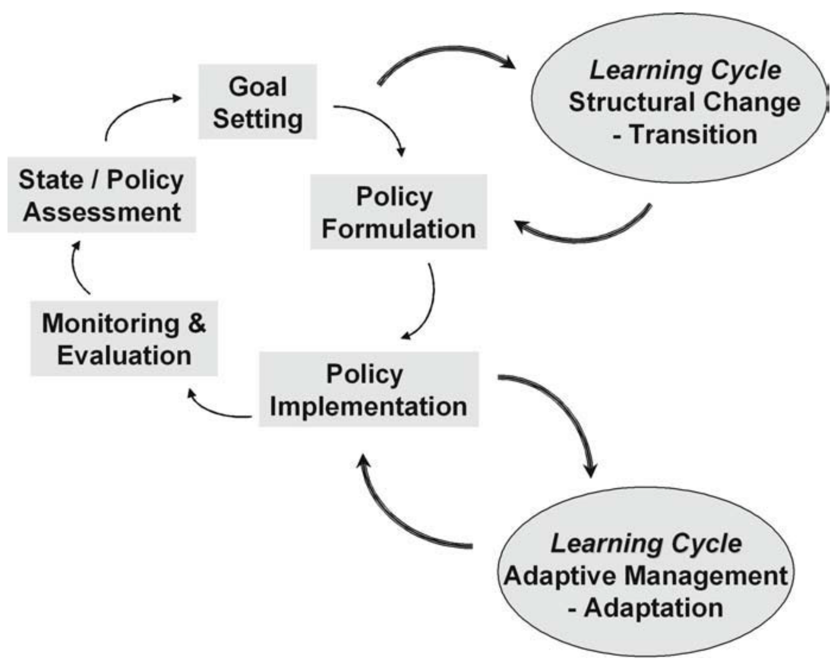
2.7.5 Physical capital

Physical capital is "the stock of human-made, material resources that can be used to produce a flow of future income," (Brondizio, Ostrom, & Young, 2009, 260). Physical capital can both constrain and create opportunities for management (Brondizio, Ostrom, & Young, 2009). For example, infrastructure that is traditionally "massive, centralized," and has "single sources of design" is less capable of adaptation, (Pahl-Wostl, 2009, 55). Instead, infrastructure that is designed to the appropriate scale, is decentralized, and includes "diverse sources of design," (55) is more capable of adapting to increasing environmental variability. Infrastructure "lock-in" can occur when existing infrastructure stifles change and creates positive-feedback loops. An example of this has been called "levee disease" (Find quite in RRNW notes) where the installation of levees along the Mississippi River has caused increased development along the floodplain. The levees, which cannot withstand large flood events, eventually fail, leading to the construction of new levees and the eventual future infrastructure failure. Another potential impact of physical capital that is misplaced is the "dominance and control of resources by particular groups," which can have "lasting effects on patterns of access and distribution," (Brondizio, Ostrom, & Young, 2009, 260). Finally, physical capital requires human capital in the form of technical expertise to operate and maintain infrastructure as well as social capital to ensure that communities benefit from that infrastructure (Brondizio, Ostrom, & Young, 2009).

2.8 Management tools and strategies

Integrating learning cycles into water management requires the creation of policies that are adaptive, which in turn requires space for innovation and the creation of goals that are measurable and can be monitored and evaluated. Based on information gathered from assessing the implementation of goals through policy or other project implementation, new goal can then be established and new policy then formulated in turn (Pahl-Wostl, 2009). Figure 2 below introduces the "Learning Cycle" for structural change and transition.

Figure 2. Learning Cycle (Pahl-Wostl, 2009).



2.8.1 Innovation

Adaptive governance capacity increases as the number of management tools that prepare for and respond to variation and change in the system. Traditional management tools and strategies that respond to environmental variability such as large dams, which increase supply during drought and decrease flood risk during times of abundance. The ability of infrastructure to respond to increases in variability due to climate change is limited, however. Therefore, adaptation in water management requires "increasing the ability of the water system to operate under a wider range of environmental variation," (Pahl-Wostl, 2009, 52), which requires new management tools. For example, "instead of building larger reservoirs to maintain supply in case of drought, management of demand is used to reduce and/or shift the requirements of certain water uses if supply is scarce," (52).

An examination of the California Bay Delta's (CALFED) Water Use Efficiency Program found that lack of innovation stifled program success (Lajano & Ingram, 2008). Regulatory design that created a "centralized coordinating body," and member agencies who only agreed to those Best Management Practices that were cost-effective for the agency (Lejano & Ingram, 2008, 658). The "upper limit of conservation" that the program achieved through BMP implementation was "set by what is calculated as cost effective at the local level," which hindered the "employment of local initiative and knowledge in solution generation," (658). In contrast, CALFED's Environmental Water Acquisition Program was more innovative (and ultimately successful), because of its voluntary, decentralized institutional structure that required strong communication. The inclusive nature of the process encouraged open dialogue and innovation, creating a space where new narratives could emerge. This was achieved through frequent meetings, which built trust, created new language, and built mutual understanding of the challenges each group faced in meeting their day-to-day water management goals. The program also encouraged innovation by shifting traditional management roles: "fish managers manage not just fish, but also water assets, and… [had to] consider risks to both simultaneously," (Lejano & Ingram, 2008).

2.8.2 Goals

Clear goals allow managers to evaluate and monitor the success of their management, in order to restructure and improve management strategies when necessary. Collaborative natural resources management literature is divided on the role of goals in sustainable natural resources management. Having shared goals can mean having a common understanding of the problem definition and the tools and information required to address the problem or having a common mission or common purpose, (Ansell & Gash, 2008). Overall, it means that "at some point in the collaborative process…stakeholders must develop a shared understanding of what they can achieve together," (560). Weber (2014) has argued that increased clarity of goals lead to smoother implementation of those goals. Leach & Pelkey (2001) found that many watershed partnerships agree that goals need to be manageable in number and attainable. Collaborative efforts are successful when there is a clear mission, common problem definition, and identification of common values (Ansell & Gash, 2008). However, there are inherent paradoxes in the creation of goals in a collaborative resources management arena. Successful collaborations, for example, "allow participants to maintain separate, diverse goals, while developing and working toward the accomplishment of common goals," (Connelly, Zhang, & Faerman, 2008, 24).

2.8.3 Ability to adapt

An adaptive management approach, requires "explicitly embracing conscious experimentation in the design of policy measures," (Karkkainen, 2002, 38-39). Thus, an important element of adaptive governance capacity is flexibility within the legal system. Laws are often conceptualized as rigid however flexibility is inherent in the legal system in several ways. Laws create constraints for governing institutions, both by inhibiting certain actions and by requiring others. Discretion is the flexibility within those constraints to interpret and implement laws and policies, which can be a function of political will as well as individual awareness of available discretion (Amos, 2014). Discretion can be exercised or unexercised, creating opportunities and constraints for legal adaptation. Unexercised discretion can lead to ossification of the law, prohibiting the law from being used as a proactive problem-solving tool. For example, administrative law can serve as a pool of unexercised discretionary authority.

Adaptation also involves "social learning," which is "an exploratory, stepwise search process where actors experiment with innovation until they meet constraints and new boundaries," (Pahl-Wostl, 2009, 358). This process involves revisiting values and decisions and reflecting on the success of management decisions and institutional design. Thus, social learning goes beyond simply having tools and capital to adapt; it requires institutional awareness. Water system adaptation requires that "new information must be available to the system and the system must be able to process this information" and "the system must have the ability to change based on processing new information," (53).

2.9 Governance

Governance in adaptive water management regimes is polycentric, horizontal, and has broad stakeholder participation (Pahl-Wostl, 2010). Polycentric governance systems are better suited for adaptation because "smaller systems are easier to manipulate than big ones [and] the existence of many smaller systems…opens up opportunities to make use of natural or quasi-experiments to explore the consequences of different government arrangements," (Brondizio, Ostrom, & Young, 2009, 270). Polycentric governance systems can be defined as "complex, modular systems where differently sized governance units with different purpose, organization, spatial location interact to form together a largely self-organized governance regime," (Pahl-Wostl, 2009, 357).

2.9.1 Authority

Authority in adaptive governance regimes does not reside within a single level of government (Pahl-Wostl, 2009, 357). This mirrors the role of authority in collaborative governance regimes, which are characterized by increased involvement and shared power among public and private actors in natural resources management, and which is established through consensus-based and collaborative decision processes (Weber, 2003; Ansell & Gash, 2008). Adaptive governance systems have high levels of both vertical and horizontal integration (Weber, Lovrich, & Gaffney, 2006; Pahl-Wostl, 2010). This requires balancing levels of authority when the roles of actors and their respective authority become blurred (Pahl-Wostl, 2009, 357).

Centralized governance, on the other hand, has been associated with reduced social learning and adaptive governance capacity (Huntjens et al., 2008, 2010; Pahl-Wostl et al., 2007; Brondizio, Ostrom, & Young, 2009). For example, groups competing over authority can exclude others from access to a common pool resource, creating a problem of "subtractability," where one stakeholder's use of the resource reduces the amount of the resource available to other interests, (Moran & Ostrom, 2005). Thus, adaptive governance capacity must balance between vertical capacity (reaching compliance with state and federal laws), and horizontal capacity (relationships across a given management level e.g. social capital), (Weber, Lovrich, & Gaffney, 2006). This can be a challenge when scaling up collaborative arrangements because groups may face the challenge of "recognizing shifts in jurisdiction and authority over resources, including overlaps, at different levels," as well as accounting for compliance with rules when "level of compliance decreases as you move from local to international levels," (Brondizio, Ostrom, & Young, 2009, 255). Creating or allowing redundancies in a poly-centric governance arrangement improve the system resilience, (Pahl-Wostl, 2009).

2.9.1 Engagement

More robust and diverse participation in natural resources, where citizens, private entities, and public entities come to the table to discuss management challenges and goals is an important element of adaptive governance capacity. For example, civic engagement increases innovation and mobilization of social capital. Also, increased engagement and collaborative decision-making processes in natural resources management can lead to better outcomes for ecosystems than traditional consultation (Weber, 2003). One of the reasons for this success is that increased engagement creates opportunities for knowledge sharing, capital sharing, and holistic management goals that benefit multiple stakeholder groups. While there may be legal and financial barriers to agency participation, engagement of federal and state agency staff with technical expertise is especially important for adaptive governance capacity (Leach & Pelkey, 2001; Chamley, Long, & Lake, 2014). Normative theories of democracy posit that engagement also helps individuals to see beyond their own needs to those of the broader community, which can increase a community's capacity to address collective problems (Weber, 2003).

Engagement can also lead to increased accountability. Legal scholar Adell Amos explains that, "the level of accountability for discretionary decisions increases when non-governmental entities are involved in the decision-making process," (Amos, 2006, 1281). Additionally, collaborative natural resources management remains accountable to local, state, and national laws in part because individuals who participate retain their independence (Weber, 2003; Ansell & Gash, 2008). For example, an environmental organization that participates in collaborative natural resources management (in the United States) retains its right to use legal tools if his or her organization's goals are not being met.

Engagement in water resources management is not always an easy or attainable goal. Diversity and inclusive participation in collaborative arrangements has been identified as an important factor for success, although some watershed partnerships have stated that this can create serious problems, (Leach & Pelkey, 2001). Lack of continuity in membership can also weaken a collaborative arrangement (Ansell & Gash, 2008). Stakeholders with different levels or organizational and institutional support can affect involvement in collaborative efforts if credible commitment is questionable. Credible commitment, one of the necessary components of collaborative governance, "means that participants will refrain from reneging on deals once agreed and will not use private information gained through cooperation for their own advantage," which can then affect trust among members (Weber, 2003). Credible commitment also requires active commitment through the demonstration of "clear and consistent support for collaboration throughout their hierarchy or group," the willingness of stakeholder groups to send representatives for the long-term, and a more general commitment to "place." Furthermore, it requires commitment to one's own group through retaining group independence that is balanced by recognizing mutual interdependence with other group members.

2.9.2 Leadership

In a meta-study of watershed partnerships, having an effective leader or facilitator was most frequently cited as important for success (Leach & Pelkey, 2001). Qualities that successful leaders in collaborative arrangements include, "cultural competencies in establishing and managing collaborative efforts, including respect for local knowledge, flexibility, humility, and understanding of the importance of long-term commitments," (Chamley, Long, & Lake, 2014, 674; Fortmann and Ballard, 2011). Leaders are also individuals who "see cooperation as a viable option…shape how issues and incentives are defined, [and] choose group members and manage group conflict," (Faerman, McCaffrey, & Van Slyke, 2001, 383). Leaders can become a champion of the collaborative process when instead of developing "strategies to solve problems per se" they aim to "achieve the *strategic synergies* between participants that will eventually lead to finding innovative solutions," (O'Brien, 2010, n.p.). Finally, leaders must also balance several paradoxical goals such as "recognize[ing] the importance of both diversity and unity in the collaboration," being "authoritative, without being authoritarian," and "lead[ing] best by encouraging followers to lead," (Connelly, Zhan, & Faerman, 2008, 24). This does not mean that a single leader is required, rather leaders that are able to recognize when their leadership skills are required and when to allow another leader step in (Connelly, Zhang, & Faerman, 2008, 22).

Each of the four major elements of adaptive governance capacity (1. social capital; 2. human, financial, and physical capital; 3. management tools and strategies; and 4. governance) are important for adaptive governance capacity. As described above, each element was operationalized in a questionnaire with several measures of each concept (Pakenham-Stevenson, 2017). All of the elements are connected, thus a weakness in one area is a weakness in overall adaptive governance capacity. On the other hand, an area of strength, such as trust, can be leveraged to improve other elements of adaptive governance capacity.

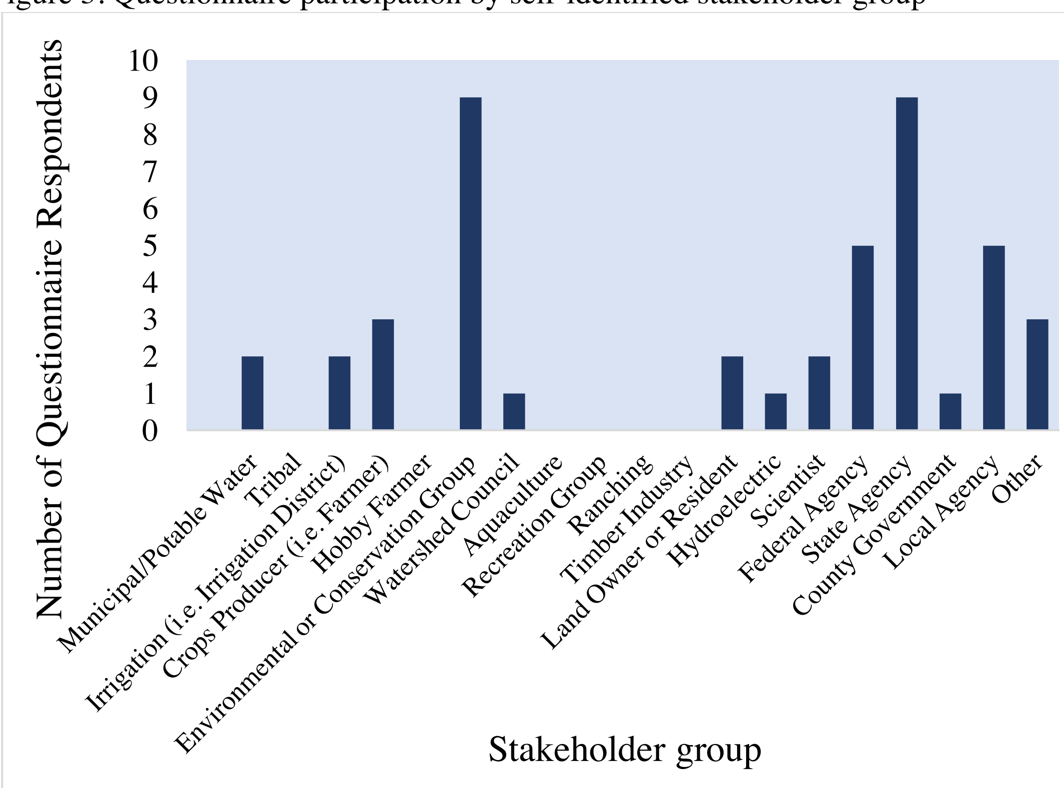
CHAPTER 3: QUANTITATIVE RESULTS

In the winter of 2017 a questionnaire was sent to water policy actors in the Willamette Basin, who were identified using purposeful sampling techniques, to gather quantitative measures of the four main elements of adaptive governance capacity: 1) social capital, 2) human, financial, and physical capital, 3) management tools and strategies, and 4) governance. A total of 119 surveys were sent via email to water policy actors and 46 surveys were completed for a response rate of 39%. When asked which watershed respondents most strongly associate with, seven (15.2%) respondents associated with the North Fork Santiam River, nine (19.6%) respondents associated with the McKenzie River, and five (10.9%) respondents associated with the Middle Fork Willamette River. A total of 25 (54%) respondents chose "other" and indicated the Willamette main stem, the Willamette Basin or another watershed in the Willamette Basin. Respondents were asked what one group or organization they most strongly associate with (see Figure 3). The stakeholder groups with the highest participation in the questionnaire were environmental or conservation groups and state government with 9 (19.6%) participants each.

Due to small sample size, exploratory factor analysis was not conducted, therefore subsequent reliability analyses were not completed. However, the same questionnaire was tested for reliability using exploratory factor analysis and confirmatory factor analysis in previous research in the Upper Deschutes River Basin and the Snake River Basin in Idaho, with all items having a Cronbach's alpha > .73 and factor loadings <.60 (Pakenham-Stevenson, 2017). Results for the main unit of analysis (the Willamette River) and the three nested units of analysis (North Santiam, McKenzie River, and Middle Fork Watersheds) were not collapsed into one since the three nested units of analysis cannot be assumed to be representative of all sub-basins in the Willamette Basin. Data was analyzed by watershed, and by the main stem Willamette category, which included water managers operating at a basin-wide scale.

In the tables below, N refers to the number of responses received for each question. As is often the case with survey research, some participants not answer all questions. Questionnaire responses with a mean equal to or higher than 4.00 indicated "strong" adaptive governance capacity while questionnaire responses with a mean equal to or lower than 3.00 indicated "weak" adaptive governance capacity. In describing results, means were rounded to the tenth decimal for clarity of explanation. For example, a mean of 2.60 was rounded up in explanation and described as "neither agree nor disagree," which is the language that corresponds with a mean of 3.00 on the questionnaire scale. It is important to note that the significance of the difference between each mean was not tested for each question response, but was tested on a watershed scale (see Tables 25 through 36). With small response rates for each watershed, these are not definitive assignments, but they help to interpret results to indicate areas of potential strengths and weaknesses in the Willamette Basin water management regime. Furthermore, while questions on 5-point scales were treated as continuous variables, individuals will treat the scales differently and distances between the means cannot be assumed to be equal because questions are operationalizing complex concepts. The questionnaire tool has been tested by a previous empirical study and it uses a standard social science design (Pakenham-Stevenson, 2017).

Figure 3. Questionnaire participation by self-identified stakeholder group



3.1 Results: Main stem Willamette

3.1.1 Social capital: Main stem

Respondents who identified most strongly with the main stem Willamette when thinking about their involvement in water resources have relatively low trust in water management decisions like their sub-basin counterparts. Results indicate overall adequate reciprocity but inadequate network strength and a history of conflict with some negative impacts. There were several groups that were generally trusted, including scientists (4.32), watershed councils (4.18), and tribal groups (4.00), and several groups that are generally distrusted, including hydroelectric (2.59) as well as irrigation (2.91), farmers (2.86), hobby farmers (2.73), and ranching (2.64) (See Table 44). Respondents generally distrust water management decisions (2.65), distrust stakeholders to keep their needs in mind (2.13), and disagree that stakeholders are willing to sacrifice their short term needs to meet long-term needs (2.48). However, respondents do feel a personal obligation to contribute to water management (4.42), to help educate others (4.42), and they agree that they know their behaviors impact others (4.25) and want to do more to ensure solutions are found (4.17) (See Table 5). Results indicate that there has been moderate conflict in the main stem Willamette over the past ten years (3.43-3.64) and respondents expect extreme conflict in the next ten years (4.26). In contrast to the North Santiam, McKenzie, and Middle Fork Willamette where conflict has had mixed results with a generally positive influence, more respondents in the main stem Willamette indicated that conflict has caused animosity (64%) than it has motivated people to work together (40%) or helped people to collectively solve problems (12%) (see Table 6). Over half of respondents (54%) agree that the most important water use over the next 20-50 years is the availability of clean, potable water (See figure 4). While many respondents also agree that a high functioning ecosystem is the most or second-most important water use in the future, a vibrant agricultural economy is most or second-most important to 16% of respondents.

Table 5. Social Capital: Main stem

Trust decision-making[1]	N	Mean	Std Deviation
Trust water management decisions	23	2.65	0.98
Trust stakeholders to keep my needs in mind	23	2.13	0.76

Reciprocity[2]	N	Mean	Std Deviation
Personal obligation	24	4.42	0.58
Responsibility to help educate others	24	4.42	0.65
Know that my own behaviors impact others	24	4.25	0.74
Do more to ensure water solutions are found	24	4.17	0.82
Feel powerless	24	3.21	0.42

Networks[2]	N	Mean	Std Deviation
Share information	24	3.21	0.88
Supportive of each other	23	3.22	0.95
Willing to work together to solve problems	23	3.52	0.73
Willing to sacrifice	23	2.48	0.95

Conflict[3]	N	Mean	Std Deviation
In the last year	23	3.43	0.79
In the past 5 years	22	3.64	0.49
In the past 10 years	1	3.62	0.50
Expected level of conflict in next 10 years	23	4.26	0.62

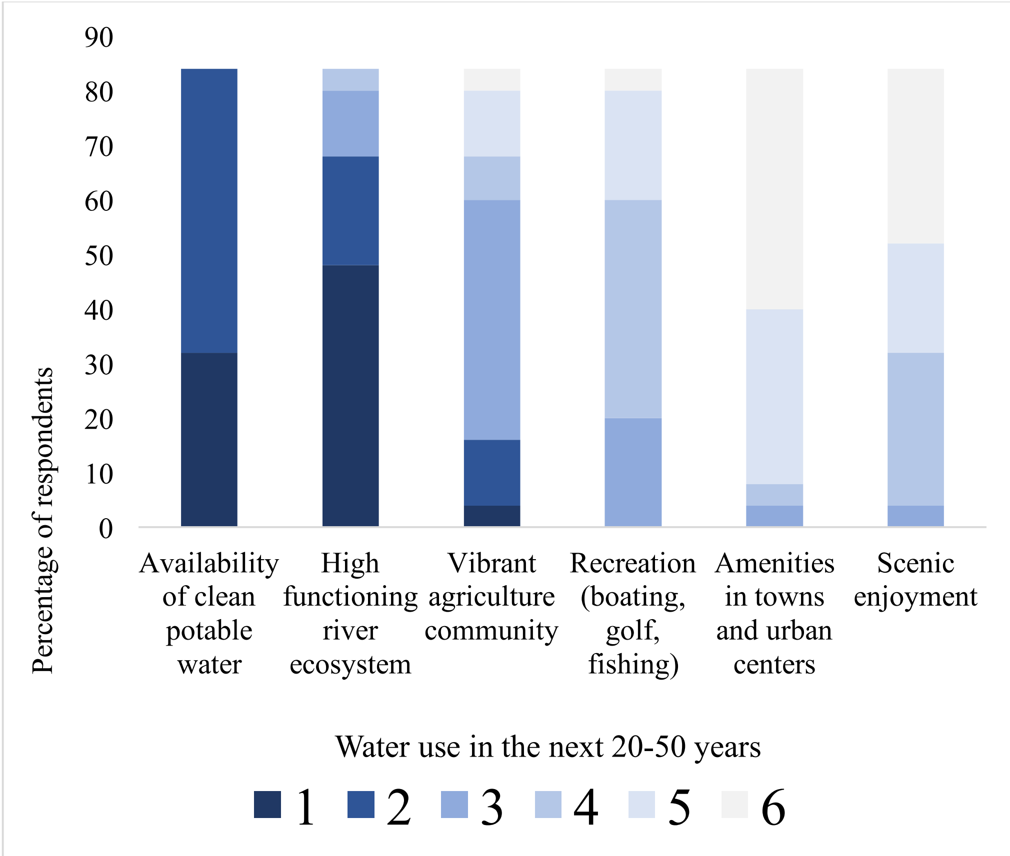
[1] Trust was measured on five-point scale from strongly distrust (1) to strongly trust (5).
[2] Reciprocity and networks were measured on a five-point scale from strongly disagree (1) to strongly agree (5).
[3] Conflict was measured on a five-point scale from little to no conflict (1) to extreme conflict (5).

Table 6. Effect of conflict on stakeholders working together: Main stem

Effect of conflict[1]	N	Percentage
Created lasting divides between stakeholders	3	12%
Caused some animosity between stakeholders	16	64%
No impact on how people work together	2	8%
Motivated people to work together	10	40%
Helped people to collectively solve problems	3	12%

[1] Effects of conflict were measured on a scale of strongly disagree (1) to strongly agree (5).

Figure 4. Ranked most important water use: Main stem



3.1.2 Human, financial, and physical capital: Main stem

Results for the main stem indicate a lack of adequate financial (2.22) and physical capital (2.00) and a strong awareness of the impacts of human factors that influence water management (4.00). Respondents neither agree nor disagree that they have the capacity to plan and manage outreach activities (3.25), report on outcomes (3.13) or analyze management outcomes (3.04). They neither disagree nor agree that they their stakeholder group has sufficient access to information (3.38) and technical expertise (3.54). Respondents generally agree that they have an awareness of the economic factors that influence water management (3.92), the impacts of biophysical changes on water resources (3.88) (see Table 7).

Table 7. Human, financial, and physical capital: Main stem

Human capital	N	Mean	Std Deviation
Capacity to plan and manage outreach activities	24	3.25	1.25
Capacity to report on outcomes	24	3.13	1.19
Capacity to analyze management outcomes	24	3.04	1.23
Information	**N**	**Mean**	**Std Deviation**
Sufficient access to information	24	3.38	1.47
Sufficient access to technical expertise	24	3.54	1.35
Awareness of impacts	**N**	**Mean**	**Std Deviation**
Aware of economic factors	24	3.92	1.10
Aware of the impact of biophysical changes	24	3.88	0.99
Aware of human factors	24	4.00	1.02
Financial capital	**N**	**Mean**	**Std Deviation**
Adequate financial resources available	23	2.22	1.04
Physical capital	**N**	**Mean**	**Std Deviation**
Adequate infrastructure needed to optimize water use	23	2.00	0.80

Human, financial, and physical capital were measured on a five-point scale from strongly disagree (1) to strongly agree (5).

3.1.3 Management tools and strategies: Main stem

Results from the main stem indicate several weaknesses in the application of management tools and strategies and ability to adapt to changes (see Table 8). While respondents generally agreed that their stakeholder group is innovative (3.83), has technologies or techniques to share (3.77), and values knowing about new technology (3.92), respondents neither agree nor disagree that their stakeholder group is willing to try new things to meet multiple needs (3.04). Respondents neither agree nor disagree that there are measureable goals (3.20) or that these goals reflect the needs of the watershed (3.00). Respondents generally disagree that progress is evaluated against those goals (2.75), and that stakeholders have a firm grasp of opportunities and alternatives (2.57). While respondents neither agree nor disagree that their watershed can adapt to changes (3.22) and to capitalize on change (3.27), they do not agree that their watershed can adapt to changes in supply and demand (2.13). Use of specific management tools and strategies and support for voluntary and regulatory use of management tools is located in Appendix C.

Table 8. Management tools and strategies: Main stem

Innovation	N	Mean	Std Deviation
Willing to try new things to meet multiple needs	23	3.04	0.77
Knowing about new technology is important	24	3.92	0.78
My stakeholder group is innovative	24	3.83	0.96
My stakeholder group has techniques to share	22	3.77	0.87
Goals	**N**	**Mean**	**Std Deviation**
Measureable water management goals	20	3.20	0.95
Progress is evaluated against those goals	20	2.75	0.97
Goals reflect the needs of the watershed	19	3.00	1.05
Stakeholders have a firm grasp of opportunities	21	2.57	0.75
Ability to adapt	**N**	**Mean**	**Std Deviation**
Ability to adapt to changes	23	3.22	0.10
Ability to capitalize on that change	22	3.27	0.99
Adapt to changes in supply and demand	24	2.13	0.80

Management tools and strategies were measured on a five-point scale from strongly disagree (1) to strongly agree (5).

3.1.4 Governance and institutions: Main stem

Results show several weaknesses in governance and institutions in the main stem and no strengths (mean scores of 4.00 or higher) (see Table 9). Respondents generally agree that there is someone who helps to bring diverse stakeholders together (3.80), but they neither agree nor disagree that there is someone that is trusted by stakeholders to lead (3.25). Respondents generally agree that they have an opportunity to engage in water management (3.88) and that they have a meaningful role in water management decisions (3.84), and that those engaged are motivated to get things done (3.58). They generally agree it is clear who has senior water rights (3.59), but neither agree nor disagree that it is clear who has jurisdictional authority to make decisions (3.36). Three areas of weakness were apparent in results on governance and institutions: that it is clear how groundwater use affects surface water (2.92), that there is a common vision for managing water (2.40), and that current water management can meet needs 2.60). These weaknesses are similar in the North Santiam, McKenzie, and Middle Fork Willamette Watersheds.

Table 9. Governance and institutions: Main stem

Leadership	N	Mean	Std Deviation
Someone who helps to bring stakeholders together	25	3.80	0.87
Someone who is trusted by stakeholders to lead	24	3.25	0.79

Engagement	N	Mean	Std Deviation
Opportunity to engage in management decisions	25	3.88	0.83
Meaningful role in management decisions	25	3.84	0.94
Those engaging are motivated to get things done	24	3.58	0.93

Authority	N	Mean	Std Deviation
Who has jurisdictional authority to make decisions	25	3.36	1.19
Who has senior water rights	22	3.59	0.96
How groundwater use affects surface water	24	2.92	1.10

Solo items	N	Mean	Std Deviation
Common vision for managing water	25	2.40	1.23
Current management can meet water needs	25	2.60	1.47
Regulatory changes are necessary	24	3.50	1.47

Governance and institutions were measured on a five-point scale from strongly disagree (1) to strongly agree (5).

3.2 Results: North Santiam Watershed

3.2.1 Social capital: North Santiam

A total of seven respondents indicated that they identify most closely with the North Santiam when thinking about their work in water management. Mean scores for social capital were overall higher than mean scores for the main stem and results indicate that reciprocity and networks are strong in the watershed (see Table 10). Respondents feel that they have a personal obligation to contribute to water management (4.29), a responsibility to help educate others (4.29), and know that their behaviors impact others (4.00). Networks are also strong in the watershed, with respondents agreeing that stakeholders share information (3.71), are supportive of each other (4.00), are willing to work together to solve problems (4.00), and are willing to sacrifice their needs for the benefit of others (4.00). Trust in specific stakeholder groups to contribute positively to water management is notably low among key stakeholder groups, including environmental organizations (3.00), federal government (3.00), and recreation and tourism (3.00) (see Table 45). Respondents in the North Santiam neither trust nor distrust water management decisions (3.29) and neither trust nor distrust stakeholders to keep their needs in mind (3.29).

According to respondents, the level of conflict in the North Santiam has decreased over the past ten years (See Table 11), however respondents expect conflict to increase in the next 10 years (3.86). Respondents indicated that conflict has had mixed effects in the watershed, both causing animosity and motivating people to work together. Two times more respondents (33%) ranked a vibrant agricultural community as the first or second most important future water use in the North Santiam than in the main stem (see Figure 5) and only 14% of respondents ranked a high functioning river system as the most important future water use.

Table 10. Social capital: North Santiam

Trust decision-making[1]	N	Mean	Std Deviation
Trust water management decisions	7	3.29	0.95
Trust stakeholders to keep my needs in mind	7	3.29	1.11

[1] Trust was measured on a five-point scale from strongly distrust (1) to strongly trust (5).

Reciprocity	N	Mean	Std Deviation
Personal obligation	7	4.29	0.76
Responsibility to help educate others	7	4.29	0.76
Know that my own behaviors impact others	7	4.00	0.58
Do more to ensure water solutions are found	7	3.57	0.98
Feel powerless	7	3.00	1.00

Networks	N	Mean	Std Deviation
Share information	7	3.71	0.76
Supportive of each other	7	4.00	0.58
Willing to work together to solve problems	7	4.00	0.58
Willing to sacrifice	7	4.00	0.58

Conflict	N	Mean	Std Deviation
In the last year	7	2.71	1.25
In the past 5 years	7	3.14	1.07
In the past 10 years	7	3.17	1.17
Expected level of conflict in next 10 years	7	3.86	1.35

[1] Trust was measured on five-point scale from strongly distrust (1) to strongly trust (5).

[2] Reciprocity and networks were measured on a five-point scale from strongly disagree (1) to strongly agree (5).

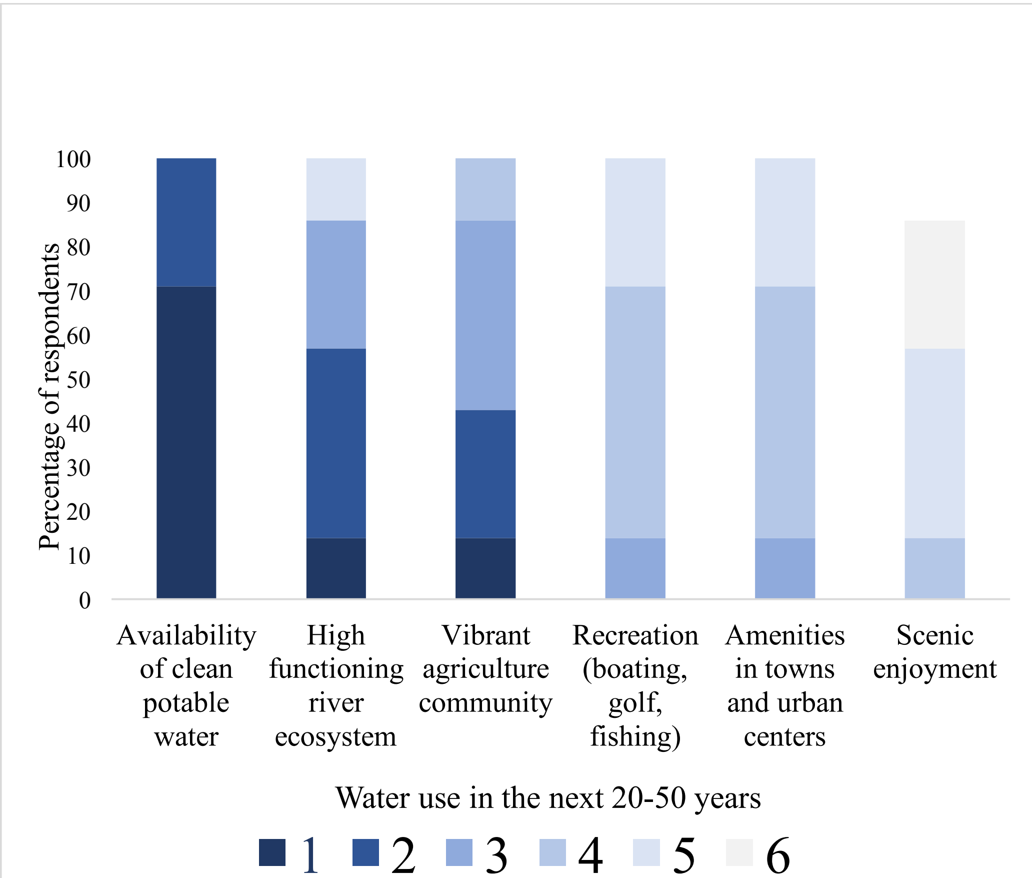
[3] Conflict was measured on a five-point scale from little to no conflict (1) to extreme conflict (5).

Table 11. Effects of conflict: North Santiam

Effects of conflict	N	Percentage
Created lasting divides between stakeholders	1	14%
Caused some animosity between stakeholders	3	43%
No impact on how people work together	1	14%
Motivated people to work together	4	57%
Helped people to collectively solve problems	3	43%

[1] Effects of conflict were measured on a scale of strongly disagree (1) to strongly agree (5).

Figure 5. Ranked most important water use: North Santiam



3.2.2 Human, financial, and physical capital: North Santiam

Responses from the North Santiam watershed indicate that there is a strong awareness of impacts, but financial and physical capital are weak (see Table 12). Stakeholders generally agree that they have the capacity to plan and manage outreach activities (3.67), and analyze management outcomes (3.67), but neither agree nor disagree that they have the capacity to report outcomes (3.17), have adequate access to information (3.17), and adequate technical expertise (3.33). Respondents agree, however, that they are aware of the economic (4.00), and human factors that influence water management (4.14), and are aware of the impacts of biophysical changes on water resources (4.17). Respondents in the North Santiam disagree that there are adequate financial resources (2.33) or physical infrastructure (2.20) available.

Table 12. Human, financial, and physical capital: North Santiam

Human capital	N	Mean	Std Deviation
Capacity to plan and manage outreach activities	6	3.67	1.03
Capacity to report on outcomes	6	3.17	1.17
Capacity to analyze management outcomes	6	3.67	0.82
Information	**N**	**Mean**	**Std Deviation**
Sufficient access to information	6	3.17	1.17
Sufficient access to technical expertise	6	3.33	1.21
Awareness of impacts	**N**	**Mean**	**Std Deviation**
Aware of economic factors	7	4.00	0.00
Aware of the impact of biophysical changes	6	4.17	0.41
Aware of human factors	7	4.14	0.38
Financial capital	**N**	**Mean**	**Std Deviation**
Adequate financial resources available	6	2.33	1.21
Physical capital	**N**	**Mean**	**Std Deviation**
Adequate infrastructure needed to optimize water use	7	2.20	1.30

3.2.3 Management tools and strategies: North Santiam

In the North Santiam Watershed, results do not indicate particular strengths in management tools and strategies (indicated by a mean score of ≥ 4.00) and respondents generally disagree that they have the ability to adapt to changes in supply and demand (2.43) (see Table 13). Respondents generally agree that their stakeholder group is willing to try new things (3.50), values knowing about new technology (3.83), is innovative (3.86), and has techniques or technologies to share (3.57). They also generally agree that there are measurable water management goals in their watershed (3.60) and that these reflect the needs of the watershed (3.80). However, respondents neither agree nor disagree that progress is evaluated against those management goals (3.25).

Table 13. Management tools and strategies: North Santiam

Innovation	N	Mean	Std Deviation
Willing to try new things to meet multiple needs	6	3.50	1.05
Knowing about new technology is important	6	3.83	0.41
My stakeholder group is innovative	7	3.86	0.38
My stakeholder group has techniques to share	7	3.57	0.54

Goals	N	Mean	Std Deviation
Measureable water management goals	5	3.60	0.89
Progress is evaluated against those goals	4	3.25	0.96
Water management goals reflect needs	5	3.80	0.45
Stakeholders have a firm grasp of opportunities	5	3.17	0.98

Ability to adapt	N	Mean	Std Deviation
Ability to adapt to changes	6	3.86	0.38
Ability to capitalize on that change	7	3.00	0.82
Adapt to changes in supply and demand	7	2.43	0.54

3.2.4 Governance and institutions: North Santiam

Measures of the adaptive governance capacity of governance and institutions in the North Santiam indicate strong engagement and a clear understanding of who has senior water rights (see Table 14). Respondents generally agree that there is someone in the watershed who helps to bring diverse stakeholders together (3.57) and who is trusted by stakeholder groups to lead (3.80). They also agree that there are opportunities to engage in watershed management decisions (4.00), that they have a meaningful role in water management decisions (4.00), and that those engaging are motivated to get things done (4.14). Respondents generally agreeing that it is clear who has jurisdictional authority to make decisions (3.71) and how groundwater use affects surface water (3.57), and they agree it is clear who has senior water rights (4.00). In contrast to the main stem, respondents generally agree that there is a common vision for managing water (3.57), that current water management can meet needs (3.57), and they disagree that regulatory changes are necessary (2.86).

Table 14. Governance and institutions: North Santiam

Leadership	N	Mean	Std Deviation
Someone who helps to bring stakeholders together	7	3.57	0.98
Someone who is trusted by stakeholders to lead	5	3.80	0.84
Engagement	**N**	**Mean**	**Std Deviation**
Opportunity to engage in management decisions	7	4.00	1.00
Meaningful role in management decisions	7	4.00	1.00
Those engaging are motivated to get things done	7	4.14	0.69
Authority	**N**	**Mean**	**Std Deviation**
Who has jurisdictional authority to make decisions	7	3.71	1.70
Who has senior water rights	7	4.00	1.41
How groundwater use affects surface water	7	3.57	1.40
Solo items	**N**	**Mean**	**Std Deviation**
Common vision for managing water	7	3.57	1.27
Current management can meet water needs	7	3.57	1.27
Regulatory changes are necessary	7	2.86	0.90

3.3 Results: McKenzie Watershed

3.3.1 Social capital: McKenzie

Results from 9 respondents in the McKenzie Watershed show strong reciprocity and information sharing (see Table 15). Respondents agree that they have a personal obligation to contribute to water management (4.22), are willing to do more to ensure that water solutions are found (4.22), and to help educate others (4.33), and that they know their behaviors impact others (4.22). Results for network strength measures show that people are willing to share information (4.00), are generally supportive of each other (3.56), and are generally willing to work together to solve problems (3.63), however respondents neither agree nor disagree that they are willing to sacrifice their needs to meet the needs of others (2.75).

There were notable differences in trust in specific stakeholder groups (see Table 46). For example, respondents strongly trust municipal providers (4.67) but neither trust nor distrust irrigation (2.88). Respondents neither trust nor distrust water management decisions (3.11) and neither trust nor distrust stakeholders to keep their needs in mind (3.00). Results show that the level of conflict in the watershed is currently neither high nor low (3.11), and there has been a decrease in levels of conflict compared to the past five (3.56) and ten (3.56) years. Conflict has both created animosity and motivated people to work together and respondents expect conflict to be relatively high over the next ten years (3.75). In comparison to the main stem and North Santiam, respondents in the McKenzie share more values in common. All respondents ranked the availability of clean, potable water and a high functioning river ecosystem as either the first or second most important water use in the next 20-50 years (see Figure 6).

Table 15. Social capital: McKenzie

Trust decision-making	N	Mean	Std. Deviation
Trust water management decisions	9	3.11	0.78
Trust stakeholders to keep my needs in mind	9	3.00	0.71

Reciprocity	N	Mean	Std Deviation
Personal obligation	9	4.22	1.30
Responsibility to help educate others	9	4.33	1.30
Know that my own behaviors impact others	9	4.22	0.67
Do more to ensure water solutions are found	9	4.22	0.67
Feel powerless	9	3.00	0.00

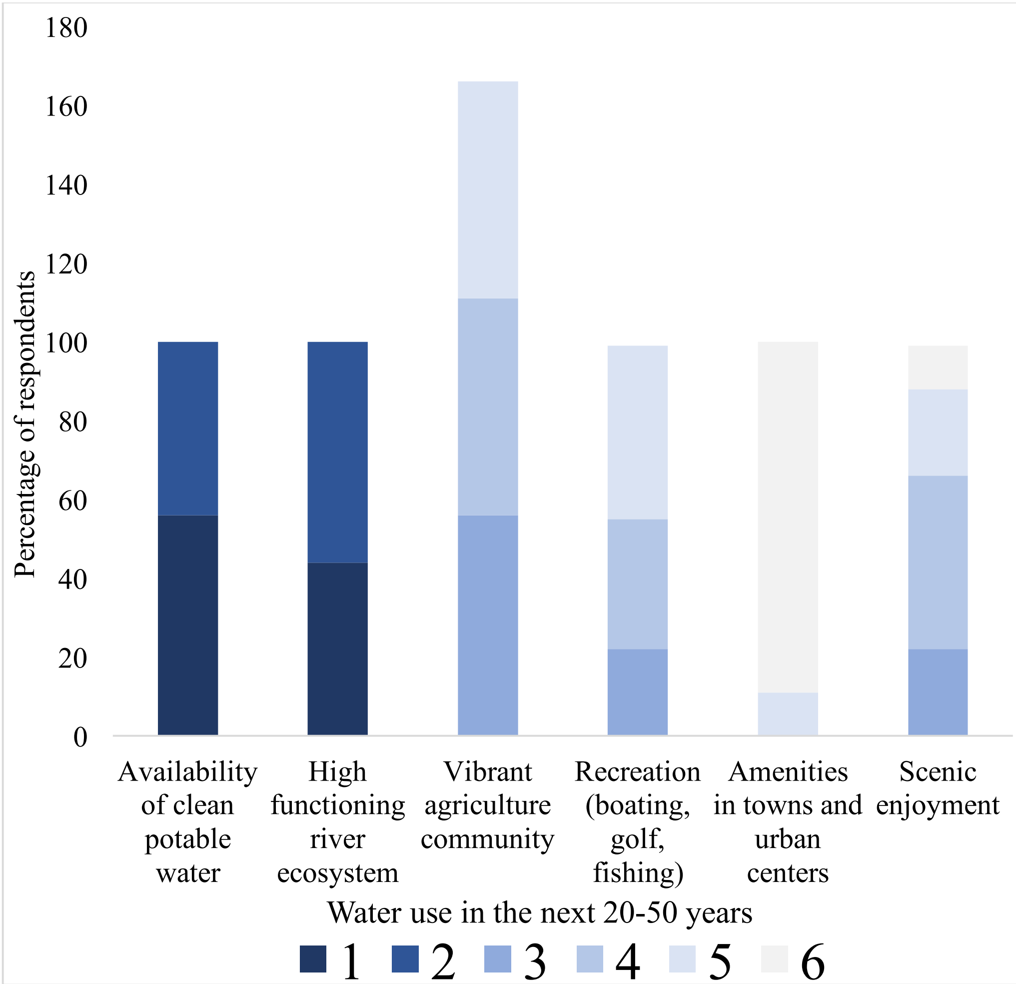
Networks	N	Mean	Std Deviation
Share information	9	4.00	0.87
Supportive of each other	9	3.56	1.13
Willing to work together to solve problems	8	3.63	0.74
Willing to sacrifice	8	2.75	1.04

Conflict	N	Mean	Std Deviation
In the last year	9	3.11	0.93
In the past 5 years	9	3.56	0.53
In the past 10 years	9	3.56	0.73
Expected level of conflict in next 10 years	8	3.75	0.71

Table 16. Effect of conflict on stakeholders working together: McKenzie

Effect of conflict	N	Percentage
Created lasting divides between stakeholders	1	11%
Caused some animosity between stakeholders	5	56%
No impact on how people work together	0	0%
Motivated people to work together	5	56%
Helped people to collectively solve problems	1	11%

Figure 6. Ranked most important water use: McKenzie Watershed



3.3.2 Human, financial, and physical capital: McKenzie

Measures of human, financial, and physical capital in the McKenzie Watershed reveal that the availability of financial resources and physical capital are not adequate, but there is a strong awareness of the human factors that influence water management (see Table 17). Respondents generally disagree that there are adequate financial resources (2.67) and physical capital (2.43) in the watershed. Notably, respondents strongly agree that their stakeholder group is aware of the human factors that influence water management (4.78). Results for other measures of capital did not cross the threshold for strong (≥4.00) or weak (≤ 3.00) adaptive governance capacity. Respondents generally agree that they have the capacity to plan and manage outreach activities (3.89), but they neither agree nor disagree that they can report on outcomes (3.22) and analyze management outcomes (3.11). They generally agree that there is access to sufficient information (3.56) and technical expertise (3.89), and that stakeholders have an awareness of economic factors that influence water management (3.56) and the impact of biophysical changes on water resources (3.89).

Table 17. Human, financial, and physical capital: McKenzie

	N	Mean	Std Deviation
Capacity to plan and manage outreach activities	9	3.89	1.17
Capacity to report on outcomes	9	3.22	1.30
Capacity to analyze management outcomes	9	3.11	1.05
Information	**N**	**Mean**	**Std Deviation**
Sufficient access to information	9	3.56	1.24
Sufficient access to technical expertise	9	3.89	0.78
Awareness of impacts	**N**	**Mean**	**Std Deviation**
Aware of economic factors	9	3.56	1.24
Aware of the impact of biophysical changes	9	3.89	0.78
Aware of human factors	9	4.78	0.44
Financial capital	**N**	**Mean**	**Std Deviation**
Adequate financial resources available	9	2.67	0.54
Physical capital	**N**	**Mean**	**Std Deviation**
Adequate infrastructure needed to optimize water use	7	2.43	1.05

3.3.3. Management tools and strategies: McKenzie

Results for management tools and strategies in the McKenzie Watershed indicate strong innovation, and a weak understanding of alternative management scenarios and ability to adapt to supply and demand (see Table 18). Respondents generally agree that their stakeholder group is willing to try new things (3.50) and has techniques or technologies to share (3.63) and respondents agree that their stakeholder group is innovative (4.13) and values knowing about new technology (4.13). While respondents generally agree that there are measurement water management goals (3.83) and that progress is evaluated against those goals (3.83), they neither agree nor disagree that water management goals reflect the needs of the watershed (3.20) and neither agree nor disagree that stakeholders have a firm grasp of opportunities and alternatives (2.83). Ability to adapt is also mixed in the McKenzie Watershed, with respondents generally agreeing that their stakeholder group can adapt to changes (3.75), and capitalize on those changes (3.50), but they disagree that their group can adapt to changes in water supply and demand (2.50).

Table 18. Management tools and strategies: McKenzie

Innovation	N	Mean	Std Deviation
Willing to try new things to meet multiple needs	8	3.50	0.76
Knowing about new technology is important	8	4.13	1.13
My stakeholder group is innovative	7	4.00	1.16
My stakeholder group has techniques to share	8	3.63	0.92
Goals	**N**	**Mean**	**Std Deviation**
Measureable water management goals	6	3.83	0.41
Progress is evaluated against those goals	6	3.83	0.41
Water management goals reflect needs	5	3.20	0.84
Stakeholders have a firm grasp of opportunities	6	2.83	0.75
Ability to adapt	**N**	**Mean**	**Std Deviation**
Ability to adapt to changes	8	3.75	0.71
Ability to capitalize on that change	8	3.50	0.76
Adapt to changes in supply and demand	8	2.50	0.54

3.3.4 Governance and institutions: McKenzie

Results show strong leadership in the McKenzie, but a weak common vision for water resources management and a lack of adequate information on how groundwater use affects surface water (see Table 19). Respondents agree that there is someone in the watershed who helps to bring diverse stakeholders together (4.00) but they neither agree nor disagree that there is someone who is trusted by stakeholders to lead (3.44). Respondents also generally agree that there is an opportunity to engage in water management (3.67), they have a meaningful role in water management decisions (3.67), and those engaging are motivated to get things done (3.78). While respondents generally agree it is clear who has jurisdictional authority to make decisions (3.89), they neither agree nor disagree that it is clear who has senior water rights (3.13) and how groundwater use affects surface water (2.63). Respondents neither agree nor disagree that there is a common vision for managing water (2.89), and that current management can meet water needs (3.11), and they generally agree that regulatory changes *are* necessary (3.89).

Table 19. Governance and institutions: McKenzie

Leadership	N	Mean	Std Deviation
Someone who helps to bring stakeholders together	9	4.00	0.50
Someone who is trusted by stakeholders to lead	9	3.44	0.73
Engagement	**N**	**Mean**	**Std Deviation**
Opportunity to engage in management decisions	9	3.67	0.71
Meaningful role in management decisions	9	3.67	0.71
Those engaging are motivated to get things done	9	3.78	0.83
Authority	**N**	**Mean**	**Std Deviation**
Who has jurisdictional authority to make decisions	9	3.89	0.78
Who has senior water rights	8	3.13	1.36
How groundwater use affects surface water	8	2.63	1.03
Solo items	**N**	**Mean**	**Std Deviation**
Common vision for managing water	9	2.89	1.36
Current management can meet water needs	9	3.11	1.54
Regulatory changes are necessary	9	3.89	1.27

3.4 Results: Middle Fork Watershed

3.4.1 Social capital: Middle Fork

Results indicate strong reciprocity and network strength in the Middle Fork and distrust in water management decisions (see Table 20), however caution should be taken when generalizing results from such a small sample size (n=5). Trust in specific stakeholder groups to contribute positively to water management was very high for scientists (4.80) and watershed councils (4.80), and notably low for hobby farmers (2.50) and aquaculture (2.67) (see Table 47). Respondents distrust water management decisions (2.25) and distrust stakeholders to keep their needs in mind (2.50), however they have high levels of reciprocity. Respondents feel that they have a personal obligation to contribute to water management (4.40) and to help educate others (4.40). They know that their behaviors impact others (4.40), agree that they want to do more to ensure that water solutions are found (4.20), however they generally agree that they feel powerless to influence water management (3.60). Network strength in the Middle Fork Willamette is somewhat mixed, with respondents indicating that stakeholders generally share information (4.00), support each other (3.60), and are willing to work together to solve problems (4.00), but respondents neither agree nor disagree that they are willing to sacrifice their needs for the needs of others (3.00). Respondents indicated that there has been moderate conflict in the watershed over the past ten years (3.00-3.25), however they expect conflict to increase over the next ten years (3.60). Similarly, to the North Santiam and McKenzie Watersheds, respondents in the Middle Fork indicated that conflict has had mixed results. A majority of respondents indicated that conflict has both created animosity (80%), motivated people to work together (60%), and helped people to collectively solve problems (80%).

Table 20. Social capital: Middle Fork

Trust decision-making	N	Mean	Std Deviation
Trust water management decisions	4	2.25	0.50
Trust stakeholders to keep my needs in mind	4	2.50	0.58

Reciprocity	N	Mean	Std Deviation
Personal obligation	5	4.40	1.34
Responsibility to help educate others	5	4.40	1.34
Know that my own behaviors impact others	5	4.40	0.55
Do more to ensure water solutions are found	5	4.20	0.45
Feel powerless	5	3.60	0.55

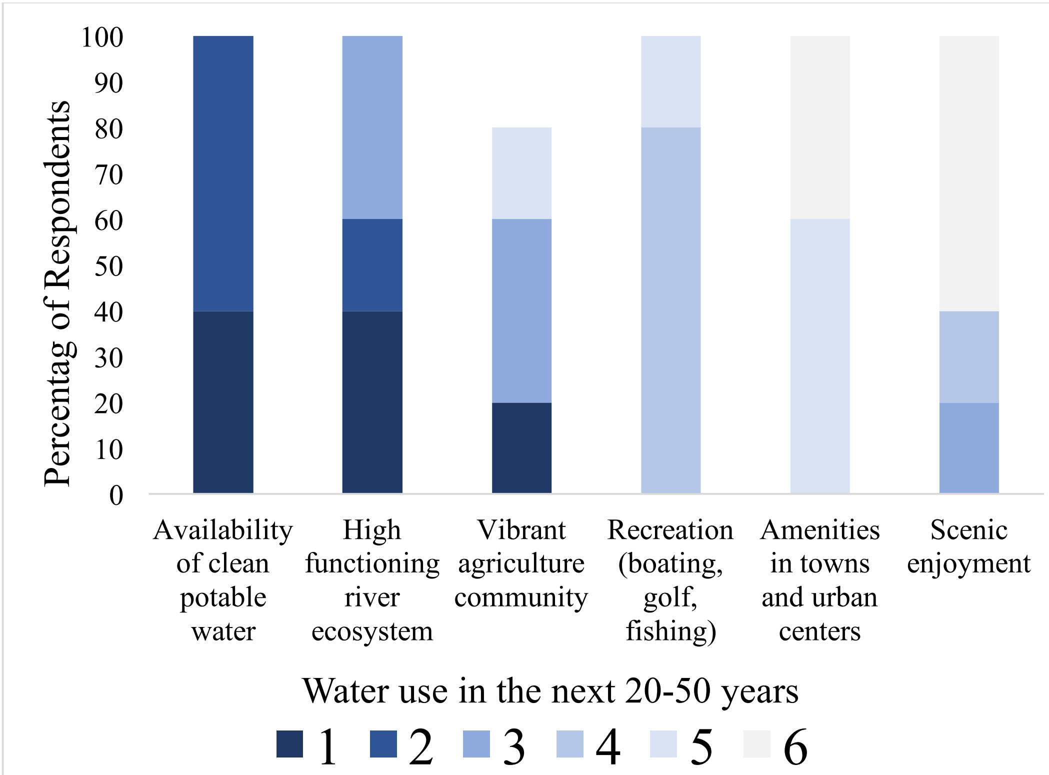
Networks	N	Mean	Std Deviation
Share information	5	4.00	0.71
Supportive of each other	5	3.60	0.89
Willing to work together to solve problems	5	4.00	0.71
Willing to sacrifice	5	3.00	0.71

Conflict	N	Mean	Std Deviation
In the last year	5	3.00	0.00
In the past 5 years	5	3.00	0.00
In the past 10 years	4	3.25	0.50
Expected level of conflict in next 10 years	5	3.60	0.55

Table 21. Effect of conflict on stakeholders working together: Middle Fork

Effect of conflict	N	Percentage
Created lasting divides between stakeholders	1	20%
Caused some animosity between stakeholders	3	60%
No impact on how people work together	0	0%
Motivated people to work together	2	40%
Helped people to collectively solve problems	1	20%

Figure 7. Ranked most important water use: Middle Fork



3.4.2 Human, financial, and physical capital: Middle Fork

Water policy actors agree that they have a strong awareness of impacts in the Middle Fork, but disagree that there is adequate financial and physical capital available (see Table 22). Respondents do agree, however, that their stakeholder group is aware of the impact of biophysical changes on water resources (4.40) and the human factors that influence water management (4.40). Like the North Santiam and the McKenzie Watersheds, respondents disagree that there is adequate financial (2.00) and physical capital (2.20) available. Results for measures of human capital and information resources were neither strong nor weak. While respondents generally agree that they have the capacity to plan and manage outreach activities (3.60), they neither agree nor disagree that they can report on outcomes (3.20) or analyze management outcomes (3.20). Access to information (3.40) and technical expertise (3.20) are not adequate and respondents neither agree nor disagree that their stakeholder group is aware of the potential economic factors that influence water management (3.20).

Table 22. Human, financial, and physical capital: Middle Fork

Human capital	N	Mean	Std Deviation
Capacity to plan and manage outreach activities	5	3.60	1.14
Capacity to report on outcomes	5	3.20	1.10
Capacity to analyze management outcomes	5	3.20	1.10
Information	**N**	**Mean**	**Std Deviation**
Sufficient access to information	5	3.40	1.34
Sufficient access to technical expertise	5	3.20	1.30
Awareness of impacts	**N**	**Mean**	**Std Deviation**
Aware of economic factors that influence water management	5	3.20	0.55
Aware of the impact of biophysical changes on water resources	5	4.40	0.45
Aware of human factors that influence water management	5	4.40	0.55
Financial capital	**N**	**Mean**	**Std Deviation**
Adequate financial resources available	5	2.00	0.71
Physical capital	**N**	**Mean**	**Std Deviation**
Adequate infrastructure needed to optimize water use	5	2.20	0.45

3.4.3 Management tools and strategies: Middle Fork

Questionnaire results indicate the use of management tools and strategies is mixed in the Middle Fork. Some measures of innovation and adaptation are strong, while others are weak (see Table 23). Notably, while respondents generally agree that there are measurable water management goals in the watershed (3.75) and progress is evaluated against those goals (3.75), respondents do not agree that water management goals reflect the needs of the watershed (2.50) or that stakeholders have a firm grasp or opportunities and alternatives (2.33). Respondents agree that their watershed has the ability to adapt to changes (4.00) and capitalize on that change (3.67), but they neither agree nor disagree that their watershed has the ability to adapt to changes in supply and demand (2.60). Respondents neither agree nor disagree that their stakeholder group is willing to try new things (3.00), despite the fact that respondents generally agree that knowing technology is important to their stakeholder group (3.60), their stakeholder group has technologies to share (3.75), and agree that their stakeholder group is innovative (4.25).

Table 23. Management tools and strategies: Middle Fork

Innovation	N	Mean	Std Deviation
Willing to try new things to meet multiple needs	5	3.00	1.41
Knowing about new technology is important	5	3.60	0.89
My stakeholder group is innovative	4	4.25	0.50
My stakeholder group has techniques to share	4	3.75	0.50

Goals	N	Mean	Std Deviation
Measureable water management goals	4	3.75	1.26
Progress is evaluated against those goals	4	3.75	1.26
Water management goals reflect needs	4	2.50	0.58
Stakeholders have a firm grasp of opportunities	3	2.33	0.58

Ability to adapt	N	Mean	Std Deviation
Ability to adapt to changes	4	4.00	0.00
Ability to capitalize on that change	3	3.67	0.58
Adapt to changes in supply and demand	5	2.60	0.55

3.4.4 Governance and institutions: Middle Fork

While respondents in the Middle Fork indicated strong engagement in water management, some measures of authority and common vision were weak (see Table 24). Respondents neither agree nor disagree that there is someone who helps to bring diverse stakeholders together (3.20) and someone who is trusted by stakeholders to lead (3.40) and they neither agree nor disagree that it is clear who has jurisdictional authority to make decision (3.20) and who has senior water rights (3.00). Respondents disagree that it is clear how groundwater use affects surface water (2.20) and that current water management can meet their stakeholder group's needs (2.60). However, respondents agree that there are opportunities to engage in water management decision (4.40), that their stakeholder group has a meaningful role in water management decisions (4.00), and that those engaged are motivated to get things done (3.80). Respondents neither agree nor disagree that there is a common vision for managing water resources in the watershed (3.20) and that regulatory changes are necessary (3.20).

Table 24. Governance and institutions: Middle Fork

Leadership	N	Mean	Std Deviation
Someone who helps to bring stakeholders together	5	3.20	1.30
Someone who is trusted by stakeholders to lead	5	3.40	1.14
Engagement	**N**	**Mean**	**Std Deviation**
Opportunity to engage in management decisions	5	4.40	0.55
Meaningful role in management decisions	5	4.00	0.00
Those engaging are motivated to get things done	5	3.80	1.10
Authority	**N**	**Mean**	**Std Deviation**
Who has jurisdictional authority to make decisions	5	3.20	1.30
Who has senior water rights	5	3.00	1.41
How groundwater use affects surface water	5	2.20	1.30
Solo items	**N**	**Mean**	**Std Deviation**
Common vision for managing water	5	3.20	1.30
Current management can meet water needs	5	2.60	1.30
Regulatory changes are necessary	5	3.20	0.89

3.5 Results: Differences between watersheds

Due to small sample size (N= 46), non-parametric statistics were not appropriate for questionnaire results. A Kruskal-Wallis test, the non-parametric alternative to a One-Way ANOVA that does not assume similar distribution form (Vaske, 2008), was used to test differences among the watersheds. The Kruskal-

Wallis test uses means and standard deviations to identify where variation between watersheds is greater than variation within each watershed. Significance value was set to *p <.1* for rejecting the null hypothesis that differences among respondents in each watershed are greater than differences between the watersheds. However, unlike the One-Way ANOVA, there is no post-hoc test to the Kruskal-Wallis that identifies specifically where the difference lies. Where differences occur may seem obvious when examining means for the different watersheds, but extreme caution should be used when interpreting results of the Kruskal-Wallis test.

3.5.1 Social capital: differences between watersheds

3.6 Results: Differences between watersheds

Due to small sample size (N= 46), non-parametric statistics were not appropriate for the questionnaire results. A Kruskal-Wallis test, the non-parametric alternative to a One-Way ANOVA that does not assume similar distribution form (Vaske, 2008), was used to test differences among the watersheds. The Kruskal-Wallis test uses means and standard deviation to identify where variation between watersheds is greater than variation within each watershed. Significance value was set to *p <.1* for rejecting the null hypothesis that differences among respondents in each watershed are greater than differences between the watersheds. However, unlike the One-Way ANOVA, there is no post-hoc test equivalent for the Kruskal-Wallis that identifies specifically where the difference lies. Where differences occur may seem obvious when examining means for the different watersheds, but extreme caution should be used when extrapolating on the results of the Kruskal-Wallis test. Effect size, expressed as ETA squared, (η^2) is calculated for the Kruskal-Wallis and indicates the percentage of variation in responses between groups that is a result of the variable of interest, as opposed to random variation. For example, an ETA squared of 0.3 means that 30% of the variance in responses can be attributed to the differences between watersheds, rather than random variation within each watershed. In each table, N refers to the number of responses to the question in each watershed and Total N refers to the total number of responses across all watersheds.

3.6.1 Social capital: differences between watersheds

A Kruskal-Wallis test to evaluate differences among social capital between watersheds revealed a significant difference in conflict during the past five years with a significance of $p < .08$ and a large effect size (η^2 .16). Means for conflict in the last five years are in the main stem (3.64), followed by the McKenzie (3.56), North Santiam (3.14) and Middle Fork (3.00). There was also a significant difference ($p < .05$) between networks sharing information among the watersheds with a large effect size (η^2 .17). In the McKenzie (4.00), the Middle Fork (4.00), and the North Santiam (3.71), information sharing was relatively high, whereas the main stem mean suggests less information sharing (3.21). There was also a significant difference ($p < .1$) among watersheds in stakeholders being willing to sacrifice their needs in the short term to meet everyone's needs in the long term with a large effect size (η^2 .15). The mean score for sacrifice in the North Santiam (3.57) was much higher than the main stem (2.48), the McKenzie (2.75) and the Middle Fork (3.00).

Significant differences in trust were evident between the watersheds ($p < .01$), with the main stem Willamette having the lowest trust in other water managers to take their needs into account. In the main stem, the mean score for trust among stakeholders was low (2.13), with means suggesting slightly more trust in the Middle Fork (2.50), McKenzie (3.00), and North Fork Santiam (3.29). The effect size for differences in trust was large (η^2 .27). Trust of specific stakeholder groups varied significantly across watershed. Trust in ranching differed significantly ($p < .08$) with a large effect size (η^2 .17) and was highest in the Middle Fork (4.00) and lowest in the McKenzie (2.56).

Trust in municipal providers was significantly different among watersheds ($p < .01$, test statistic 11.37) and was very high in the McKenzie (4.67) and relatively high in the North Santiam (4.29), but lower in the Middle Fork (3.60) and main stem (3.59) with a large effect size (η^2 .27). There was high trust in environmental organizations in the McKenzie (4.11) and main stem (3.95), but lower trust in the Middle Fork (3.50) and North Santiam (3.00). Differences among trust in environmental organizations were significant among the watersheds ($p < .09$) with a large effect size (η^2 .15). Finally, there was a significant difference between watersheds in trust of municipal governance (*p<.04*) with a large effect size (η^2 .19). Trust in municipal governance was very high in the North Fork Santiam (4.43), but in the remaining watersheds the means for trust in municipal governance suggest neither strong nor weak trust.

Table 25. Kruskal-Wallis Test: Conflict past 5 years

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	3.14	7	43	19	6.68	0.16	0.08
McKenzie River	3.56	9		23.17			
Middle Fork	3	5		11.5			
Main stem	3.64	22		24.86			

Table 26. Kruskal-Wallis Test: Networks sharing information

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	3.71	9	45	24.43	7.68	0.17	0.05
McKenzie River	4	9		30.11			
Middle Fork	4	5		29.2			
Main stem	3.21	24		18.62			

Table 27. Kruskal-Wallis Test: Willing to sacrifice short term needs

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	3.57	7	43	31.14	6.32	0.15	0.09
McKenzie River	2.75	8		22.12			
Middle Fork	3	5		24.1			
Main stem	2.48	23		18.5			

Table 28. Kruskal-Wallis Test: Trust in ranching

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	3.29	7	42	25.64	6.82	0.17	0.08
McKenzie River	2.56	9		18.17			
Middle Fork	4	4		34			
Main stem	2.64	22		19.27			

Table 29. Kruskal-Wallis Test: Trust in environmental organizations

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	3	7	42	12.97	6.3	0.15	0.09
McKenzie River	4.11	9		24.11			
Middle Fork	3.5	4		17.62			
Main stem	3.95	22		23.91			

Table 30. Kruskal-Wallis Test: Trust stakeholders to take my needs into account

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	3.29	7	43	30.29	11.25	0.27	0.01
McKenzie River	3	9		28.94			
Middle Fork	2.5	4		22.25			
Main stem	2.13	23		16.72			

Table 31. Kruskal-Wallis Test: Trust in municipal providers

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	4.29	7	43	25.93	11.37	0.27	0.01
McKenzie River	4.67	9		31.83			
Middle Fork	3.6	5		15.3			
Main stem	3.59	22		18.25			

Table 32. Kruskal-Wallis Test: Trust municipal government

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	4.43	7	44	33.64	8.1	0.19	0.04
McKenzie River	3.67	9		23.17			
Middle Fork	3.4	5		19.8			
Main stem	3.39	23		19.43			

3.5.2 Human, financial, and physical capital: differences between watersheds

The only significant difference detected in human, financial, and physical capital between watersheds was the awareness of impact of biophysical changes on water resources ($p<.04$) with a large effect size (η^2 .19). The mean score for awareness of biophysical impacts was very high in the Middle Fork (4.40) and relatively high in the North Fork (4.14), however respondents in the main stem slightly disagree that stakeholders in their watershed are aware of the biophysical impacts of management decisions (2.88).

Table 33. Kruskal-Wallis Test: Awareness of biophysical impacts

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	4.14	7	45	20.71	8.46	0.19	0.04
McKenzie River	3.89	9		32.78			
Middle Fork	4.40	5		25.6			
Main stem	2.88	24		19.46			

3.5.3 Management tools and strategies: Differences between watersheds

There was a significant difference between the watersheds in their capacity to measure progress against goals in their watershed ($p<.05$) with a large effect size (η^2 .24). While respondents in the North Fork (3.25), McKenzie (3.83) and Middle Fork (3.75) generally agree that progress toward goals in their watersheds is measured, respondents in the main stem slightly disagree (2.75). Also, the watersheds differed significantly in their support of using regulatory means to increase reservoir storage or optimize existing storage ($p<.04$), but the effect size was small to medium (η^2 .04). In the North Santiam and Middle Fork watersheds, no respondents indicated that they support using regulatory means to increase or optimize reservoir storage, while about half of respondents in the Middle Fork (56%) and main stem (48%) support using regulatory means. In the McKenzie watershed (78%) and the main stem (76%), the majority of respondents supported using regulatory means to monitor and measure water use. However, only 40% of respondents supported regulatory use of this tool in the Middle Fork and only one respondent (14%) from the North Santiam watershed indicated support and differences among watersheds were significant ($p<.01$) and the effect size was large (η^2 .24).

Table 34. Kruskal-Wallis Test: Progress is measured against goals

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	3.25	7	34	18.62	7.77	0.24	0.05
McKenzie River	3.83	6		24.58			
Middle Fork	3.75	4		23.38			
Main stem	2.75	20		13.97			

Table 35. Kruskal-Wallis Test: Support increased reservoir storage/optimization of existing storage (regulatory)

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	0.14	7	46	27.36	1.99	0.04	0.04
McKenzie River	0.56	9		26.89			
Middle Fork	0	5		20.2			
Main stem	0.28	25		21.86			

Table 36. Kruskal-Wallis Test: Support water use monitoring and measuring devices (regulatory)

	Mean	N	Total N	Mean Rank	Cronbach's alpha (α)	η^2	Sig.
North Fork Santiam	0.14	7	46	12.29	10.69	0.24	0.01
McKenzie River	0.78	9		29.89			
Middle Fork	0.4	5		18.2			
Main stem	0.76	25		26.48			

3.6 Results: Summary of quantitative results

Elements of adaptive governance capacity that were strong (mean score $\geq$ 4.00) at the watershed scale in the North Santiam, McKenzie, and Middle Fork watersheds and at the basin scale included reciprocity, trust in watershed councils, and awareness of the impacts of human factors on water management (see Table 37). There are two main weaknesses (mean score $\leq$ 3.00) that stand out at the basin level and watershed level: availability of adequate financial capital and the ability to adapt to changes in supply and demand (see Table 38). At the watershed level, results indicate stronger network strength, including the sharing of information. Notably, there were no governance strengths at the basin level and there were no weaknesses in governance in the McKenzie. Setting clear goals and measuring progress against those goals was not a strength in any of the sampled watersheds or at the basin level and several measures of management tools and strategies were weak at the basin level and in the Middle Fork. Trust in specific stakeholder groups varies by watershed, suggesting each watershed has unique characteristics and relationships. The Middle Fork Willamette is the only watershed where respondents had high trust in irrigation, farmers, ranchers, and state government and it is the only watershed were respondents generally agree that they can adapt to changes. There are also several stakeholder groups that are not well trusted by questionnaire respondents at the basin level and within each of the three surveyed watersheds. Like high trust scores, these low trust scores indicate the unique character of each watershed and existing relationships.

Table 37. Adaptive governance strengths in the Willamette Basin

	Main Stem	North Santiam	McKenzie	Middle Fork
STRENGTHS				
SOCIAL CAPITAL	RECIPROCITY[1,2,3,4]	RECIPROCITY[1,2,3] NETWORKS[2,3,4]	RECIPROCITY[1,2,3,4] NETWORKS[1]	RECIPROCITY[1,2,3,4] NETWORKS[1,3]
	TRUST Tribes Watershed council Scientists	TRUST Watershed council Municipal providers Municipal government	TRUST Tribes Watershed council Municipal providers Environmental orgs. Scientist	TRUST Tribes Watershed council Scientists Irrigation Farmers Ranching State government
OTHER CAPITAL	AWARENESS[3]	AWARENESS[1,2,3]	AWARENESS[3]	AWARENESS[2,3]
TOOLS	N/A	N/A	INNOVATION[2,3]	INNOVATION[3] ABILITY TO ADAPT[1]
GOVERNANCE	N/A	ENGAGEMENT[1,2,3] AUTHORITY[2]	LEADERSHIP[1]	ENGAGEMENT[1,2]

*Numbers indicate specific measures of each concept that were strong (mean score ≥ 4.00). Numbers correspond to the order that each measure appears in Tables 5 through 24 and 44 through 51).

Table 38. Adaptive governance weaknesses in the Willamette Basin

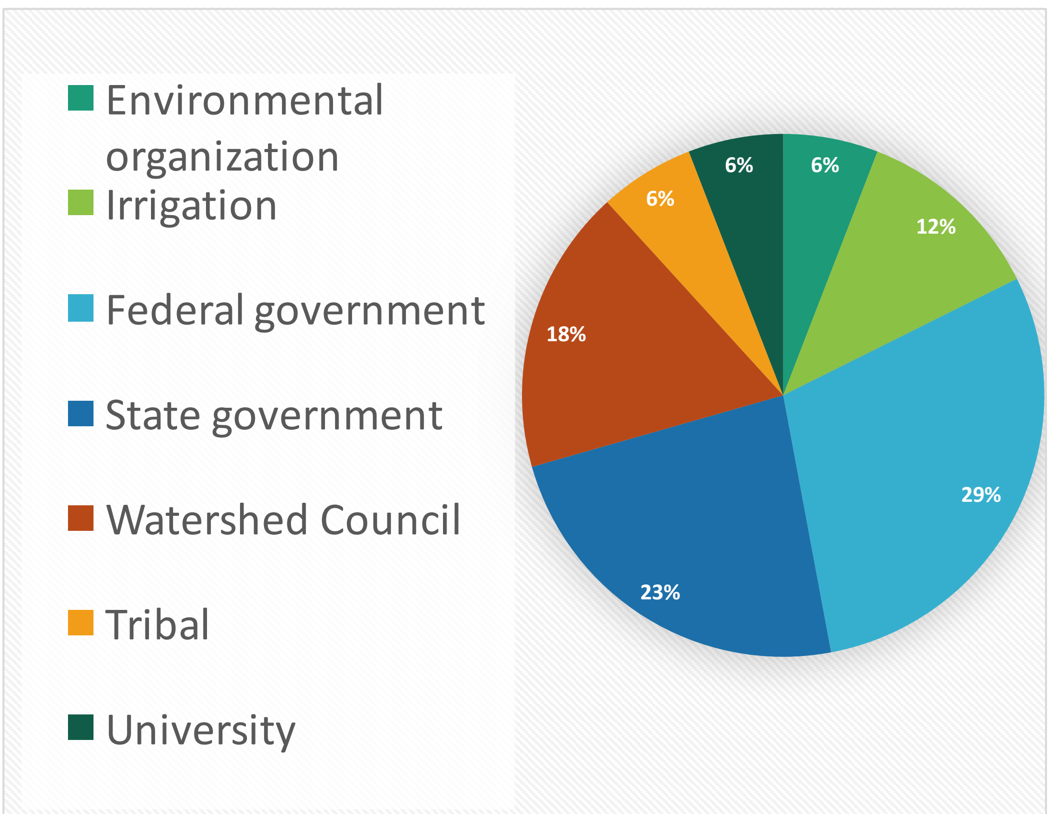
	Main Stem	North Santiam	McKenzie	Middle Fork
WEAKNESSES				
SOCIAL CAPITAL	TRUST[1,2] NETWORKS[4]	**N/A**	TRUST[2]	TRUST[1,2]
	TRUST Agriculture Aquaculture Landowners Hydroelectric	TRUST Environmental orgs. Federal government Scientists Recreation	TRUST Agriculture Aquaculture Landowners	TRUST Aquaculture Landowners Hydroelectric
OTHER CAPITAL	**FINANCIAL** PHYSICAL	**FINANCIAL** PHYSICAL	**FINANCIAL**	**FINANCIAL** INNOVATION[1]
TOOLS	**ABILITY TO ADAPT (S& D)**; GOALS[2,3,4]	**ABILITY TO ADAPT (S&D)**	**ABILITY TO ADAPT (S&D)**	**ABILITY TO ADAPT (S&D)**; GOALS[3,4]
GOVERNANCE	COMMON VISION MEETS NEEDS AUTHORITY[3]	**N/A**	COMMON VISION	COMMON VISION AUTHORITY[2,3]

*Numbers indicate specific measures of each concept that were weak (mean score ≤ 3.00). Numbers correspond to the order that each measure appears in Tables 5 through 24 and 44 through 51).

CHAPTER 4: QUALITATIVE RESULTS

In the winter of 2017, interview invitations were sent to a total of 41 water policy actors. A total of 17 interviews were conducted, for a response rate of 41%. Of the interviews conducted, four (24%) water managers identified with the North Santiam, two water managers identified with the McKenzie (12%), and two water managers identified with the Middle Fork (12%). Nine (53%) water managers interviewed did not identify with one of these three watersheds, due to their basin-wide scope of work, and were given the category “main stem.” Interviews spanned a broad representation of stakeholder groups, but state and federal government were most strongly represented (See Figure 8).

Figure 8. Qualitative results: interviewees by stakeholder group



4.1 Qualitative results: Main stem

When asked what watershed they identify with, nine interviewees identified with the main stem. Jurisdictional boundaries where water managers work rarely follow watershed boundaries and often do not follow Basin boundaries, and these nine respondents work within the main stem in their work as water managers. These interviews produced rich qualitative data and introduced numerous complex aspects of water management and adaptive governance capacity in the Willamette Basin. Results were condensed into the most commonly expressed strengths in the water management regime and the most commonly stated factors affecting limiting capacity.

4.1.1 Leadership in the Willamette main stem

The Willamette River Initiative has probably the single most important clearinghouse for communication, opportunity, challenge, and idea generating [in the Willamette Basin]. – Anonymous university stakeholder (interview 2/21/17 B).

The elements of adaptive governance capacity that were most frequently mentioned across interviews were management tools and strategies, social capital, and governance. Specifically, there is strong collaboration across the basin, suggesting networks and reciprocity are strong, and there are several groups in the basin applying innovative management strategies, indicating strong leadership and engagement. Quantitative results generally support strong reciprocity, the value of learning new technology, and innovation (See Table 5 through Table 9). Despite inadequate financial resources, some federal and state agencies are collaborating to share information. Innovation in the Basin is occurring across watershed councils, quasi-municipal entities, private foundations, and the state, including Eugene Water and Electric Board (EWEB), Portland Water Bureau (PWB), Clean Water Services (CWS), the Meyer Memorial Trust, OWRD, and USFS.

All water managers provided examples of collaboration within the Basin involving federal, state, and private partners. USFS employees who were interviewed feel that all the work they do is collaborative, due to the multi-purpose land management mission of the USFS and integration across management goals. At the state level, there has been increasing coordination between OWRD and DEQ in recent years to share monitoring data in the South Willamette Groundwater Management Area. An OWRD employee explained that agency staff and DEQ's staff are "always looking for opportunities for staff to share resources, learn from each other, and piggy back studies that are going to benefit both of us," (Anonymous state government, interview 2/16/17 A) and OWRD has also worked with ODA to assist the integration of water quality and water quantity management. Finally, collaboration among scientists across the basin and at Oregon State University led to the Willamette Water 2100 study (WW2100), which modeled a multitude of land use, population, and climate scenarios, providing updated information for water managers.

Water managers operating on a basin-wide scale in the Willamette exhibit strong use of management tools and strategies. They are identifying legal tools, such as the conversion of minimum perennial stream flows into water right certificates, introducing water right "shares" for federal stored water, and adjudicating water rights in the basin, as ways to improve the clarity of management goals and water accounting in the system. The BiOp instream flow targets are also seen as management tools that can be adjusted to allow more flexibility in management. One USACE staff explains that the lack of clarity regarding allocation of stored water and BiOp and state instream flow requirements to different user groups creates both flexibility and ambiguity.

> In the Willamette, the way it works is, nothing is allocated and you have a static BiOp [instream flow] requirement. There are [dry, average, and wet flow targets] for the main stem, but the tributary targets are static. It's not laid out that fish get this much and that's it, or recreation gets that much...the beauty of that is, theoretically there is a little more flexibility year in and year out about how you could manage. The downside is there's tons of ambiguity and there's tons of arm wrestling over it. –Anonymous federal government (interview 3/17/17)

There are several key examples of innovation in the Willamette Basin. First, the Portland Bureau of Environmental Services was named as an innovator for introducing a vote to construct a $1 billion-dollar pipe to reduce the risk of combined sewer overflows, which contribute to water quality concerns. The pipe reduced the risk of combined sewer overflows from storms with a three-year return interval by

95% (University stakeholder, interview 3/17/17 C). PWB is also a member of the Water Utilities Climate Alliance (WUCA), a national consortium of water utilities focused on creating climate change resiliency. When PWB began upgrading their Water Master Plan, a planning document required every 10 years, which outlines each utility's infrastructure improvement plans, they solicited feedback from Denver Water and the Metropolitan Water District of Southern California (participant observation, 6/28/17). PWB took a transformative approach to infrastructure resiliency modeling by examining climate change and community change scenarios, rather than probabilities. The ability of the utility to change its approach so drastically demonstrates institutional learning.

CWS, a water management utility operating in the Tualatin River Basin, was mentioned as another innovator within the Willamette Basin. The utility provides services to industry and municipalities to help manage their water resources and provide water quality mitigation to meet state water quality standards. When wastewater treatment plants release treated water, for example, the water is often at a higher temperature than the receiving water. CWS was facing more stringent NPDES permits to operate their sewage treatment and drinking water treatment plants and had to seek solutions. A university stakeholder explains their program to address these more stringent standards:

> They were faced with a difficult choice: they either sock their ratepayers with substantial increase in monthly utility bills in order to pay for what is essentially in effect a huge refrigerator that cools water just like your refrigerator that cools air and return it to the stream. And not only is that expensive to build, but it's expensive in perpetuity to operate because water is a very expensive thing to cool. It just takes a lot of energy. So, CWS said, 'there must be a better way.' What they pioneered was this strategy of looking higher up in the watershed and paying farmers to plant trees. They created this whole new capability in-house and hired people who had expertise. They recruited farmers, they paid those farmers, and that was a lot cheaper for their ratepayers than building giant refrigerators and paying them in perpetuity to cool their water. –Anonymous university stakeholder (interview 2/21/17).

According to this interviewee, CWS' approach met DEQ's temperature standards and, at the same time, provided improved habitat conditions.

At the state level, OWRD has implemented an innovative, new pilot program, Place Based Planning, which allocated resources to four communities to collaboratively plan their water management needs for the long-term. The Place

Based Planning initiative has involved multiple state agencies, including DEQ, ODFW, and federal entities such as USBR and USACE. While none of the four initial pilot grants were issued to the Willamette Basin, the pilot program indicates OWRD's commitment to integrated water management solutions and continues a culture of innovation in Oregon at the state level. As one water manager expressed, "one of the reasons I find the Willamette such a rewarding place to work is because this idea of working across intellectual and geographic and other kinds of boundaries is it's not a new idea here," (Anonymous university stakeholder, interview 2/21/17). The creation of the Land Conservation and Development Commission, the Oregon Beach Bill, and the Citizen's Initiative Review Commission are all examples of innovation in Oregon (Anonymous environmental stakeholder, interview 2/21/17). One water manager, who demonstrated a commitment to collaboration as an approach to problem solving, was especially optimistic about the new initiative:

> I think that when we look at a watershed as a whole and we get the cities and the farmers and the foresters and the people that just live along the river for enjoyment together to figure out problems together and then pool resources, that's where we're going to be successful and that's what it takes. –Anonymous state government (interview 2/17/17 A).

Finally, the majority of interviewees pointed to the Meyer Memorial Trust as a leader in the Willamette Basin. Meyer is a private philanthropic foundation that created the Willamette River Initiative in 2008 to support restoration in the Willamette Basin. The trust coordinated with BEF to create the Model Watershed Program and for the past 8 years they have hosted a bi-annual "Within Our Reach" conference for water management professionals in the basin. These conferences have fostered strong networks and coordination among environmental interests in the Basin (participant observation, 12/16/16). Through the Model Watershed Program, Meyer has pledged $100,000 per year for ten years to support restoration efforts in the Willamette Basin and encouraged watershed councils and environmental organizations to collaborate to prioritize restoration areas. Restoration progress has been significant with Meyer's support, in part because private resources have less restrictions than state and federal resources. The resources provided by Meyer enabled land trusts in the Willamette Basin to grow, hire new staff, purchase new properties, and establish conservation easements.

In addition to coordinating with BEF, Meyer coordinates with OWEB's Focused Investment Partnership to assist funder collaboration and ensure that recipients use funds in complimentary ways. Interviewees believe that, due to support from the Willamette Initiative, watershed councils in the Willamette Basin have been able to prioritize their restoration goals in a "spatially and temporally in an explicit way, particularly habitat in the floodplain" and they have "both the financial resources and mechanisms in place…to actually engage them [landowners] through conservation easements, fee simple acquisition, and on the ground restoration," (Anonymous university stakeholder, interview 2/21/17 B). The Willamette River Initiative is sun-setting in 2019 and Meyer has initiated conversations about how the basin can continue restoration, collaboration, and coordination of funding, and helped partners to remain engaged for the long-term.

> So, it's just this slow lifting and rolling of the boat of our capacity. We're enlarging our capacity to do effective on the ground conservation and restoration of both land and water over time. And more has happened in the last 8 years than happened in the previous 30 in the Willamette in that regard. –Anonymous university stakeholder (interview 2/21/17 B).

This quotation illuminates how pivotal Meyer has been in promoting restoration and collaboration throughout the main stem.

4.4.2 Further change needed in the main stem

The legal framework is based on this sort of wonderful fiction that federal, state, and local laws all fit together in one great seamless whole that sort of all functions perfectly well together. But we know that it doesn't.
– Anonymous federal government (interview 2/27/17)

There are numerous challenges to adaptive governance capacity in the Willamette main stem. The four most prominent challenges include 1) a governance system that is not adequately polycentric, 2) uncertainty in future water right seniority 3) inadequate financial resources, and 4) distrust among stakeholder groups. Quantitative results for the main stem also indicated inadequate financial resources (Table 7), distrust among stakeholder groups (Table 44) and distrust of water management decisions (Table 5), however quantitative results for governance were mixed (Table 9), indicating that governance challenges may be tied to trust and network strength, which were considerably lower in quantitative results. The first of these challenges, a governance system with centralized authority, has contributed to reduced local capacity to practice innovation and improve ecological conditions in the main stem. Second, uncertainty in future water right seniority means that water right holders could lose access to their water in the future. Third, inadequate financial resources limit the information available to managers, limit the ability to gather and analyze information, and limit the capacity of groups such as state agencies and watershed councils to remain involved in collaborative efforts, and limit the ability of federal and state partners to share information. Finally, unresolved tension between stakeholder groups leads to lawsuits and moral exclusion, which literature suggests does not promote innovative win-win solutions and may erode the trust and networks that increase adaptive governance capacity (see Chapter 2).

First, there is evidence that the governance system in the Willamette basin, in which the USACE and NMFWS have strong control over resource allocation decisions, is not sufficiently polycentric. Interviewees provided examples of how innovation is sometimes stunted, progress slowed, and state and federal laws are not managed conjunctively. Examples of inadequate information sharing and structures that may not promote adequate stakeholder participation in planning the Willamette Basin include the Willamette Basin Review Study, USBR's management of contracts for stored water in the basin, and USACE's management of the Willamette Project Reservoirs. It is important to note that these challenges may also be a result of inadequate financial capital.

The Willamette Basin Review Study, which was initiated in the 1991 and was placed on hold in 2000, following the listing of chinook and steelhead in 1999 (OWRD, n.d.) was reinitiated in 2015 to examine the possibility of allocating the remaining unallocated stored water behind the Willamette Project Reservoirs. This stored water is some of the last remaining surface water in the Willamette Basin. The review study, however, is not integrating currently unconverted minimum perennial stream flows in the basin into their flow allocation model, called SWIFT. Recent research by WW2100, which modeled the effects of converting minimum perennial stream flows into certificated water rights, found that the effect on water availability would be significant (Jaeger et al., 2017). When asked about the relationship between the BiOp and the minimum perennial stream flows at a March 1st public meeting, USACE responded that, "Although MPSFs are not directly linked to discussions of the SWIFT group [fish and wildlife flows], it is anticipated that conclusions and ResSim modeling outputs will help inform appropriate minimum perennial stream flow requirements," (OWRD, n.d.). Thus, while OWRD is involved in the Willamette Basin Review, some interviewees feel that USACE has a heavy hand in the study and reallocation process.

The language of the Willamette Basin Review study design places USACE as the "Federal Study Lead," and lists other agencies as "Core Agencies," which "contribute technical support." This language reflects more of a command control governance regime when place in contrast to the new Place Based Planning model, where studies have "team leads" and "study groups," which are comprised not only of agencies, but also of private citizens and multiple stakeholder groups. An example of concerns about the Review study's approach is that when NMFS originally contacted several tribes in the Basin, they were concerned about "tribal participation and roles in implementation structure, lamprey protection, and tribal participation in studies and decisions related to fish passage, flows, and other RPA measures," (NOAA, 2008, 9). One water manager explains how the study design and USACE's legal authority plays out in on the WATER team:

> What I have observed over the years is it seems under the BiOp the feds, particularly the USACE (because of the way USACE is structured), they are on the hook to avoid jeopardy and they are more likely to listen to NMFS or other federal action agencies like the BPA than they are willing to listen to the state because they're not obligated [to listen to the state]. If they're going to deviate from the BiOp in any way they have to get concurrence from NMFS in their decision. I think the state has really struggled to have a voice in the BiOp process. – Anonymous state government (3/10/17 C).

These interviewee concerns are important because having a team of state and federal agencies participate in the implementation without involvement of non-governmental organizations has the potential to decrease governmental accountability (Amos, 2014).

The USACE's reallocation study approach is also different than WaterSMART studies completed in other basins, such as the Upper Deschutes Basin, where numerous stakeholder groups are involved in the planning process. In 2013 USBR was prepared a draft plan of study for a collaborative, basin-wide WaterSMART grant for the Willamette Basin, however one interviewee stated that "USACE decided that a basin study wouldn't give them the information they wanted in preparation for doing a basin allocation," (Anonymous federal government, personal communication 6/5/17), so the study was never completed. Another water water policy actor mentioned tension in the WATER study team, which is tasked with advising the implementation of the BiOp that informs the Willamette Basin Review Study.

The outcome of the Review study, which will lead to reallocation of the stored water, will have a lasting impact on the Basin. However, there is low trust in water managers' decisions (see Table 5) and relatively low trust in federal stakeholder in the main stem (see Table 44). Some water managers feel that their input in the Review study is irrelevant because USACE has ultimate authority over reallocation.

> In the local population, [people are] asking, 'why are they [USACE] here? What's their role in this?' I think right now in the Willamette Project, there's a lot of distrust towards the USACE. Regarding the Willamette Basin Review Study, I've heard some stakeholders say, 'Of course the USACE's just going to do what they want. They don't care about agriculture; they don't care about instream flows.' When really, they're not a neutral entity, but they don't have a stake in the game. They're not trying to push one use over the other, per se. So, I think working with the USACE is a good platform for water users in the basin. –Anonymous state government (interview 3/10/17 C).

Some water managers are looking to stored water as a new water supply solution, but recent outreach from USACE has helped them understand how little water is truly "unallocated."

> And one great comment we got from the Farm Bureau last week was, 'Okay, are you telling me we need 1.2 MAF to meet the BiOp in a dry year?' Their wheels got spinning. And they immediately thought, 'What's the benefit to us in continuing to go down this path if so much water is already given to the fish?' –Anonymous state government (interview 3/10/17 C).

The BiOp is a paradigm shift in USACE's management of the Basin, and the agency is having mixed success in communicating its role. One interviewee stated that the BiOp "the first time they [USACE] were legally mandated to manage river flows for a species other than homo sapiens," since "they have been actively managing this system since the civil war. And what is that? 150 years?" (Anonymous university stakeholder, interview 2/21/17 B). USACE has been dredging the system since 1871, when the USACE Portland office was established (USACE, n.d.) and they have been providing flows for navigation and Columbia River Treaty obligations, but the BiOp is a significant change in flow operations and navigating ESA obligations.

USACE staff interactions with the public provide an example of the challenge in managing this shift. At the December 2016 "Within Our Reach" conference, one USACE engineer's presentation was questioned and, when put on the defensive, the engineer responded, "I'm just an engineer, folks," (participant observation, 12/8/16). At another conference in February 2017 (River Restoration Northwest), another USACE scientist expressed in his presentation that the USACE is trying to be seen as the "cuddly kitten," not the "Gorilla," (participant observation, 2/7/17). On the other hand, some USACE staff understand that, "it's just a continual process of educating people about why we do what we do and working with entities to implement the ESA," and they have seen "huge changes over the time" with the USACE's communication (Anonymous federal government, interview 3/21/17). While some USACE staff are trying to navigate this shift, water managers still question: "Is it an adequate paradigm shift?" (Anonymous university stakeholder, interview 2/21/17 B).

USACE's authority in the basin may also hinder adaptive governance capacity by limiting restoration goals to federally required actions in some instances (see section 4.4.1 for an example of how this is not always the case). The USACE has a state obligation to provide fish passage at Dorena Dam, but they have yet to fulfill this requirement because there is not a federal driver to the state's requirement. Additionally, the BiOp reinforces the static roles determined by legal authority. The WATER study team does not include non-agency stakeholder groups and the formal agreement among agencies is that no one agency's legal authority is reduced or increased by participating on the team. While these legal roles are an important reality, strong adaptive governance capacity would suggest that stakeholders exercise their legal discretion to provide solutions that increase flexibility in the system and adequate financial and political support are required to exercise legal discretion.

A second barrier to adaptive governance capacity in the Willamette Basin is the potential future change in de facto water rights seniority. This potential uncertainty is due to legacy impacts of Oregon's water rights allocation system, political decisions, and the relationship between federal and state governments. The Oregon Water Resources Department has experienced difficulty in water rights accounting due to reduced staff capacity and challenges coordinating with USBR. Future accounting may be increasingly difficult if unconverted minimum perennial stream flows are converted. Minimum perennial stream flows represent large blocks of water that are already allocated to instream uses, but are not currently legally protected. The state has not been regulating users that are junior to these minimum perennial stream flows because they are not officially certificated. The Willamette Basin Program rules direct OWRD to "retain minimum perennial stream flows…until the process for conversion to instream water rights is completed," (OAR 690-502-0030), however OWRD cannot regulate the portion of the minimum perennial stream flows that call on stored water as a source and it is currently unclear what that portion is, due to vague language on the original documents. If these minimum perennial stream flows become certificated, water right holders who were previously unregulated could be regulated.

> If you look at all of those historic, unconverted flows, and you look at the time of year when they mandate [water to be instream], which is at the time of year when water is at its greatest scarcity, it would be a very large raising of the priority of fish for the use of instream flows, which would then restrict and reduce out of stream uses at least at certain times of the year in certain streams in certain water years. And so that's the reason they weren't turned into water rights in the first place: everyone realized what that would do to extant rights. It would just turn the whole system on its head. –Anonymous university stakeholder (interview 2/21/17 B).

Table 39 through Table 41 below show unconverted minimum perennial stream flows in the North Santiam, McKenzie, and Middle Fork Rivers. Unconverted flows which are expected to have a considerable impact on water rights are highlighted in green. Flows which also have a certificate number listed have already been converted.

Table 39. Minimum perennial streamflow in the North Santiam

MF Number	Certificate	Purpose	Priority date	Rate (cfs)	Point of Diversion
MF 141		Supporting Aquatic Life	6/22/64	430	In the North Santiam River and its tributaries above USGS Gage No. 14-1841, near Jefferson
MF 142		Supporting Aquatic Life	6/22/64	580	In the North Santiam River and its tributaries above USGS Gage No. 14-1830 at Mehama
MF 143		Supporting Aquatic Life	6/22/64	500	In the North Santiam River and its tributaries above USGS Gage No. 14-1815, at Niagara
MF 112	65755	Supporting Aquatic Life	6/22/64	40	In the Little North Santiam and its tributaries above USGS Gage No.14-1825, near Mehama
All other instream rights in the North Santiam have a priority date of 1990.					
*Orange indicates MFs which are likely to have significant impact on water rights.					

Table 40. Minimum perennial streamflow in the McKenzie

MF Number	Certificate	Purpose	Priority date	Rate (cfs)	Point of Diversion
MF 57		Supporting Aquatic Life	6/22/64	30	In the Blue River and its tributaries above the confluence with the McKenzie River
MF 126		Supporting Aquatic Life	6/22/64	1025	In the McKenzie River and its tributaries above the intersection of the McKenzie River and Interstate Highway 5
MF 127		Supporting Aquatic Life	6/22/64	1400	In the McKenzie River and its tributaries above USGS Gave No. 14-1625, near Vida
MF 158		Supporting Aquatic Life	6/22/64	200	In the South Fork of the McKenzie River above its mouth.
MF 134	59720	Supporting Aquatic Life	5/24/62	20	In the Mohawk River and its tributaries, above the confluence of the Mohawk and McKenzie Rivers.
MF 103	59756	Supporting Aquatic Life	5/24/62	20	1.0 Mile above Gate Creek – McKenzie River confluence.
MF 528	59757	Supporting Aquatic Life	5/24/62	1025	In the McKenzie River and its tributaries above the intersection of the McKenzie River and Interstate Highway 5.
MF 529	59758	Supporting Aquatic Life	5/24/62	1400	In the McKenzie River and its tributaries above USGS Gage No.14-1625, near Vida.
MF 530	59759	Supporting Aquatic Life	5/24/62	30	In the Blue River and its tributaries above the confluence with the McKenzie River.
MF 531	59760	Supporting Aquatic Life	5/24/62	200	In the South Fork of the McKenzie River and its tributaries above the South Fork McKenzie River confluence.
All other instream rights in the McKenzie have a priority date of 1990 or later.					
*Orange indicates MFs which are likely to have significant impact on water rights.					

Table 41. Minimum perennial streamflow in the Middle Fork Willamette

MF Number	Certificate	Purpose	Priority date	Rate (cfs)	Point of Diversion
MF 98		Supporting Aquatic Life	6/22/64	40	In Fall Creek and its tributaries above the Fall Creek-Willamette Middle Fork confluence.
MF 128		Supporting Aquatic Life	6/22/64	640	In the Middle Fork of the Willamette and its tributaries above the confluence of the Middle Fork and Coast Forks of the Willamette.
MF 129		Supporting Aquatic Life	6/22/64	285	In the Middle Fork of the Willamette and its tributaries above the confluence of the Middle Fork and the North Forks of the Willamette.
MF 107	59546	Supporting Aquatic Life and Minimizing Pollution	11/3/83	12*	Hills Creek at its mouth, near Jasper.
MF 110	59457	Supporting Aquatic Life and Minimizing Pollution	11/3/83	80*	Little Fall Creek at its mouth.
MF 115	59548	Supporting Aquatic Life and Minimizing Pollution	11/3/83	50*	Lost Creek at its mouth.
MF 140	59721	Supporting Aquatic Life	5/24/62	115	In the North Fork of the Middle Fork of the Willamette River and its tributaries above the North Fork of the Middle Fork.
MF 535	59764	Supporting Aquatic Life	5/24/62	640	In the Middle Fork of the Willamette and its tributaries above the Middle Fork-Coast Fork of the Willamette confluence.
MF 536	59765	Supporting Aquatic Life	5/24/62	285	In the Middle Fork of the Willamette and its tributaries above the Middle Fork-North Fork of the Willamette confluence.

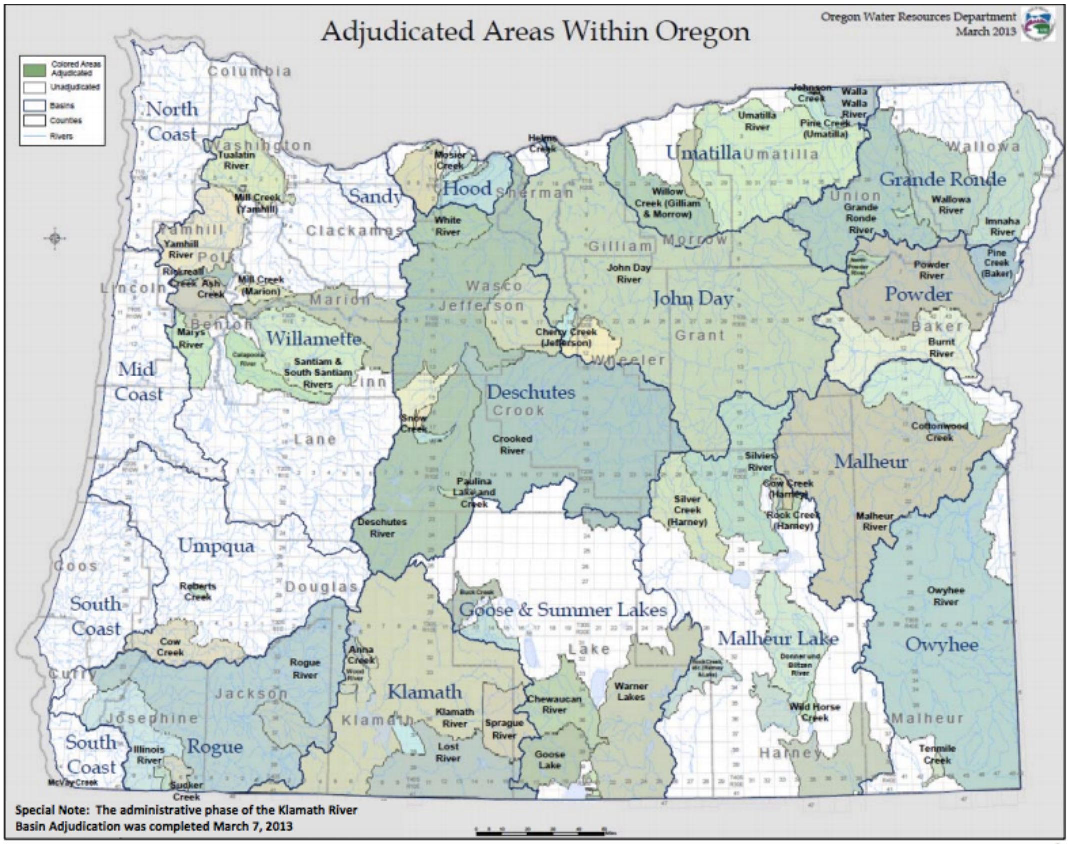
MF 537	59766	Supporting Aquatic Life	5/24/62	40	In Fall Creek and its tributaries above the Fall Creek-Middle Fork Willamette confluence.
All other instream rights in the Middle Fork Willamette have a priority date of 1991 or later.					
* Flow varies considerably by month. Flows indicated in table are the maximum flows identified. **Orange indicates MFs that are likely to have a considerable impact on water rights.					

The fact that the Willamette Basin is un-adjudicated adds another challenge because adjudication is an extremely long, expensive, and complex process, as the Klamath Basin adjudication illustrates (OWRD, n.d.). Adjudication is a beneficial process, according to OWRD, because "The ability to manage water resources has been greatly facilitated in those areas of the state where adjudications have been concluded. By creating a record of enforceable water rights through the adjudication process, water users have greater security, predictability, and flexibility in meeting their water needs," (OWRD, n.d.). Figure 9 below shows several large areas (white) in the Willamette Basin that have not been adjudicated.

Finally, the federal-state nexus of water rights in with Willamette Basin has created accounting challenges, which make accounting for actual water use in the system unclear at times. Water rights that authorize the use of stored water from the Willamette Project Reservoirs must be accompanied by a contract from the USBR, which is authorized to contract stored water from the USACE's flood control dams. As one interviewee explains, USBR's contracting program and OWRD's water rights accounting have not aligned perfectly, which is partly the result of inadequate financial resources.

> There's been this disconnect between the USBR and our agency [OWRD] over the years. The USBR is over there running their water contracting program issuing new water contracts, discontinuing some, canceling some, and issuing new contracts, but not coordinating with our agency. We don't have a single person responsible coordinating a program to figure out which USBR contracts are valid and which permits are valid. –Anonymous state government (interview 3/10/17 C).

Figure 9. Adjudicated areas within Oregon (OWRD, 2013).



As explained in section 1.1.7, OWRD manages live flow water rights separately from stored water rights, but the management is not always so simply bifurcated. Irrigators who hold water rights for live flow on the North Santiam River have been relying on the release of stored water from Detroit Reservoir, as if it were live flow, but the agricultural community is concerned that if they have "an existing life flow water right on the North Santiam River and [have] been benefiting from free releases all these years, but now those free releases are under contract for some other use, how is that going to influence an existing life low-water right holder?" (Anonymous state government, interview 3/10/17 C). State administrative rules interacting with the 2008 BiOp have created a lack of security for water right users. The USACE releases stored water from the reservoirs to meet their BiOp flow targets on the tributaries and main stem Willamette, but has not quantified which portions of the water that are satisfying the target flows at various gages are coming from "live flow" versus "stored water." An OWRD employee explains the challenge:

> In the Willamette main stem and its major tributaries, below USACE dams, we have not done any [water rights] regulation. And that's partly because our state distribution rules say that any stored water released from the storage project that is not contracted is considered natural flow or live flow from the regulation standpoint. So, USACE, after the BiOp came out in 2008, started releasing all this water from the reservoirs as early as April or May to help with spawning and migration [for listed salmonids]. But there is no contract and no water right for that release of stored water. So, until that water is spoken for, contracted, or there's a water right protecting it from that use, we can't do any regulation for the benefit of the instream water right. Nor is it illegal for live flow-water right holder on the North Santiam to pick up Detroit water even though he only has a live flow water right. –Anonymous state government (interview 3/10/17 C).

Thus, the lack of clarity surrounding unconverted minimum perennial streamflows and challenges accounting for USBR contracts in the Willamette Basin causes current and future uncertainty both for regulators and for water users.

A third barrier to adaptive governance capacity in the Willamette Basin is the lack of adequate financial capital. In the absence of adequate financial capital, water managers lack sufficient information about the system that they manage, are not capable of maintaining infrastructure, and lack capacity to keep sufficient staff to run programs and to collaborate across stakeholder groups and attend meetings. Financial resources in are needed in the Basin for restoration, water supply infrastructure, and for agencies and non-profits to hire additional staff to help meet outreach goals.

First, the lack of adequate financial capital affects the quality of data collected about the water system itself. Available information regarding biological processes in the Basin is not adequate, which makes it difficult for water managers to solve complex problems where specific information is needed. One water manager exclaims the basic information that is often lacking:

> It's astonishing that we are here in the 21st century and so much basic information is missing, for example, how many kinds of animals are there? How many animals are there? Where are all the animals? Those are some pretty basic questions and you would think we would have a pretty good handle on these, but it's actually a very general handle. Some of the questions that we need to resolve about these conflicts require very specific information about the timing of fish arrival and departure, for example, or their sizes, or detailed information about their behavior around certain kinds of structures such as fish ladders. That's very difficult information to come by. –Anonymous federal government (interview 2/27/17).

While this statement may be an exaggeration, there is ongoing research to understand the distribution of lamprey populations and when fish use of alcoves and backwater channels, among other things. Water managers also point to the need for an improved understanding of how changes in snowpack influence groundwater resources and how changes in forest cover will influence evapotranspiration (Anonymous state government, interview 2/16/17 A). Oregon has a complex geology, yet has not adequately managed its groundwater resources (House & Graves, 2016). Efforts are being made to increase the network of monitoring wells in Oregon, but there is a need for long-term data and resources to analyze existing data.

> For us, data collected over time is very important. And so, the collection of that data is very key: you can't miss it. And that's where our resources have gone to date: maintaining long-term gaging station records on streams and long-term water level measurements on wells, but we haven't been able to put as much effort is in the analysis of those data. –Anonymous state government (interview 2/16/17 A).

Adequate surface water information is also a challenge, as river gaging stations have been discontinued across the state. This affects long-term data about surface water in the system, adding challenges for municipal and water supply planners, who prefer 30-year record periods or longer (Anonymous federal government, interview 2/27/17). As one interviewee explains, "we're really struggling with some of that basic information and that means that a lot of our decisions do come down to a clash of values," (Anonymous federal government, interview 2/27/17). For example, quantifying revenue produced from hydropower is easier than quantifying the value associated with the number of fish that survived dam passage (Anonymous federal government, interview 3/21/17).

Information about water use in Oregon is also hindered by lack of financial resources. For example, additional staff are needed to improve water accounting of allocation of water rights for stored water. One interviewee explains that, "the amount of stored water that is released for flow augmentation for ESA issues…up until this point hasn't been quantified," (Anonymous state government, interview 3/10/17 C). Finally, information about water use may be hindered by the discontinuation of the staff position to manage the Water Use Reporting database at OWRD.

> If you don't have someone in the [Water Use Reporting] position just doing quality assurance and sending reminders and doing customer service, our compliance rates drop dramatically. So, it's a program that's been around for a while since the late 80s but we've seen that if you don't have someone in the position to do the data to do the reminders, to keep up with the information and keep up the database, your compliance can drop as low as 20%. If you have someone in the position you can get it as high as 70, 75 to 80%. Just by having someone sending reminders, someone to help walk through the online utility connecting. –Anonymous state government (interview 3/10/17 C)/

Second, lack of adequate financial resources affects physical capital within the Willamette Basin. There are numerous revetments along the Willamette River, which are reaching the end of their engineered lifespan. The replacement of failing dikes has been uncoordinated, due to the many entities which manage the dikes (Anonymous environmental stakeholder, interview 3/17/17 C). The inadequacy of wastewater and storm water infrastructure is also a challenge, leading to frequent combined sewer overflows. Some interviewees believe that the federal investment, which provided financial support for the construction of the Willamette Project is no longer available (Anonymous state government 3/10/17 C). The initial investment of the infrastructure that is already in place did not consider earthquake vulnerability and the cost to upgrade systems to earthquake standards would be extremely high.

Agricultural water managers believe there is also inadequate infrastructure to convey water from the Willamette River main stem to the valley uplands. The cost of conveyance infrastructure to move water just one quarter mile uphill can be cost-prohibitive (Jaeger et al., 2017). The challenge of establishing this infrastructure also includes establishing easements across properties, considering who will pay for the infrastructure, and the additional cost of the water, for which USBR has per acre-foot fees. Some interviewees suggest a consolidated approach to expanding irrigation infrastructure, including establishing new irrigation districts, but this approach has been contested by environmental organizations (Anonymous state government, interview 3/10/17 C; Anonymous irrigation stakeholder, interview 2/16/17 C).

Third, lack of adequate financial capacity in the Willamette Basin affects staff capacity and programs, reducing the ability of agencies and organizations to meet outreach goals. For example, NOAA struggles to dedicate adequate time to outreach and participation in meetings that are not required for the agency. Oregon State University's extension program budgets have been cut, reducing outreach to farmers that included climate change education and adaptation, crop experiments, and training programs (Anonymous irrigation stakeholder, interview 2/16/17 B) and Soil and Water Conservation Districts, in collaboration with ODA, are not always able to pursue restoration projects, even when farmers show interest. This is especially challenging because building trust among farmers requires a considerable time commitment.

> Right now, we rely heavily on OWEB for funding to do projects. Most of the time those projects are so competitive for a few dollars that we only recommend approval of certain projects: the ones that mean the most for OWEB's mission. Often times [when] a farmer who wants to put in a streamside area, it's not going to be as attractive as some other project. So that's really disheartening because you have a lot of people out there wanting to do something and there's just not the dollars to help them do it. –Anonymous state government (interview 2/17/17 A).

To make matters worse, some farmers are not willing to consider restoration projects unless they receive a strong financial incentive and there is sometimes a lack of adequate financial resources to provide such incentives.

Finally, the lack of adequate financial incentives affects the ability of organizations to innovate and plan. Oregon's Water Resources Development Program provided $2.8 million for feasibility studies between 2008 and 2017, $14 million for water supply projects between 2013 and 2015, but only $750,000 to test out its new Place-Based Planning Program (OWRD, 2016). A recent Secretary of State Audit found that as an agency, OWRD is underfunded and understaffed (Atkins & Wenger, 2016). While the innovative Place-Based Planning Program may continue, water managers express uncertainty and worry about the future state budget. At the state and federal level, many water managers mentioned that staff are not being replaced as they retire. The effects of inadequate staff can lead to crisis management, and as one water manager points out, "If you're crisis managing all the time and you don't have the resources and some poor person's workload doubles, it's hard to plan beyond that, (Anonymous irrigation stakeholder, interview 2/16/17 B).

Finally, inadequate financial capital may have unanticipated consequences. For example, when small farms are not provided with assistance for complying with regulations, or the price of irrigation increases, larger farms and corporations can take the place of family farms (Anonymous state government, 2/17/17 A). A shift in the amount of financial capital that goes toward restoration initiatives could also affect adaptive governance capacity in the Basin. Before the Willamette River Initiative, collaboration and restoration in the basin were limited.

> Before WRI, people were just so stretched keeping their own activity underway… pedal to the medal doing whatever it is that they're doing. Could you also organize a conference every two years? You can just see what the reality of that is. There's a reason why, before Meyer stepped into that role, that stuff wasn't happening. It's not part of anybody's job and their job is currently consuming every waking moment. –Anonymous university stakeholder (interview 2/21/17 B).

As the Willamette River Initiative ends in 2019, the Willamette Basin will need additional resources to fill a potential gap.

A fourth potential barrier to adaptive governance capacity in the Willamette Basin is distrust between agricultural, municipal interests, and environmental interests. There is low trust between these groups (see Table 44), which creates difficulty in identifying a common management goal, reduces the effectiveness of innovative collaborative groups in the Basin, and leads to these groups seeking out methods other than collaboration to meet their needs. One interviewee explains that some water managers representing agricultural interests are willing to work with environmentalists, but others are not.

> I would like to see new projects built that benefit agriculture and also benefit local communities and environmental components. And that's not something that other folks in my position would necessarily state, but I look at it practically that ESA isn't going to go away and fundamentally we care about the environment too and if we don't do it voluntarily the alternative is worse and then you have that whole group of people that are invested in it and it makes it more difficult to pull it apart. –Anonymous irrigation stakeholder (interview 2/1617 B).

Tension between the agricultural community and environmental organizations were apparent at the 2016 "Within Our Reach" conference, which had very few farmers and agricultural representatives present. A discussion panel following a talk series on working landscapes revealed tensions between the Farm Bureau and restoration community (participant observation, 12/16/15). One riparian landowner and farmer expressed his distrust of government and environmental organizations for trying to interfere with private property rights. Another example of how some water managers in the agricultural community are distrusting of environmental organizations comes from a recent settlement agreement in the Upper Deschutes Basin between the Center for Biological Diversity and Water Watch and five central Oregon irrigation districts and USBR.

> I think the other really big part is that there are some groups who make their livelihood by suing other people or suing state agencies or suing federal agencies. That causes a lot of problems because it further amplifies the fear and paranoia that's already naturally there. It puts the agencies in more of a crisis mode because it forces the agencies to put more money into fighting things instead of managing things and that pretty much is the same for all of us...what happened last year in the Deschutes over the spotted frog will color the mood in all areas for a while because that was a basin where they had a basin planning process and they were all at the table and they were trying to do all these good things and one group felt it wasn't moving fast enough and so they sued. –Anonymous irrigation stakeholder (interview 2/1617 B)

Some water policy actors in the agricultural community also feel that the recent Willamette Water 2100 was not inclusive and did not invite agricultural interests into the study soon enough. This may have been a misstep because, as one water manager states, irrigated agriculture can be "a very paranoid group of people and once something has already happened, if you're not involved and you're not really sure what the point of the effort is, then it gives it a little bit more of a suspicious ring than otherwise," (Anonymous irrigation stakeholder, interview 2/16/17 B).

While members of the agricultural community are displeased by the recent lawsuit, the agricultural community also uses lawsuits as a tool to reach their goals. The Farm Bureau is coordinating with realtor associations and individual landowners to prepare a lawsuit against NOAA. In 2016, FEMA consulted with NOAA regarding the impacts of their flood insurance program on endangered species and NOAA determined that "the NFIP in Oregon reduces the quantity and quality of floodplain and in-channel habitat, which will jeopardize the continued existence of 17 marine and anadromous species," (NOAA, 2016). It is still unclear how this BiOp will be implemented, but it will likely interact with the LCDC's planning process to regulate agricultural and residential development in floodplains.

Other examples of stakeholder group problem-solving strategies indicate that trust is a barrier to adaptive governance capacity in the Willamette Basin. For example, the Northwest Environmental Advocates have sued DEQ, alleging that the Willamette Basin TMDLs are not being adequate to protect salmon and steelhead.

This lawsuit could affect Clean Water Service's shade mitigation program. Another example is the challenge of regulating exempt wells using democratic processes. One water manager explains that when regulating exempt well is suggested, groups against regulation practice moral exclusion and use the narrative of "the little old lady who can't get enough water and her husband died and so she can't pay $100 a year for that well...don't make her do that! So, no politician wants to touch that," (Anonymous irrigation stakeholder, interview 2/16/17).

Another indication that trust is a barrier to adaptive governance capacity is the practice of "moral exclusion." Moral exclusion occurs when people rationalize and justify harm for those outside the "scope of justice," viewing them as "expendable, undeserving, exploitable, or irrelevant," (Opotow & Weiss, 2000, 468). The "scope of justice" is encompasses three attitudes toward others: "(1) believing that considerations of fairness apply to them, (2) willingness to allocate a share of community resources to them, and (3) willingness to make sacrifices to foster their well-being," (Opotow & Weiss, 2000, 478). Some farmers in the Willamette Basin question the moral relevance of those in state and federal government. One water manager explains that, "their perspective which is fair enough, is 'what's your skin in the game? This is my farm, it's been in the family for all these generations, everybody needs food: it's in the Bible, and what are you? You're some smarty pants federal guy who's telling me how to do this," (Anonymous irrigation stakeholder, interview 2/16/17 B). Another example of moral exclusion in the Willamette is displayed by recreational interests.

> I've heard people stand up in public meetings and say, 'I don't care if we flood people downstream and kill them, I want the reservoir full.' I've heard individual people say that. It's vile; it's cruel. But they're coming from this from a vested interest, whatever that is, and they want the reservoir full. It doesn't matter what everybody else wants. –Anonymous federal government (interview 3/21/17).

Finally, some water policy actors have reduced trust in the USACE because they have not yet completed BiOp fish passage requirements above Detroit, Lookout Point, and Green Peter Dams. This has caused tension between USACE and ODFW (Anonymous state government, interview 3/10/17 B; Anonymous federal government, interview 2/27/17). Some water policy actors also lack trust in traditional mitigation measures because they feel that, “we're spending a lot of money trying to restore wild salmon populations and at the same time we're putting in a couple hundred thousand pounds of hatchery trout that are out competing all the salmon so it's definitely complex,” (Anonymous irrigation stakeholder, interview 3/17/17 A). This has led the Willamette Riverkeeper to file an intent to sue USACE Regarding ESA Impacts of Hatchery Summer Steelhead Program on May 3, 2017, (Willamette Riverkeeper, 2017).

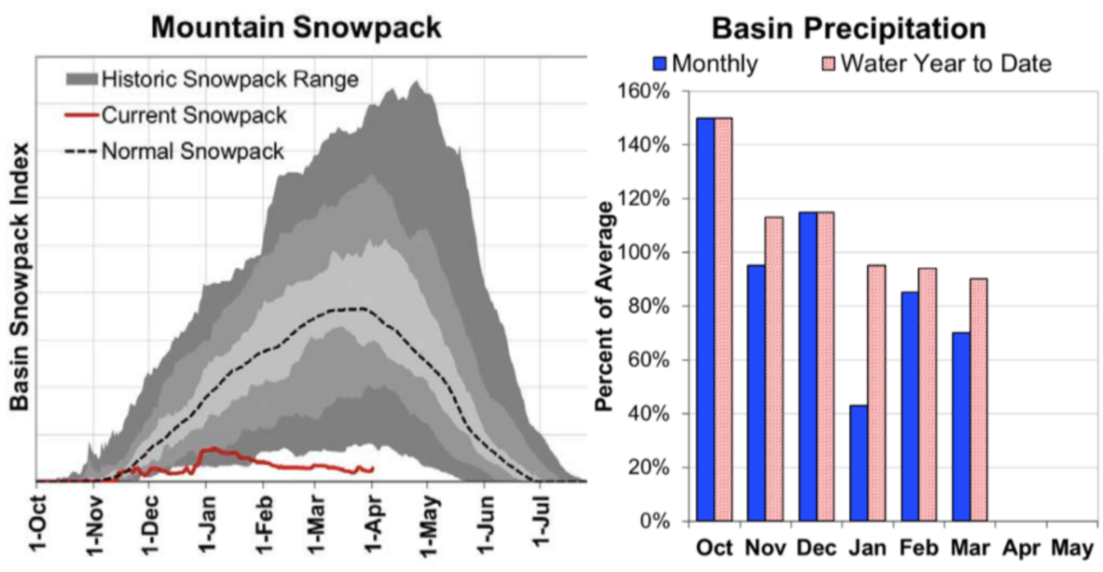
4.2 North Santiam: qualitative results

Four water managers were interviewed in the North Santiam Watershed and three of the four water managers highlighted USACE operations of Detroit Reservoir and the reallocation of the stored waters in the Willamette Project Reservoirs as major concerns, a complex web of authority surrounding water rights that leads to uncertainty. Quantitative results support these findings with mixed trust in federal and state government (Table 45), however, quantitative results for authority were adequate. The watershed has increasing adaptive governance capacity due to several new collaborative partnerships, strong engagement in water management, and innovative approaches to forest management. Quantitative results show high levels of engagement, a common vision for managing water, trust in leadership, and a belief that water managers can adapt to changes (see Tables 10 through 14). Two recent lawsuits suggest that needs of environmental groups are not being met and poor urban growth planning and communications have led to a conflict between a municipality and an irrigation district. According to quantitative results, there is low trust in environmental groups, however low trust in municipal government was not apparent (Table 45). Finally, adaptive governance capacity is restricted by limited human, financial, and physical capital on the local, state, and federal levels.

4.2.1 Increased collaborative capacity in the North Santiam

Increased collaborative capacity in the North Santiam watershed has manifested in several ways. First, high levels of trust and strong leadership allowed the North Santiam Watershed Council to gather together stakeholders to support each other and work together to solve problems in response to changing reservoir operations and a drought, which occurred in 2015. In April of 2015, Detroit Lake snowpack was at a historical low (See Figure 9) (USACE, 2017) and in October 2015 the Lake's levels were the lowest since dam construction, exposing the original location of the town of Detroit, which was flooded upon dam construction (Rose, 2016). The shared sense of urgency brought people to the table: "for the first time [we] had Norpac [a large food corporation that supplies vegetables to the foodservice industry]. We had their engineers come to the drought meeting and we have these annual basin summits and that was the first time they came to the table," (Anonymous watershed council, interview 3/10/17 A). Annual basin summits were focused on energy spill planning and they identified water supply as a specific concern, which also provided momentum to the Watershed Council and Santiam Water Control District [a local irrigation district; the largest district in the Willamette Basin] to apply for a WaterSMART planning grant from USBR on June 25, 2015, just one month after USBR released funding opportunities to promote drought contingency planning and resiliency projects. The applicants received $399,080.00 to complete their study one month before Governor Brown declared a drought emergency in Marion County. (North Santiam Watershed Council, n.d.). Under the leadership of the Watershed Council, in 2015, stakeholders voluntarily formed a collaborative partnership to create a drought contingency plan for the watershed and establish drought preparation and response actions which accounts for economic, social, and environmental concerns. In this sense, drought conditions in 2015 had a positive impact on collaboration by raising the level of problem severity and helping stakeholders to recognize their interdependence. Thus, the North Santiam Watershed Council has promoted communication, knowledge of diverse perspectives, and contributed to relationship building and trust among stakeholders, supporting the high measures of reciprocity and strong social capital in the Watershed evidence in quantitative results.

Figure 9. Mountain snowpack and basin precipitation: Santiam Watershed in April 2015



(USACE, 2015).

Second, key government agencies are working collaboratively with local partners on restoration projects. For example, the USFW and ODFW are engaged in temperature and habitat monitoring to better understand needs for chinook salmon and have worked collaboratively on restoration projects, including the addition of large woody debris structures next to the local fish hatchery to encourage spawning outside of the hatchery. To make restoration financially feasible, local USFS staff helped to craft policy innovations that approve Stewardship Sales, which allow the proceeds of timber sales to be spent on restoration both inside the timber sale boundary area as well as outside on other high need forested areas. To coordinate timber sale proceeds and the purchase of large woody debris for restoration, the USFS is collaborating with the Santiam Watershed Council. One employee expresses his pride in the USFS' efforts to regularly engage in outreach and collaborative efforts:

> Collaboration and communication is really important and our ranger has been doing a great job with that. He's very outgoing and collaborative, trying to bring the different stakeholders together and planning big projects. Right now, we have the highway 46 planning area up the Breitenbush. It's a huge planning area and there's lots of projects that will be implemented. Not just timber projects, but river restoration projects that go along with that and so…the forest planner [and] the district planner have these public meetings where they gather people together and show them what we propose to do. And he's also had meetings with North Santiam Watershed Council concerning that big project and the kinds of projects that would come out of that. –Anonymous federal stakeholder (interview 3/13/17 B)

Another new collaborative in the North Santiam that focuses on restoration is the Partners of the North Santiam (PNS), founded in 2015. The PNS is an inclusive, watershed-wide collaborative group focused on salmon and steelhead recovery as well as pacific lamprey reintroduction. It was started by the North Santiam Watershed Council to improve communication and collaboration around restoration projects and is designed to increase adaptive management capacity by setting clear restoration goals by sharing information to "identify all of the potential projects in our high priority areas" and then "prioritize those as high, medium, and low," (Anonymous federal stakeholder, interview 3/13/17 B). When setting goals, the Partnership considers areas of vulnerability and resiliency to climate change and identifies activities that can be implemented to mitigate for drought, while ensuring that projects will affect "water quality, quantity, aquatics, riparian habitat, and terrestrial habitat," (Anonymous federal stakeholder, interview 3/13/17 B).

Organizations not directly involved in water management have also increased adaptive governance capacity in the North Santiam, indicating engagement across stakeholder groups. For example, the North Santiam Economic Development Corporation (NSEDC), which hosted a workshop to examine ways to revitalize the economy in the Santiam Canyon, is exploring how small forest products and tourism can foster economic growth. NSEDC serves the communities of Lyons, Mehama, Mill City, Gates, Detroit, Idanha, Breitenbush, and Marion Forks with the mission to, "enhance the economic, social and educational environment of the North Santiam Community and to assist in providing a high quality of life for all its citizens," (NSEDC, n.d.) The response to their workshops has been very positive: "the conversations are happening: they are having meetings and are really pulling together to try and find solutions locally," (Anonymous watershed council, interview 3/10/17

A). Highlighting the engagement in the Watershed, the Santiam Watershed Council Director stated, “I feel like everyone in the North Santiam is very eager to do what they can,” (Anonymous watershed council, interview 3/10/17 A).

The new levels of cooperation in the watershed have made stakeholders more successful in their grant applications and water managers believe that partnerships may even be required to successfully fund projects. The USFS has collaborated with North Santiam Watershed Council on grant applications as well as funding, which has opened-up staff time for the USFS to work with contractors instead of complete logistics and paperwork. Regarding collaborative grant applications, one respondent said, “individually you struggle for funding, but collectively you may be much more successful in getting funded those high priority projects that are going to provide the biggest benefit for salmon at the least amount of cost,” (Anonymous tribal stakeholder, interview 4/1/17).

4.2.2 Obstacles to adaptive and capacity in the North Santiam

Despite these steps toward greater collaboration in the North Santiam, interview results suggest that there are several important obstacles limiting the overall adaptive governance capacity. These challenges include distrust between local and federal partners, disputes over science and its application to water management, information asymmetry and poor communication among federal and local stakeholders, infrastructure limitations, and budget constraints, all of which are supported by quantitative results. Trust in federal government and scientists is not strong, water managers only slightly trust state government (See Table 45). While quantitative results suggest relatively strong networks in the North Santiam, water managers feel somewhat powerless in water management decisions (See Table 10), explaining poor communications between federal and local managers. Finally, as is the case with all other watersheds, quantitative results support inadequate financial and physical capital in the North Santiam (See Table 12).

First, concerns over management of the Willamette Project Reservoirs have contributed to low trust in the state and federal government. Water policy actors in the North Santiam feel that their needs will be impacted by the Willamette Project management, stored water allocation, and water rights management. This may explain the complete lack of support in the North Santiam for using regulatory tools to reallocate stored water (See Table 49). Specifically, they are nervous that OWRD will not observe senior water rights and OWRD and USACE will not take their needs into consideration in the Reallocation Study. Concern is framed as an equity issue surrounding the allocation of stored water, as an irrigation stakeholder illustrates,

> From a policy perspective if you took a snapshot in the Willamette Basin today the water behind the dams really isn't unallocated: it's going to fisheries. And that's ok if we're secure [irrigated agriculture] in our portion of the stored water, but I don't want to reallocate the stored water if some is going to go to fisheries, some is going to other consumptive uses, our district experiences increased scarcity…If the water is really going to fisheries purposes today and it's all needed for that then we should leave it alone and call it what it is. But if you start talking about divvying out additional [stored water] to others and existing agricultural uses can't have a portion of that, then it seems like there's maybe an issue. –Anonymous irrigation stakeholder (interview 2/16/17 C).

Irrigated agriculture in the North Santiam may be focused on the federal role in water allocations because they have the most at stake. As shown in Table 42, the North Santiam has more contracted stored water than either the McKenzie or the Middle Fork Watersheds. Furthermore, the large quantity of contracted stored water, 22,824.53 acre-feet, that does not specify a single reservoir in the basin, but rather draws from the Willamette Project Reservoirs, introduces both added flexibility and uncertainty (to be discussed in further detail).

Table 42. Stored water contracts for agriculture by stream reach

Reach	Reservoirs Upstream	Contracts	Acre Feet	Acres
Willamette River	All Reservoirs	45	22,824.53	11,289.45
Santiam River	All Reservoirs on North and South Santiam Rivers	3	242.30	323.30
North Santiam River	Big Cliff, Detroit	29	11,375.20	6,584.26
South Santiam River	Foster, Green Peter	13	913.61	491.68
Willamette River	All Reservoirs Except Santiam Reservoirs	28	15,603.39	11,015.16
Long Tom River	Fern Ridge	55	19,715.25	8,378.62
Willamette River	All Reservoirs Except Santiam and Fern Ridge	9	749.20	457.50
McKenzie River	Blue River, Cougar	31	1,772.41	910.64
Middle Fork Willamette River	Fall Creek, Dexter, Lookout Point, Hills Creek	2	910.73	472.29
Middle Fork Willamette River	Dexter, Lookout Point, Hills Creek	2	92.00	36.80
Fall Creek	Fall Creek	3	11.25	4.50
Coast Fork Willamette River and Row River	Dorena, Cottage Grove	6	581.28	232.51
Row River	Dorena	1	51.00	20.40
Coast Fork Willamette River	Cottage Grove	1	56.39	45.11
	Total	**228**	**74,898.53**	**40,262.22**

Source: (USBR, personal communication, 4/21/17).

Second, there are disputes over science and its application to water management decisions in the North Santiam. The previously reported quantitative results for trust in science are lower here than for other watersheds, and are also linked, at least in part, to the management of the Willamette Project. For instance, irrigation and state government feel that better science is needed to determine instream flows required for listed fish species and believe that storing more water in April and May, rather than releasing water as the BiOp requires could benefit fish later in the summer when water temperature is too high for some fish species.

Several water policy actors in the North Santiam believe that there is inadequate access to information regarding the hydrology in the Watershed (including irrigation return flows and groundwater–surface water interactions) and future demand for agricultural needs. Adding to the challenge in trust in science and available information is the contradiction between two recent agricultural demand studies by OWRD and WW2100. OWRD anticipated increasing demands, while WW2100 modeled decreasing demands for agriculture (OWRD, 2015; Jaeger et al., 2017). Water policy actors also believe that they do not have adequate knowledge about impacts of future policies and show some distrust for current information that drives regulation. For example, an irrigation stakeholder in communication with OWRD does not have full information on the impacts of the allocation of stored water, the future impacts of converting minimum perennial stream flows into certificated instream water rights, or the impacts of future revisions to the Willamette BiOp, as these changes have not yet occurred. Regarding the uncertainties, this interviewee stated, “to me, there are more unknowns than knowns,” (Anonymous irrigation stakeholder, interview 2/16/17 B). The same interviewee expressed skepticism of fisheries science that is driving current releases from the Willamette Project Reservoirs:

> USACE looks at different scenarios. A lot of them are based on snowpack. Snowpack's great. We love it, but these reservoirs fill with rain primarily. So, they base a lot of decisions on short-term and long-term forecasts. Sometimes-this is not a fun process to participate in-but sometimes NMFS are willing to settle for a lower outflow [from the reservoirs]. But that's certainly not their goal. Their goal is to meet the flows that the BiOp calls for. They set lower outflow targets in 2001, but the BiOp targets play a big role in how the reservoirs are managed. –Anonymous irrigation stakeholder (interview 2/16/17 B).

The USFS also stated the need for more research to develop infrastructure that promotes the passage of salmon. According to one interviewee, ODFW has studied the movements of salmon to “find a way to move the smolts downriver” and found that Detroit dam would need “a 9-mile long fish ladder to be able to get the gradient long enough to get fish to come up,” (Interview 4/1/17). The USACE is facing challenges regarding downstream steelhead passage for adult fish, specifically kelts, which are female steelhead which return to the ocean as adults after spawning. Adult salmon are currently trucked up the Detroit dam and juveniles do not have safe passage downstream.

Third, interviewees pointed to an information asymmetry, leading key stakeholders to believe that environmentalists do not understand the full complexity of irrigation management and surface water-groundwater interactions. For example, instream flows in Mill Creek are tied to return flow and seepage from the Santiam Water Control District, the largest Irrigation District in the Willamette Basin and the City of Salem holds a water right certificate to divert water from the North Santiam River into Mill Creek for aesthetic purposes. One irrigation stakeholder remarks that piping the District to reach 100% water conveyance efficiency would have detrimental effects, such as drying up Mill Creek in the summer, which flows through the heart of downtown Salem. This is “probably not what everybody would wish for if they knew and understood the whole picture and, but from a resource user's perspective I know that that's happening, but if you sat an environmentally-oriented person in that chair, they would probably say, ‘you need to be 100% efficient in your delivery of water because you're taking it out of the river and you're going to hurt the river’ without hearing that conversation,” (Anonymous irrigation stakeholder, interview 2/16/17 B). There is also a perception that “farmers sometimes feel very defensive because they feel like, oh people think we're being hard on the environment.”

Fourth, stakeholders highlight the inadequacy of information sharing and communication across several groups at the federal level. An Oregon statute “encourages” USACE to prioritize the filling of Detroit Reservoir for recreation purposes (ORS 536.595) and another statute requires communications in the watershed between the USACE and recreation interests (ORS 536.595). While USACE holds spring meetings in the town of Detroit to share reservoir management plans, some interviewees feel that communication is still insufficient. One federal stakeholder said, “It's hard getting USACE always to tell me what they're doing. The work in their own little world,” (Anonymous federal government, interview 3/13/17 B). Another federal stakeholder indicated that lack of communication has also resulted in USACE informing the USFS of actions they are planning to take without the knowledge that a permit is required for those actions.

A fifth limitation on North Santiam's adaptive governance capacity and the ability of water managers to address various impacts stems from budgetary and other financial limitations. For example, at the state and federal levels, staff recognize the importance of education and outreach, however budget limitations are leading to staff cuts. One federal stakeholder says, "My time is already stretched...overstretched. I have more things to do than I have time to do them. That's just the nature of the world we live in. We still try to meet the same number of targets with half the people that we used to have," (Anonymous federal government, interview 3/13/17 B). The large geographic area that the USFS district rangers cover reduces their ability to spend time educating the public on how to reduce their impact on land and water resources. At the state level, the enforcement office of the Water Resources Department has limited resources for outreach and education and just one or two staff manage very large geographic areas. As a result, watermasters do not have adequate resources to maintain property information for properties with water rights that are not regulated frequently, creating added stress during drought years. Recently, resources are increasingly stretched by the influx of farmers planning to grow marijuana, which was legalized in Oregon in July 2015 for recreational purposes, and are seeking property and water right support from OWRD. The following quotation illustrates these challenges:

> Watermasters don't have the capacity to educate users on regulation and water rights. They focus on this and do as much as they can, but have to cover such a vast area. The amount of time spent on "pesky little challenges" takes away from time spent researching and managing. Marijuana takes up lots of time with new people asking about properties and water rights. Eugene and Clackamas are slammed with this. –Anonymous state government (interview 3/10/17 B).

Another example to illustrate the point involves the USFS. USFS officials believe that, "from a fish or aquatic standpoint the single largest impact is roads," but they are financially limited in their ability to control those impacts. One USFS employee states, "we have a budget that enables us to maintain 30-50 miles of road a year on the district and we have over 1,000 miles of roads just in this district," (Anonymous federal government, interview 3/13/17 B). The USFS is also actively replacing culverts in Wilderness areas with natural step down crossings, not just to comply with the Wilderness Act, but also to maintain amphibian movement across streams, even when ESA listed fish are not present. This suggests a willingness to go beyond legal requirements in management goals.

The financial issues associated with government agency budgets also affects the development of necessary infrastructure. An Oregon Administrative Rule referred to as the "Three Basin Rule" (OAR 340-041-0350), which is effective in the Clackamas, McKenzie (above river mile 15), and the North Santiam, places restrictions on granting increases in "permitted mass load limitations" on NPDES permits for the purpose of maintaining the watershed areas that supply drinking water to the cities of Eugene, Salem, and Portland. One respondent pointed to this rule as a challenge for small towns in the Watershed and raised the equity concern of who should observe the cost of improving water treatment systems in these communities.

> Infrastructure is a huge challenge for the North Santiam because we have the Three Basin Rule that impacts development. So, the economies are pretty depressed in Idanha, Detroit, Gates, Mills City, and Lyons-Mehama. Their water systems, both delivery and waste, are old and they're leaking and even the City of Salem has a lot of piping delivery systems that are leaking and have issues. Waste management is a big challenge up in the canyon because towns can't discharge their waste into the river. So, in order for them to improve their systems, they have to find off-site land where they could dump the treated clean water. – Anonymous watershed council (interview 3/10/17 A).

Some municipalities in the North Santiam had their water rights regulated for the first time in history in the drought of 2015, suggesting a potential need for deeper wells or alternative supply. While smaller towns higher in the watershed have struggled to improve their water systems, the town of Stayton upgraded its water treatment facility at Geren Island was in 1996 to withstand higher turbidity levels (Mauldin, 2004). City of Salem's concerns over turbidity and sediment from forest roads has decreased as USFS road systems and culverts have improved.

Another obstacle to effective adaptive governance capacity in the North Santiam concerns the uncertainty and lack of clarity in the water rights system coupled with increasing federal authority over state water quantity management that is resulting in location-based seniority and uncertain future regulations. The

Willamette BiOp restricted the BOR from issuing new contracts for stored water in the North Santiam Watershed, while not closing other watersheds to new federal contracts for stored water with the same priority date. This has essentially created a prior appropriation system where the state water right system of seniority is trumped by the federal requirements created by NMFS for USACE.

> Should a 2017 Willamette River water user have the same exact priority and ability to withdraw water as a 1,000-acre right that was established in 1982? The reality is, they do. – Anonymous irrigation stakeholder (interview 2/16/17 C).

There are also several certificates for stored water in the Willamette Project Reservoirs that are held by the USBR. Some of these certificates give the USBR a right to a certain amount of stored water from the "Willamette Project Reservoirs," and other certificates give the USBR a right to stored water and "live flow." The complexity lies in the authorized points of diversion for these certificates and the lack of specification in contracts to use stored water that have been awarded by the USBR to irrigators. Thus, the lack of specificity of the water rights and the contracts has led to large sums of water that are difficult to account for.

Finally, the minimum perennial stream flows explained above create a situation where seniority of water rights is not clear and water managers do not have adequate information for managing water. The following stakeholder explains the challenge of coordinating state and federal water management:

> Another challenge for us is the different flavors of water rights in the Santiam. There are some that are very clear, which say your source of water is Detroit Lake. There are some that say your source of water is Detroit Lake and the North Santiam. So, if there's no storage that means [the water right holder] can take live flow. Live flow might be junior to the instream water right when it's converted…But if it's a year where the Bureau says, 'we don't have [enough] water to contract-we have to release it for BiOp flows,' then the water right that said Detroit Reservoir is your source, well you don't have access to your source, so you can't use it. And then we have other kind of wild cards out there. Since you can't get a new contract on the Santiam, there are people that haven't kept their contract valid. And if they've done that then they've really put themselves in jeopardy because they can't get a new one. You can't use your water right without a contract, so that would lead to some regulation down the road. – Anonymous irrigation stakeholder (interview 2/16/17 C).

One small step that water managers are taking to help relieve the uncertainty over water rights in the North Santiam is to improve water monitoring and auditing. OWRD is focused on ensuring that all larger diversions are monitored and metered, a condition placed on recent water right permits and certificates. This helps the watermasters know “who's using what and if it's right and if we need to cut it back or if they've used water after they've been cut off and things like that,” which requires “good outreach and education as to what we're doing so the people understand and some strategic measurement within the basin as far as auditing,” (Anonymous state government, interview 3/10/17 B). Measurement remains significant challenge, however. OWRD has identified “134 significant diversions within seventeen priority watersheds in the Willamette Basin. As of March 2007, about 44% of these…were being monitored, with fifty-nine measurement decides in place,” (Amos, 2014, 13). Monitoring is likely to be a challenge, however, because regulatory enforcement of monitoring is not supported by stakeholders in the basin (See Table 49).

A final potential obstacle to improving adaptive governance capacity despite the fact that water managers in the North Santiam are aware that they will need to adapt to changes in water policy and water availability in the future, is the general perception held by many that the water exists in abundance. This perception is stated by the SWC: “One of the things is for a long time we've seen the Willamette as always having water. We always have water. So, I think it's a relatively new idea that water isn't always abundant or may not always be abundant. So, I think it's something that we're not well adapted to.” Reflecting on the 2015 drought and changes in reservoir management, the SWC and the SWCD applied for a Water Smart Planning Grant and is starting to ask, “how can we better prepare for this? Because we're not prepared. If we have extreme drought, do we have emergency response systems in place that would have water trucks? Where would people go get the water to get delivered out to people?” (Interview 3/10/17). A Marion County has been addressing drought planning in their emergency management plan, but there is a recognition that more work is needed to prepare: “We don't actually have anything in place and a lot of the small cities don't have anything in place. So, I think it's being looked at more and more now, but we're far from prepared,” (Interview 3/10/17).

4.3 Qualitative results: McKenzie

Two interviewees identified with the McKenzie River: one from an environmental organization and another from the McKenzie River Watershed Council. Interviews showed that the McKenzie River Watershed is characterized by high social capital, clear restoration priorities, and strong leadership and coordination, which has led to innovation. Quantitative results support these findings with high levels of engagement, leadership, (Table 19) innovation (Table 18), and network strength and reciprocity (Table 15). State and Federal level actors have had a mixed role in promoting collaboration in the basin while the local utility, Eugene Water and Electric Board (EWEB), and Meyer Memorial Trust have played a strong role as collaborators and innovators. Quantitative results for the McKenzie show exceptionally high trust in municipal providers (Table 46), supporting EWEB's success in the watershed, and high scores for leadership, compared to other watersheds (Table 19). Adaptive governance capacity in the watershed is limited by finances, which limit the implementation of restoration goals. Although financial capital in the McKenzie is higher than the North Santiam or Middle Fork, it is still inadequate (Table 17) and water managers do not have adequate capacity to report on outcomes or analyze management outcomes (Table 18). Specific challenges the Watershed is facing include increasing commercial and residential development, agriculture, and forestry practices, which all have impacts on water quality. Numerous parcels of privately owned riparian land present challenges for educating landowners and establishing agreements to preserve and restore floodplain habitat. These challenges could explain the relatively high levels of support for regulatory tools to support long-term basin planning, demand projections, and water delivery efficiency projects (Table 50). Unlike the North Santiam Watershed, the drought of 2015 and the BiOp target flows did not emerge as prominent topics in interviews the McKenzie Watershed.

4.3.1 Strong social capital and local innovation in the McKenzie Watershed

And within our basin, we have huge collaborations. All of our work is collaborative. We try to get as many partners as we can at the table.
–Anonymous watershed council (3/13/17 A).

Interviewees focused on strong social capital, strong goals, and strong innovation in the McKenzie River, supporting quantitative results (see Tables 15 through 19). First, there are numerous partnerships in the McKenzie River Watershed and ongoing efforts to encourage coordination among watershed councils in the Upper Willamette Basin. Second, Meyer Memorial has improved coordination of restoration goals in the Watershed and across watersheds. Third, a local utility, Eugene Water and Electric Board, (EWEB) has implemented an innovative pilot program to improve source water protection and riparian habitat. Finally, the McKenzie River Watershed is hoping to implement new flow management techniques at Cougar and Blue River Reservoirs to improve fish passage.

One example of collaboration and strong relationships in the McKenzie watershed is the lower McKenzie River Partnership, which includes ODFW, EWEB, and the McKenzie River Watershed Council. These groups have been collaborating for twelve years to enhance fish habitat between Walterville and Leeburg diversions on the river. The partnership has focused on long-term restoration goals and partners share financial capital by using EWEB funds to match larger contributions from OWEB and others. Financial capital is then shared for restoration goals, including acquisitions and conservation easements coordinated by the McKenzie River Trust. Quantitative results that show a high trust in municipal/potable water and watershed councils are affirmed by the strong networks between the Watershed Council, EWEB, and other stakeholders (See Table 46). The McKenzie River Watershed has an additional partnership with the USFS in the upper reaches of the watershed that is largely focused on aquatic habitat work and a third collaborative is currently forming between watershed Councils in the Upper Willamette and the Trust and Friends of Buford Park and Mount Pisgah.

Financial incentives have encouraged collaboration both within and across watersheds, as one interviewee explains:

> How can we spend our dollars together better? Foundations are asking for that, it makes sense. If we're all going to similar foundations or agencies for the same grant request for the same kind of work for the same geography the response is, wow, wait a minute are you guys talking to each other about this it sounds like you're trying to do the same thing. –Anonymous watershed council (interview 3/13/17 A).

In addition to collaborating on grant applications, collaboration occurs more generally in the Watershed to stretch financial resources and human capital to their maximum. A watershed council representative explains, “We have dialogues going on constantly on how we can collaborate better, share resources, timing of project submission, because there's a limitation on funding. We have actually shared staff with other entities-other watershed councils.”

To overcome challenges with inadequate financial resources, Watershed Councils in the Upper Willamette Basin have shared work spaces, staff resources and expertise. The Watershed Councils have high reciprocity with the McKenzie River Trust, who secures conservation easements in turn for Watershed Council expertise in landowner relations. Additionally, Watershed Councils will complete restoration work on McKenzie River Trust conservation easement lands. The integration of land and water conservation demonstrates integrated water resources management. An anonymous environmental stakeholder remarks that, “over time you're going to see a consolidation of land and water conservation efforts. I think the next ten years is going to be some really interesting consolidation of things where we might be under one umbrella at least if not one roof, organizationally.”

Water managers in the McKenzie Watershed are working towards clearly identified restoration goals and prioritization of restoration sites with the leadership of the Myer Memorial Trust. Over the past eight years, the Willamette River Initiative has brought together the Myer Memorial Trust, BEF, BPA, ODFW, and McKenzie River Trust, among others, “to collectively come together around a prioritization to look at, given limited funding, limited availability, where can we really invest in trying to both pattern our own acquisitions or projects around those higher priority areas," (Anonymous environmental stakeholder, interview 3/3/17). Meeting restoration goals on the main stem of the McKenzie, where Cougar and Blue River Reservoirs block fish passage, will require significant investment from USACE.

Strong social capital in the watershed has enabled collaboration between McKenzie River Trust and EWEB, which has implemented an innovative pilot program to improve water quality. Protecting water quality in the McKenzie River is a high priority for EWEB, which provides drinking water for the city of Eugene and surrounding areas with water from the McKenzie River. The utility collaborates with local groups and has been identified as a key partner and leader in water quality protection as well as fish and wildlife habitat improvement. EWEB was praised as a "major player" and a "key partner." Water managers outside of the McKenzie River Watershed also pointed to EWEB as a successful restoration partner. EWEB has created a pilot program called Pure Water Partnership, which engages landowners in a non-regulatory, voluntary habitat restoration projects. The project is part of ongoing watershed protection to protect drinking water for the cities of Eugene and Springfield. The pilot program was established to develop a comprehensive water quality monitoring program and provide incentives for landowners to maintain high quality riparian habitat in exchange for annual payments from EWEB. The utility incentivizes property owners with land in the floodplain to pursue conservation-oriented land management practices and hires professionals to plant and maintain riparian habitat on residential properties.

The Pure Water Partnership program has increased awareness between urban populations and rural populations about the source of their drinking water and the importance of upland habitat for clean water supply. To date, the pilot program has worked with 15 landowners in the McKenzie River watershed (See Table 43 below), funded by a number of EWEB's partners, including OWEB, USFS Stewardship Contracting receipts, the Metropolitan Wastewater Management Commission, and local businesses (EWEB, n.d.). Overall, the pilot program increases EWEB's influence on private land management practices that affect water quality in the Watershed while promoting restoration goals and providing landowner incentives on parcels of land the McKenzie River Trust cannot protect with conservation easements due to high transaction costs. Connecting with private landowners is important for adapting to urbanization since some water managers believe the public does not have a strong understanding of the impact they have on the river through development in the floodplain.

Table 43. EWEB Pure Water Partners restoration (EWEB, n.d.).

PWP Pathway	Number of Taxlots*	Number of Acres
Protection	7	85
Restoration	6	16
Naturescaping	4	6

* Some landowners have multiple pathway recommendations for different sections of their properties.

EWEB has taken another innovative approach to water management through testing out a "Green Bond" project. The main supply of water for the city of Eugene is the McKenzie River, so water supply is sensitive to water quality conditions in the McKenzie. To create redundancy in the supply for the City of Eugene, the City is adding an intake on the Upper Willamette River, below the confluence of the Middle Fork and Coast Fork Willamette, where they are planning to construct an additional water treatment plant. To cover the cost for the additional intake and water treatment plant, EWEB is proposing a "Green Bond," which indicates the utility is responsive to customer needs. One interviewee explains the bond:

> To pay for that the Green Bonding, which is another innovative idea, EWEB requires a vote when requesting bonding authority, because they are a public authority. EWEB is convinced that the likelihood of that bond measure will go up if bond they promise to spend 25% of it on green strategies, including green infrastructure and ecosystem credit trading. Instead of spending 100% of the bond on a new treatment plant, we'll spend 75% of the bond on the treatment plant and 25% of the bond keeping the cost of that treatment plant down by avoiding the water getting degraded in the first place through things like better floodplain habitat and better resource management in the lands that drain the river. So, it's a much more comprehensive and integrated way to think about water. –Anonymous environmental stakeholder (interview 3/17/17 C).

A final example of strong adaptive governance capacity in the Watershed is the planned introduction of pulse flows to improve habitat for fish species, indicating strong innovation. The McKenzie River Watershed council is requesting pulse flows from the USACE, which operates Blue River Reservoir and Cougar Reservoir on the

McKenzie River. The reservoirs are significant barriers to fish movement and pulse flows provide high volume flows for a short duration, which can mobilize large woody debris and gravel from behind the dam, which are important elements of fish habitat. The planned program is an opportunity for USACE to support innovation at the watershed level, but local water managers understand the complex factors USACE must consider in their management.

> USACE kind of said yes [to implementing pulse flows], but it all depends. They have huge responsibilities- more than just helping us with our project, [such as] providing flows for people and fish down to Albany and [managing for] different patterns by season. They have a rule curve to follow. –Anonymous watershed council (interview 3/13/17 A).

USACE has changed management and made improvements to infrastructure since the issuance of the 2008 BiOp, however these were mandated changes, making it unclear whether USACE is willing to try new things without legal obligation. Pulse flow operations on the McKenzie present an opportunity for local-federal collaboration and innovation. USACE has constructed a temperature control facility at Cougar Dam and retrofitted an adult salmon collection facility at the base of the dam to truck adult fish above the dam.

4.3.2 Multiple barriers to adaptive governance capacity

Network strength between federal, state, and local partners in the McKenzie are barriers to adaptive governance capacity. The horizontal strength of networks and the vertical weakness of networks explain qualitative results of relatively neutral network strength (see Tables 15 through 19). Specific measurements for trust in water management decisions (Table 15) and trust in federal and state stakeholders (Table 46) support nuances discussed in interviews. Overall, interviews highlighted a lack of trust in state and federal government, inadequate information sharing, unclear information, and a lack of innovation and leadership all at the state and federal levels. Finally, a lack of awareness of human impacts on water resources is a concern in the face of increasing population growth.

First, interviewees provided examples of inadequate information. One interviewee reported that “lack of inertia” at the state level for sharing information with local groups has limited the formation of a strong collaborative research and monitoring framework. This water policy actor perceived a lack of coordination between USGS research on sediment and streamflow, USACE dam management, H.J. Andrews Experimental Research Forest research, and EWEB research and created challenges for an environmental organization to play the role of convener.

> I do feel like there is an isolation of OWRD from ODFW, from OWEB, from the watershed council work, from USFWS and a lack of coordination of data...I don't think it's a reluctance as much as an inertia around a real collaborative research and monitoring framework that would allow different agencies and groups to work with each other. –Anonymous environmental organization (interview 3/17/17 C).

Second, there are examples of distrust in state and federal government, despite quantitative results, which show that respondents in the Watershed trust state government and scientists (see Table 46). One interviewee expressed challenges with DEQ's water quality temperature standards, explaining concerns that temperature standards do not accurately reflect natural conditions because several streams have been listed in wilderness areas where there is no development and no ongoing logging operations.

> DEQ came to a monthly council meeting the other month. They gave us a presentation on TMDLs. It didn't help with the confusion it just made the whole process look of little silly. We're producing bull trout in some of the coldest, purest water around and there's nothing we could do to make it better than what it is. The fact that bull trout even live here means it's about the best water quality you can find anywhere in the country. –Anonymous watershed council (interview 3/13/17 A).

Another water policy actor expressed distrust of the federal reallocation study for the Willamette Project Reservoirs, indicating that environmental interests do not have equal power in the process and was also concerned that the study was creating a dynamic of pitting "an agricultural community of interest versus an urban community of interest," (Anonymous environmental stakeholder, interview 3/17/17 C). Additionally, there is concern that information regarding shift in future agricultural demands and demographics are not being discussed at a policy level. Thus, while collaboration among local partners is strong, networks across federal, state, and local levels do not appear as robust.

Third, some water policy actors feel that USACE has not communicated adequately regarding their fish hatchery operations management, causing anxiety among community members. For the past 70 years, ODFW has had sole source agreements to run USACE hatcheries, including Leeburg, but USACE is changing their hatchery management protocol and is beginning to contract out the management of several of its hatcheries in the Willamette Basin. The change in hatchery management may result in the closure of Leeburg Hatchery, reducing recreational fishing opportunities in the middle McKenzie River.

> The USACE kind of stepped on its own foot when they didn't really come out and get public input. They just said, 'oh, by the way, we haven't really been following what our lawyers think should be a proper procurement practice. We need to go out to bid for the hatchery contracts now.' So ODFW will not automatically run all the USACE hatcheries like they have since day one…It really upsets people here [the potential closing of Leeburg hatchery] because the whole guide business and most of the fishing relies on hatchery trout… states are having a hell of a time selling [fishing] licenses and getting kids interested in fishing. So, having a hatchery trout that you can go out and bait, catch and eat is important to many people…It's a part of history: the Leeburg hatchery. They have ponds where big sturgeon swim around and the kids come up and look at the trout. I'm not a big proponent of hatcheries, but nevertheless it's kind of a fixture. –Anonymous watershed council (interview 3/13/17 A).

USACE has the authority to make changes in the management in the hatcheries and a decision to change contracting of the hatcheries has not yet been made, leaving USACE an opportunity to work with local water policy actors and community members to examine innovative solutions to unintended consequences of closing the hatchery.

Fourth, interviewees provided several examples of poor innovation and leadership at the local, state, and federal levels of government, which in one instance left local managers unable to solve problems. For example, one water manager expressed concern that local government promotes the status-quo of supporting development, limiting the implementation of innovative regulatory tools, which quantitative results suggest are supported in the Watershed. While EWEB has only recently begun its watershed protection program, Bull Run watershed, which provides drinking water to the City of Portland, has had a water quality protection program since the early 1900's through strict development limitations. Such development limitations are politically unpopular in Lane County today. Challenges with county code are illustrated by the one interviewee:

> There's pretty good evidence that the implementation of Lane County code relative to riparian areas has been so riddled with exception. You can't build within this distance *unless* your situation is X and 'oh, your situation is ok.' [When someone says] 'I should be able to build in this spot because of this exception,' [the County says] 'ok you get that exception.' Lane County has been very reluctant to deny building permits in the floodplain. –Anonymous environmental stakeholder (interview 3/17/17 C).

One water policy actor suggested that the USACE was not innovative and responsive to local needs during the Metro Waterways Study, which this interviewee called a "failed project." In 2001, USACE, Lane County, and the cities of Eugene and Springfield began the Metropolitan Waterways Study to identify opportunities to improve the health of waterways in the metro waterways (USACE, 2014). From the perspective of one water manager, "it fell apart." The study focused on improving flows in Cedar Creek and Amazon Creek, "including moving and improving the diversion from the McKenzie to make Cedar Creek a viable place for fish and wildlife," (interview 3/13/17 A).

> USACE, at the tail end of the work, said to the City of Springfield, 'in order to do this we've got to buy these private properties and kick the landowners out,' and Springfield said, 'no way! We're not going to be part of that.' And that was the end of the Metro Waterways Study…they just made the decision 'we've got to more or less condemn these properties [or] purchase the properties or we can't do the improvements that need to get done.' *Of course,* not all the landowners are going to agree to work with you, so anything is going to be a voluntary solution. –Anonymous watershed council (interview 3/13/17 A).

During the Metropolitan Waterways Study, USACE had established plans for public engagement and solicited public feedback (USACE, 2005), demonstrating the USACE's efforts to communicate and engage the public, however involvement was still perceived as inadequate by some. When the study was completed and USACE's regulatory approach was not accepted by local partners, financial capital was lost for the project. Cedar Creek is still listed for water quality limitations due to storm water drainages and high water temperatures. Thus, while innovation may occur at the watershed level, state and federal support are often needed.

Fifth, a lack of adequate financial resources has restricted the ability of local water managers to meet some goals, indicating that financial capital is a barrier to adaptive governance capacity. An example of limited financial capital limiting goals was explained by one interviewee. Recently, EWEB was in the process of forming an agreement with FERC to make improvements for fish passage at the Trail Bridge Dam Complex. However, EWEB removed some elements of the agreement when the full cost was estimated, resulting in simplifying engineering plans to match availability of funding. At least one environmental group was not satisfied with the revised deal and left negotiations. While OWEB, which was established through the Oregon Legislature for the purpose of funding salmon restoration initiatives, provides financial assistance for restoration projects throughout the state, building capacity is still a significant challenge for watershed councils, whose staff are dependent on grant money from outside organizations.

Finally, the public's lack of awareness is also a barrier to adaptation that may become increasingly challenging as development of small, private parcels of land in the flood plain increases. Concern in the McKenzie Watershed is centered around existing and new riparian homeowners. Water managers are expecting population increases and rising pressure on riparian habitat due to private residences that lead to deforestation, habitat simplification, and an increase in non-point source pollutants such as lawn fertilizers.

4.4 Qualitative results: Middle Fork

Everybody's invited, everybody's at the table and we all think together about how we can address these issues –Anonymous watershed council (interview 4/1/17).

Only two interviewees identified with the Middle Fork in interviews, however several interviewees operating in the main stem discussed challenges in the Middle Fork System. While qualitative data is limited, interviews generally support quantitative results, which highlight strong reciprocity and innovation (Table 20 and 23), trust in the Watershed Council, and mixed trust in state and federal government (Table 47). Finally, interviews highlight challenges working with USACE, despite successes discussed in section 4.4.2, and the lack of adequate financial and physical capital.

4.4.1 Strong innovation, networks, and social capital in the Middle Fork

There is evidence of strong innovation in the Middle Fork Willamette Watershed between federal and local levels, which has led to changes in management that have reinforced relationships between local and federal water managers as well as with the Confederated Tribes of Grande Ronde. First, flow releases at Fall Creek have led to improved passage, second, innovation and strong relationships have led to passage for pacific lamprey, and finally, a local Forest Collaborative illustrates strong social capital in the basin. Quantitative results, which show relatively strong innovation (Table 23), strong networks and reciprocity (Table 20), and mixed trust in federal stakeholders, support interviewee's stories about the Middle Fork.

The release of pulse flows of water from Fall Creek Reservoir, the smallest reservoir in the Middle Fork Watershed, located on Fall Creek, has improved fish passage and relationships in the Middle Fork. The operation of the Willamette Project Reservoirs is a challenge in the Middle Fork because four dams, including Hills Creek, Lookout Point, Fall Creek, and Dexter Reservoirs, block fish passage for anadromous salmon. The BiOp requires USACE to provide upstream and downstream passage at Lookout Point Dam (NOAA, 2008). Middle Fork Willamette Watershed Council coordinated with local USACE dam operators at the Fall Creek facility to improve downstream juvenile fish passage through these flow management techniques.

> At Fall Creek, they have a system at the base of the dam to catch salmonids and other fish that are moving up into the system and truck and haul them over the dam. And more recently the operators of the dam lower it to near run of the river for a portion of the year, and they did that primarily to get chinook to pass. It was effective in passing over 20,000 Chinook in a year. –Anonymous watershed council (interview 2/21/17 A).

Figure 10. Fall Creek Reservoir Drawdown, 2015 (USACE)

The Confederated Tribes of Grand Ronde has also coordinated with local USACE operators at Fall Creek to allow for passage of pacific lamprey, a culturally important species for many tribes in the Willamette Valley, but not a federally listed endangered species. Social capita; between the tribe and local USACE staff allowed the USACE to utilize "the few remaining funds to modify the fish ladder [at Fall Creek Dam] to make it Lamprey friendly." Lamprey are an anadromous fish that is jawless and has a disc sucker mouth, making it difficult for the fish to navigate 90 degree angles. A modification of fish ladder at Fall Creek Dam allowed adult pacific lamprey to navigate up the dam and return to their fish catch facility in 2015 for the first time ever. One tribal stakeholder explains the significance of this event.

> We moved 240 fish a year. Usually 40 of those fish usually were tagged to track their movement. In 2013, the first year, we moved the lamprey up on the [Fall Creek] system and the following year we conducted spawning surveys. We found that they had successfully overwintered and that they had successfully spawned. That was the first time that lamprey had spawned in Fall Creek in nearly 50 years. It was big. It was really exciting news for us [the Confederated Tribes of Grand Ronde]. –Anonymous tribal stakeholder (interview 4/1/17).

Without investment from the local USACE staff, the passage of lamprey would may have been possible. In 2003, USWS received a petition to list pacific lamprey as threatened under the ESA, but USFWS found that "the petition did not provide the required information to indicate that listing the species may be warranted and, therefore, a status review was not initiated," (USFWS, n.d.). Lamprey are not a popular sport fish and ODFW does not sell licenses to catch lamprey, resulting in little research on lamprey and a lack of concern among the broad public. One interviewee explains that, without a federal listing, many species receive little protection, while the few listed species influence multi-million dollar decisions about ecosystem management.

> The whole ESA is set up so that until you're on death's edge you don't really get any funding or attention. And the species was proposed for listing I think in 2002 or 2004 and it was declined for listing but that was also because the folks that proposed listing for the species packaged a number of other lamprey, rare lamprey species in it and kind of muddied the information so it was easier for the government to say, well we don't know enough to know if we should list or not. Lamprey could be listed right now if they were listed as separate species. –Anonymous tribal stakeholder (interview 4/1/17).

The success in passing lamprey through the Fall Creek facility, which was a result of relationships between local USACE operators and the tribes, and a willingness to innovate, may have broad-reaching positive ecological impacts. Lamprey are a food source for sea lions, which are preying on 14% of winter steelhead, which is at less than 20% of its average run (Interview 4/1/17). Thus, despite flaws in the ESA legislation and political and scientific challenges in listing species, strong social capital between federal and tribal stakeholders enabled passage for lamprey at Fall Creek Dam. This success was very important for the tribes, who have some members that harvest lamprey as an alternative protein source and other members, especially elders, who enjoy eating lamprey (interview 4/1/17).

A local Forest Collaborative with USACE, EWEB, USGS, and ODFW and the Middle Fork Watershed Council also provides evidence of strong social capital in the Watershed. The Forest Collaborative has broad representation, but continues to work towards including more stakeholders. Like the Watershed Council, the Forest Service also serves as a convener in the basin, working with numerous stakeholders on different projects. Relationships between the Watershed Council and USACE are characterized by strong communication and information sharing, providing further evidence for strong social capital.

> We work with USACE on all kinds of things. Eric Peterson [USACE] is on our board and we regularly have updates from them [USACE]. We work with their fisheries biologist to help inform our habitat restoration prioritization because we need to understand how our proposed work affects or is going to be affected by current and future USACE management and how it can provide benefit to the USACE. It's a very open, inclusive relationship I would say…we consider them a great partner and all of their staff want to find solutions. –Anonymous watershed council (interview 2/21/17 A).

Overall, there is a strong culture of collaboration in the basin, which is supported by very high levels of reciprocity and network strength in quantitative results (see Table 20).

> I don't know if we're just lucky, but our group is very respectful and collaborative, so there's not a lot of conflict here. There are challenges, but there's not conflict among different user groups and I think that that just the culture here. Different stakeholders and different user interests are more likely to come together and find a mutually compatible solution then they are to stake a claim and not budge. –Anonymous watershed council (interview 4/1/17).

4.4.2 No innovation without motivation and no solutions without support

While there have successful collaborative projects between USACE and local water policy actors in the Middle Fork, results suggest that adaptive governance capacity in the Middle Fork is still limited by USACE's support for innovation and change. First, despite innovation at Fall Creek Dam to provide pulse flows for listed salmon and modification of the fish ladder to provide passage for pacific lamprey, water managers in the Middle Fork do not always receive support from USACE. Second, lack of adequate financial capital is a barrier to adaptive governance capacity in the Middle Fork. Finally, the Middle Fork is expecting increasing population growth, which would add additional pressure to natural resources.

USACE has several levels of management in the Willamette Basin and water managers expressed that local level managers are more adaptive and receptive to change than USACE staff operating at larger geographic scales. According to interviewees, social capital decreases with higher levels of management, where there is little face-to-face interaction with local water managers. Quantitative results show low levels of trust in water managers and mixed trust in federal government, echoing this concern. Reduced social capital with higher USACE management limits the application of innovative solutions. Despite success at Fall Creek, USACE is reluctant to invest funds in modifications at fish ladders for lamprey passage at other dams because there is no legal requirement. One explained that not all facilities have showed support for assisting lamprey passage and his experience with USACE has been that, "the higher you go up the chain, the less likely you're ever going to get someone to care," (Anonymous tribal stakeholder, interview 4/1/17).

CHAPTER 5: DISCUSSION

Some USACE staff did not show support for the drawdown of Fall Creek reservoir for passing juvenile salmon and indicated focus on USACE's role in managing flood control, instead of its role in managing ecosystems.

> Fall Creek was a reservoir put in as a flood control structure and if you go higher up the USACE chain, you'll hear things like, "Well, we can't flood people in the valley." But the folks that are actually running the faucet in the dam will say, "What we're doing when we manage it [Fall Creek Dam] to the run of the river is fully within our directive as a flood control structure and we can do it without having an impact on the purpose of flood control." –Anonymous tribal stakeholder (4/1/17).

The lack of fish passage at Hill Creek, Dexter, and Lookout Point presents a significant challenge for river restoration that cannot be overcome by the Watershed Council and their partners alone. Juveniles fish have high mortality rates moving through these systems and passage at some facilities will be considerably more difficult than at others, Lookout Point being a perfect example with a 13-mile long pool.

Another barrier to adaptive governance capacity is lack of adequate information and financial capital and a concern that water managers are not integrating science into management decisions, partly because adequate science may not be available. One water manager expressed that there is not adequate information to identify knowledge gaps and that there is not adequate funding to address knowledge gaps. Additionally, there is not adequate financial resources for the Watershed Council to respond to all requests they receive for restoration assistance. The Watershed Council relies heavily on grants and lacks capacity resources to hire additional staff. Quantitative results also show that financial capital is a barrier to adaptive governance capacity (see Table 22).

Finally, the Middle Fork is expecting increasing population growth and water scarcity, however solutions to these problems were not readily discussed. Farmers currently have difficulty obtaining new water rights in the Middle Fork, where surface water is fully allocated ten months out of the year. The Willamette River Initiative is addressing scarcity and population growth through land acquisition and habitat restoration, but balancing needs for water is still expected to be a challenge.

5.1 Federal involvement in western water

At the time of statehood, the Equal Footing Doctrine awarded western states entering the union the bed and the banks of navigable waters. This gave each state authority to manage water as a public trust resource for the benefit of its residents. However, at the turn of the 20^{th} century, the allure of federal investment in western water infrastructure, specifically large dam construction projects, resulted in increasing federal control over state water management (Getches, 1996). The constraints of federal law have increased the importance of federally-managed water contracts and decreased the importance of state-enforced water rights (Tarlock, 2001). The resulting state-federal nexus of water law has led to ad-hoc, basin-wide reallocations between local, state, and federal stakeholders, emphasizing basin-specific agreements, rather than consistent application of the doctrine (Tarlock, 2001). In addition to the influence of federal institutions, the doctrine of Prior Appropriations has been stressed by changing public interests, growth, climate change, and transition to a post-modern economy (Tarlock 2001). These stresses to the doctrine have led to the passage of instream beneficial use laws, which recognize instream flows for environmental needs as a beneficial use, and a transition away from traditional command and control structures to "co-management, adaptive management, and voluntary programs…[that] require citizen input as part of their structures," (Crow & Baysha 2013, 304).

Changing the federal influence on state water law management in the Willamette Basin requires a closer look at USACE. USACE's authority to manage the dams and allocate stored water is bounded by several laws, which increase federal control over state water management. The Water Supply Act 1958 act, possibly "the most significant law generally applicable to all dams," (Payne, 2014, 5) requires USACE to seek approval from congress for major allocation changes. As the management of the Willamette Project illustrates, the federal ESA can also have considerable power over USACE's dam management. ESA's authority over USACE's dam management is not unique to the Willamette, however. The USACE faced competing demands for stored water behind Buford Dam near the fast-growing

City of Atlanta. Competing downstream uses and water quality concerns introduced a flurry of lawsuits, but a 2006 FWS Biological Opinion for mussels and sturgeon had an immediate impact on USACE's management of the dams, requiring the release of 6,500 cfs from Lake Lanier (5,000 cfs during drought years (Payne, 2014).

The USACE is required to balance authorized uses and to "ensure that all uses are respected, that a public hearing occur for a change in the overall balance of uses, and that only non-major changes occur without congressional approval," (Payne, 2014, 5). When the Willamette Project was authorized in 1938, Congress gave the Secretary of War authority to create and implement regulations for flood control and navigation (Amos, 2014). However, a project cannot be modified "unless a report for such project or modification has been previously submitted by the Chief of Engineers, United States Army, in conformity with existing law," (Amos, 2014; 33 U.S.C. § 701b-8, 1954). Payne (2014) suggests that USACE would have more flexibility to practice adaptive management if Congress clarifies "that it may also become necessary in the future to limit navigation, flood control, hydropower, or other authorized uses to allow for environmental protection," which would "further clarify the USACE's authority to make reallocations and rebalance uses as climate change alters flow and societal values shift," (Payne, 2014, 7). To increase local influence over water management, the USACE needs to recognize its existing discretion without "favoring of vocal, intense interests…long-standing policies, outdated water control manuals, and contractual obligations like hydropower production," (Payne, 2014, 2-5). Federal agencies must also recognize that states will incur transaction costs related to adapting their water laws, which may present "tradeoffs between up-front costs of modifying water statutes or administrative procedures to clarify the dimensions of individual water rights and the subsequent dispute-related transaction costs arising from the efforts of water users to modify or expand their water uses," (Miller et al. 1997, 170). As institutions change, policy literature should address the normative question: "who should bear the cost of environmental preservation and restoration when climate change is a factor in the degradation?" (Miller et al. 1997, 173).

5.2 The importance of trust in adaptive governance capacity

Results demonstrate that overall, conservationists, agencies, water providers, and scientists have found shared values and developed strong relationships in the Willamette River Basin. However, there is a low level of trust between several groups in the agricultural community and the environmental community with more extreme views and there appears to be an urban/rural divide that suggests further analysis of results is needed. Several kinds of trust have been identified in social psychology and policy research. Context-specific trust involves an expectation of another person or group to do or not do something and social trust, which is less related to actions, is a "perception of shared values, identities, and experiences," (Stern & Coleman, 2015, 119). Both kinds of trust can reduce transaction costs of collaboration, but the more important the outcome of collaboration, the more trust is needed (Stern & Coleman, 2015). When stakeholder groups are unable to achieve their goals through traditional strategies, including collaboration, they may engage in "venue shopping," to identify an alternative problem solving venue that will be more effective (Ley, 2016). Venue shopping theories do not explain *how* a group succeeds in policymaking within a venue, but seek to explain *why* groups choose one venue over another (Holyoke, Brown, & Henig, 2012). Problem solving venues may include state legislature, federal legislature, local government, courts, and collaborative groups. Empirical research has found that groups chose venues for impacting policy and management decisions by assessing the institutional context of each venue (Ley, 2016). To assess the context, groups examine their available resources, their opponents' resources, and how accessible the venue is, which is "a combination of opponents' degree of control over a venue and a venue's image amiability or receptivity," (Ley, 2016, 506). For example, the courts may be inaccessible for one advocacy group without sufficient financial resources to hire a lawyer, but may be preferable for another group with legal expertise on staff and a membership base that looks favorably upon the courts as a venue (venue image amiability). Additionally, the courts may be perceived as a receptive venue for environmental organizations when legal challenges are accessible due to existing laws. Groups may choose one venue that is viewed favorably, instead of pursuing multiple venues, when they have limited resources (Holyoke, Brown, & Henig, 2012).

As was briefly mentioned, there is evidence of venue shopping in the Willamette Basin. The Oregon Farm Bureau, which demonstrated low levels of trust in environmental organizations at the "Within Our Reach" conference (personal observation, 12/9/16) has chosen the state legislature as one of their main venues. The image below illustrates the organization's encouragement that members contact state government, the venue of choice (Oregon Farm Bureau, n.d.)

Figure 11. Venue shopping in the Willamette Basin

Another advocacy organization, Water Watch, encourages members to use several venues to pursue goals, including federal government, state government, and letters to the editor (Water Watch, n.d.). Venue shopping may be a barrier to adaptive governance capacity, which recognizes that diverse interests and institutions must evolve over time to respond to exogenous and endogenous changes. When an advocacy organization identifies a venue that is favorable to their concerns, they can "maintain a status quo favoring their interests in the face of negative public opinion," (Holyoke, Brown, & Henig, 2012, 9). Policy Feedback Theory posits that past policies can shape the future by providing benefits to some groups, influencing participation, creating incentives for interest groups by shaping their activity and resources, influencing whether lawmakers view activities as legitimate or illegitimate, and building procedures that affect decision for future administrators (Mettler & Sorelle, 2014). This suggests that venue shopping, when it becomes locked-in, can reinforce existing equity issues.

In their overview of collaborative governance literature, Chris Ansell and Alison Gash (2008) find that "high conflict situations characterized by low trust [can] still be managed collaboratively if the stakeholders [are] highly interdependent" (563). Quantitative results from this research across all watersheds show that water managers believe that conflict will increase over the next 10 years and a recent water users survey in several Willamette Basin counties found that residents believe there will be decreasing certainty of water supply in the future (Morzillo, 2015). Does this matter? The lack of adequate financial resources in the basin and recent budget cuts (Edwards, 2017) may restrict organizations to their traditional venues and limit resources available to travel and participate in collaborative efforts. If collaborative efforts continue with reduced participation, they may lose legitimacy in the public sector because collaborative processes that are viewed as excluding relevant stakeholders may be viewed as illegitimate (Johnston et al., 2010).

5.2.1 Overcoming low trust and promoting collaboration

This study suggests that there are several stakeholder groups in the Willamette Basin that are distrusted. Specifically, interviews and participant observation demonstrate that some irrigation stakeholders have low trust in environmental groups. This finding is important because irrigated agriculture contributes to 80% of water withdrawals in Oregon (as quoted in Hubbard & Wolters, 2014) and addressing changes to supply and demand and providing sufficient instream flows for wildlife will require collaboration with irrigators. This is also important because results from this study show that water managers believe conflict is likely to increase in the future over water resources and exogenous stressors such as climate change and population growth are anticipated to increase, adding further stress to the water resource system. In parts of Oregon, many irrigation water rights are senior to instream rights, adding challenges for instream ecological restoration. Senior water rights holders often have less incentive to conserve water because their supply is secure, while junior water rights holders are often more interested in conserving water because they recognize that reducing overall water use in a system can increase their supply reliability (Tarlock, 2001).

Improving trust between agricultural water users and environmental groups will require an understanding of shared values and history. Western states, including Oregon, have become both increasingly populated and urbanized over the past four decades, shifting from an economy dominated by natural resource extraction to one dominated by the service industry. According to Albrecht, Oregon's population increased 40.5% between 1980 and 2006 (as quoted in Wolters & Hubbard, 2014). Hubbard's analysis of metro and non-metro counties in Oregon found that all but one (Jackson County) of Oregon's metro counties, or counties with urbanized areas of 50,000 or more are located within the Willamette Basin and all but one county (Linn County) in the Willamette Basin is a metro county (as quoted in Wolters & Hubbard, 2014). In general, research on environmental beliefs has found that young, urban, and educated populations tend have more bio-centric views than rural, older, and less educated populations (Wolters & Hubbard, 2014). However, Wolters and Hubbard (2014) assessed these differences in Oregon, including belief in anthropogenic causes of climate change and bio-centric views measured on the New Environmental Paradigm Scale, and found that differences, while statistically significant, are small and often overstated. Specifically, Wolters (2014) found that living in a rural area is not a significant predictor or environmental beliefs.

There may be more similarities between the agricultural and environmental communities than we expect. Quantitative results from this study found that a majority of respondents ranked availability of clean, potable water and a high functioning river system as the most important water uses in the next 20-50 years (Figures 6 through 7), demonstrating shared values in the Basin. This research suggests that trust environmental organizations is strong in the McKenzie, indicating that environmental organizations in this watershed may have developed strong relationships with irrigated agriculture and may have lessons to share with other watersheds. Water policy actors in the Middle Fork have strong trust in agriculture, ranching, and irrigation, which presents another opportunity to examining how trust can be improved in other areas in the Basin.

Stakeholders in this research included irrigation, agriculture, and hobby farmer, however, water policy actors operating at the management level were targeted for purposive sampling. Future research should be expanded to include individual farmers, since farmers are not all represented by irrigation districts in the Willamette Basin. This research could help identify differences between senior and junior water rights holders and possibly identify adaptive governance capacity builders who can build trust across stakeholder groups.

To bridge the gap between agriculture and environmental groups, discussions about water management in the Basin between environmental organizations and agricultural communities should focus on shared values and discussions about climate change can also be framed in a way that highlights shared values, rather than different ideologies. Instead of bringing stakeholders together to discuss "climate change solutions," stakeholders should be brought together to create "resilient communities" and to "plan for extreme weather events."

Maintaining local control, which is important to many rural communities and farmers, can also serve as an incentive to collaborate with environmental organizations. When local stakeholders can work together to create management goals and produce outcomes that improve environmental conditions, they may be able to avoid litigation from an environmental organization that operates at a state-wide or national level, rather than a local level. Environmental litigation can introduce static, quantitative requirements for improved environmental conditions whereas local groups can create water quality and quantity goals that are suited to the appropriate scale and are both qualitative and quantitative.

The recent FEMA BiOp discussed in Chapter 4 is an example of a court ruling that could reduce local control of floodplain management. The BiOp establishes Reasonable and Prudent Alternatives, which are non-discretionary, including revising FEMA's floodplain management criteria and conducting "community assistance visits" in the Willamette Valley to communities with 1% or more development within their jurisdictional floodplain, (NOAA, 2016). The BiOp also outlines discretionary recommendations for conservation actions FEMA may take to reduce harm to federally listed species. These include strengthening regulatory foundations for ESA compliance, improving levee habitat quality, provide credits to communities who complete specific restoration activities, and establish minimum lot sizes for flood hazard areas (NOAA, 2016). Collaboration between environmental organization to improve floodplain ecosystem function through activities such as riparian tree planting, invasive species removal, improved culverts, fish screening, and cattle fencing, or reducing tile draining could avoid future federal regulations while meeting specific environmental outcomes for the FEMA BiOp.

In addition to local control, floodplain restoration and investing in water conservation strategies may increase resiliency for farmers. Riparian buffers can attenuate floodwaters, excluding cattle from riparian areas can reduce erosion, and removing invasive species can reduce competition with crops. Investing in water conservation practices can increase reliability for farmers with junior water rights, who may be shut off during drought years. Senior water right holders, on the other hand, may increase their economic efficiency by reduced pumping costs and fertilizer run-off by increasing irrigation efficiency.

While respondents in this study generally agree that they have the capacity to plan and manage outreach activities, some interviewees indicated that lack of adequate financial capital has reduced this capacity, especially at the state level. In order to increase the amount of voluntary riparian restoration and irrigation efficiency, ODA, OWRD, Soil and Water Conservation Districts, and Watershed Councils who all work directly with farmers, require additional resources both to for staff capacity and for project funding. In particular, groups with "collaborative capacity builders," leaders who improve network strength, information sharing, integration of information, and learning (Weber & Khademian, 2008), should receive financial support. For example, watershed councils should be the target of additional capacity funding because they are highly trusted across the basin and in the three selected watersheds in this study and consequently are likely to have the greatest success in building trust with farmers and landowners. The Oregon Water Resources Congress, which represents irrigated agriculture in Oregon, may also be a strong bridge between environmentalists and irrigators. They engage a diversity of farmers and, recently, marijuana growers, through education and outreach and they have the potential to encourage idea sharing across diverse groups.

Improving collaboration requires making small wins and improving relationships and learning, rather than focusing on large project goals and project completion. Collaboration is more than just working in partnerships to complete a task and success cannot be measured by project outcomes alone (Weber, 2005). Groundwater decision-making groups in California believe that providing improved education and awareness to famers and providing incentives for participating in collaborative decision-making processes are important for increasing participation (Brown, Langridge, & Rudestam, 2016). Efforts to educate and promote awareness will require innovative ways to include absentee landowners and different values about land management, which can be barriers to collaborative capacity (Chamley, Long, & Lake, 2014).

5.3 The role of scarcity in adaptive governance capacity and vice versa

Water scarcity is expected to increase cooperation in river basins where expanding supply is constrained by the impact of new projects and the reduction of available supply. However, in order to address new challenges in river basin management, political reforms need to encourage open and inclusive government and "increased public scrutiny of traditional evaluation tools such as cost-benefit analyses and Environmental Impact Assessments," (Molden, 2007, 586). In other words, elements of adaptive governance capacity should be developed to cope with increasing challenges river basins are facing. In basins facing water scarcity, challenges occur when water supply is constrained by contamination, overdraft of aquifers, climate change-induced variability in the natural system, and constrictive management of dams. Demand increases may simultaneously occur from an increase in non-agricultural water requirements, an increase in irrigation, or increasing water allocations for environmental flows (2007, Molden).

Both positive and negative feedbacks occur when river basins are closed to new water uses. First, "the interconnectedness of the water cycle, aquatic ecosystems, and water users increases greatly," (Molden, 2007), which can result in increased understanding and awareness among users, but can also lead to third party impacts as groundwater becomes tapped, canals are lined, and micro-irrigation is installed. Groundwater withdrawal from one well can affect a neighboring well as cones of depression overlap and reduced seepage and return flow can result from canal lining and efficient irrigation practices. Users may adapt to scarcity by conserving water, resorting to multiple sources, and reusing local losses (Molden, 2007), and reallocating water. First, "new" sources of water sought include new dams, new wells, diversions from neighboring basins, desalination, artificial aquifer recharge, and cloud seeding. Second, conservation occurs structurally (canal lining, wastewater treatment, water saving technologies, and repairing leaks) and non-structurally (dam management, policies, crop rotation, and changing cultivation techniques). Finally, reallocating water occurs both within or across water sectors, such as within a farm, between farms. Thus, responses to scarcity fall into three main categories: capital-intensive, management and conservation focused, or focused on reallocating water to higher uses.

Responses to scarcity can exacerbate problems or enhance resilience. For example, competition between regions can also create a race to accumulate the last available water, resulting in overdeveloped and uncoordinated infrastructure (Weber, 2005). In contrast, "better collective management of scarcity also results from closer monitoring of flows, involvement of users, participatory planning, stricter rotations and scheduling, and definitions of entitlements," (Molden, 2007, 595). The three watersheds selected in this study had varying levels of water availability, however policy constraints and management of infrastructure appear to have a stronger influence on water use than OWRD's measures of water scarcity. Each of the three basins has collaboration as well as conflict, but the formation of the North Santiam Drought Contingency plan is the clearest evidence that increasing water scarcity can lead to new partnerships and management schemes. Specifically, the North Santiam Drought Contingency Planning Group is examining instream water right transfers, and coordination of water curtailment plans across the watershed.

This study also shows varying levels of support for monitoring users and a lack of clear definitions of entitlements creating uncertainty for some user groups, suggesting that responses to scarcity have not always involved "better collective management." Water managers in the Willamette Basin also pointed to a false perception of abundance, which they believe is a problem for water management. Indeed, a false perception of abundance and limited support for regulatory tools to manage water may limit the Basin's ability to adapt to scarcity through management and conservation approaches. This research shows that the Willamette Basin is, in fact, focused on reallocation as a tool to address water scarcity rather than intense conservation practices. OWRD and USACE have supported the Reallocation Study because they view the federal reservoirs as a preferred "new" water source (OWRD, n.d.) This approach highlights the way in which OWRD still sees itself as a provider of water, rather than an agency focused on Integrated Water Resources Management, as its most recent statewide strategy directs. This inertia is likely a result of vestigial values of OWRD in the past decades and pressure from the legislature and other parties. Reallocation, such as is occurring in the Willamette Basin today, needs to be handled with care, as it introduces "a new pattern of access to resources [which] often stirs opposition and conflicts," (Molden, 2007, 595). Expectations for the reliability of stored water rights should be tempered so conflict does not arise when new water users purchase contracts for stored water only to discover that their water right is not fulfilled 8 out of 10 years because it is required to fulfill BiOp targets at the Albany and Salem measurement gages.

Water managers in the Willamette have also focused on infrastructure development as a response to scarcity. While this was not a topic of interviews, an example of an infrastructure-heavy response to water scarcity is the new pipeline which the City of Hillsboro and is constructing a 30-mile pipeline to supply Willamette River water to its customers (Tims, 2015). The pipeline is expected to cost approximately $1 billion dollars (Tims, 2015) and each piece of the earthquake-proof pipeline is 66 inches in diameter and weights 24,190 pounds. While OWRD has invested $750,000 in grants for the Place Based Planning Pilot Program, it has invested $2.8 million for feasibility studies and $14 million in grants or loans for water supply projects (OWRD, 2017).

5.3.1 Vulnerability in the Willamette Basin

Quantitative results show that water managers generally do not feel they can adapt to changes in supply and demand, indicating that challenges lie ahead as population is projected to increase by 3.05 million people between 2010 and 2100, a 111% increase (Bigelow & Plantinga, 2016). While population growth was mentioned in several interviews, the challenge of meeting demands was not directly discussed. Several municipalities in the Willamette Basin had their water rights regulated for the first time in history during the drought of 2015 (interview 3/10/17

C). Future modeling is needed to determine the reliability of municipal water supply and the reliability and sustainability of seeking additional municipal supply from groundwater or federal stored water to meet rising municipal demand.

Recent WW2100 modeling results found that the Willamette Project reservoirs serve to buffer the impacts of climate change by providing flood risk management into the future as well as more secure instream flows during the summer. Inflow into reservoirs is expected to be similar or slightly higher than historical norms, except during early summer and late fall (Tullos, Walter, & Moore, 2016). Instream flow targets would not be met during the summer months in the absence of the reservoirs (Tullos, Walter, & Moore, 2016). Future modeling should examine the effects on water right holders if the minimum perennial stream flows are converted, and how USACE's releases from the reservoirs would change if minimum perennial stream flows were converted.

Many interviewees mentioned climate change as a concern, but did not elaborate extensively on the challenges it poses and only one interviewee mentioned forest fires as a threat to water resources. Wildfires in the Northwest have increased over the past four decades from 23 days with wildfire in the 1970's to 116 days with wildfire in the 2000's (OCCRI, 2007). As snow-water equivalent declines in low elevations by as much as 94% over the next century (Turner & Gilles, 2016) and temperatures rise, wildfire intensity is expected to increase. Increase in fire is a significant future threat to water resources because wildfire changes the hydrologic response of ecosystems and can increase sediment load into reservoirs (Dalton et al. 2013). Increasing education of wildfire threats and planning for water resources resiliency in the face of increasing wildfires is needed to address climate vulnerability.

5.4 Study limitations and analysis recommendations

This study has several limitations, including the number of questionnaire respondents and interview participation across stakeholder groups, the limitation of watershed-level results to the selected watersheds, and necessarily limited legal analysis. While survey and interview data collection had adequate response rates, especially given the national election and extended Oregon legislative session, the number of water policy actors surveyed was limited. The extensive time commitment of purposeful sampling, which should not be underestimated, ultimately limited the number of surveys solicited. Small sample size limits statistical analysis of survey results to non-parametric statistics and limiting the confidence of results in the smaller watersheds. Several stakeholder groups did not participate in the survey at all, including aquaculture, recreation, ranching, timber, hobby farmers, and tribes. Ideally, survey responses would include several individuals from each of these stakeholder groups. Non-participation by these groups may represent a lack of trust in University research or a lack of adequate financial resources to spend time responding to surveys. The mean score for trust in stakeholder groups may be even lower with greater response rates, especially if non-respondents did not participate in the questionnaire due to distrust in scientists. Follow-up phone calls had a limited impact on survey response rates, however the time-consuming method of obtaining personal connections through interviewees and crafting personalized emails requesting survey participation were the most effective.

Where stakeholder groups did not participate in the survey, this research is limited in understanding their challenges and needs in water management. While interviews provided clues as to poor networks between the recreation community and other stakeholder groups, this perspective needs to be further examined. Further interview or document analysis should examine the role of hydropower and recreation in the Willamette Basin Review Study. Quantitative results for the main stem found very low trust in hydroelectric groups (Table 44) and relatively low across the other watersheds. The eight Willamette Project dams with hydropower plants have the capability of producing 408 megawatts of electricity, which is marketed by Bonneville Power Administration (an “action agency” in the BiOp). Hydropower turbines are responsible for mortality of fish species and contribute to the alteration of flows through ramping rates (USACE, 2017). Hydropower is among the user groups all seeking slightly different management of the dams and benefits from hydropower are easily monetized, whereas benefits from fish survival are more difficulty to quantify. This alone gives hydropower significant influence, signaling the need for more research on how well the public understands the impacts of their electricity consumption on water resources management. Recreation opportunities bring over 3.5 million visitors to the Willamette Basin annually, creating an estimated $100 million in economic benefits annually (USACE, 2017). When reservoir operations do not favor flat water recreation, towns such as Detroit, Oregon lose significant income and employment opportunities. Thus, it will be increasingly important to understand how water managers can recognize and reconcile the social, cultural, and economic meanings of water.

While results from water managers operating at a basin-wide scale provide clues as to the strengths and weaknesses in the water management regime, each watershed in the basin is unique hydrologically and socially, limiting the ability of results to be extrapolated across watersheds. For example, relationships with USACE have unique histories in each of the three watersheds illuminated in this study, and will also be nuanced in the South Santiam, Coast Fork, and the Long Tom River, which all have Willamette Project reservoirs. This research highlights the important role of the USACE in water management in the North Santiam, McKenzie, and Middle Fork watersheds, however relationships with federal government and polycentric governance challenges are likely very different in coastal watersheds in the Willamette Basin.

Finally, this study is necessarily limited given the complex array of laws influencing water management. Legal analysis included in this study illustrated numerous complexities underlying governance challenges in the basin, but more research is needed to understand the relationships between political will, social capital, financial resources, innovation, and policy change. Legal scholars have recently focused on the role of legal adaptation in the ability of complex socio-ecological systems to adapt to change (Craig, 2009; Cosens & Williams, 2012; Amos, 2014). Discretion among agencies and regulators, policy legacies, and land use policies affecting water management are all important indicators of adaptive governance capacity. For example, Amos (2014) highlights the high level of discretion awarded to USACE in the Willamette Basin, which can put to rest misnomers about barriers to policy change, such as when congressional approval is required.

An examination of legal adaptation should include city and county level laws because these have a significant impact on urban development and water use (Hanak & Chen, 2007). In Oregon, examining opportunities for improving county regulations that exempt developers from building in the floodplain may become increasingly important (or obligatory) as a new BiOp is implemented (NOAA, 2016). On the scarcity side of water management, Oregon counties can also take lessons from Colorado and New Mexico, which have regulations requiring that future developments are only conditionally approved based on the adequacy of long-term water supply, which reduces negative externalities of growth. These regulations have limited some growth to urban areas and have little to no effect on housing availability, but they have had mixed results on aquifer withdrawals, due to loopholes, such as exempt domestic wells (Hanak & Chen, 2007). Thus, an examination of legal adaptation should be included in any study of adaptive governance capacity.

In addition to document analysis, this questionnaire examined legal tools, including the clarity of jurisdictional authority, support for regulatory management tools, and conflict (which may include litigation). In the future, the adaptive governance capacity framework applied in this study could be adjusted to better examine how the legal framework influences adaptive governance capacity. For example, an additional question could be added, which addresses polycentric governance, such as “legal authority is shared among multiple agencies” or with an open-ended question that asks respondents to identify specific laws that are barriers or opportunities to adaptive governance capacity.

5.5 Survey strengths and recommendations for further survey improvement

The survey instrument used in this study is an effective tool for illustrating strengths and weaknesses in adaptive governance capacity in a watershed, however there are elements of the survey that could be improved and factors to consider in study design when using this survey. Several survey measures for social capital had high external validity, however several of the questions grouped as measures of social capital appear to more appropriately measure latent concepts of governance. Second, the survey did not capture governance challenges in the North Santiam watershed. Finally, the survey tool also requires the addition of several management tools which surfaced in interviews.

First, the survey tool measures for social capital among water managers in the Basin were very effective. Measures of network strength and reciprocity matched interview responses: where network strength and reciprocity were high, water managers were collaborating on restoration projects, drought planning, and grants. Measures of trust were also valuable because some respondents do not always readily discuss in interviews. However, trust in municipal water providers was high where EWEB was collaborating with landowners and trust measures were low when stakeholder groups were initiating lawsuits, lobbying, declining to interview, and expressing skepticism. Interactions observed at the "Within Our Reach" conference further illustrated low trust between environmental and agriculture stakeholders and survey results demonstrated low trust in irrigated agriculture, hobby farmers, and landowners, supporting these observations. Additionally, trust in aquaculture is especially low in survey results and the recent May Lawsuit displays this distrust in fish hatchery management. While trust in other water managers was high at the watershed level, the survey measures of trust in specific stakeholder groups captures the nuances and should be analyzed further.

Two specific measures of social capital require further attention because they illustrate survey weaknesses. First, the measure of whether water managers "feel powerless" to solve water management problems was low across all watersheds while other measures of social capital were quite high. Second, the measure of trust in water manager's decisions was especially low. Exploratory factor analysis completed on survey results in the Deschutes and Snake River Basins grouped these operations with social capital. However, theoretically they fit more appropriately with measures of governance because they illustrate trust in governance and the extent to which the governance system is adequately polycentric. Currently, the survey includes three main measures of governance: authority, leadership, and engagement. To measure authority, the survey focuses on the clarity of water right seniority, the clarity of jurisdictional authority, and how groundwater use affects surface water. While these measures are obviously important and were a topic of serious concern for several water managers, they do not fully encompass the concept of governance. The survey tool measures of governance should better capture the current thinking on governance. As Ostrom (2005) explains, "The introduction of the term 'governance' signaled a change in thinking about the nature of policy. The notion of government as the single decision-making authority exerting sovereign control over its citizens has been replaced by multi-scale, polycentric governance approaches that recognize the contribution of a large number of stakeholders, functioning in different institutional settings," (Pahl-Wostl, Mostert, & Tahara, 2008, 1). When multiple stakeholders are actively involved in natural resource governance it may not be clear who has jurisdictional authority, but stakeholders may have high trust in water management decisions.

Governance challenges, which were prominent interview topics in the North Santiam watershed were not fully captured by governance elements in the survey instrument, but appeared in other adaptive governance capacity measures. The North Santiam watershed had relatively high measures for authority measured by who has jurisdictional authority to make decisions, who has senior water rights, and the clarity of how groundwater use affects surface water (Table 14). In interviews, it became clear that the reallocation of stored water and the conversion of minimum perennial stream flows were a concern among some water managers. This may not have been captured in the survey for several reasons. First, it is possible that not all water managers have knowledge or understanding of this issue. Second, another measure may more appropriately capture these governance challenges such as access to information, which was not strong (Table 10), and trust in water management decisions and trust in other stakeholders, which were also not strong the watershed (Table 10). The vulnerability that one irrigation stakeholder felt to state and federal management decisions may be capture in the means for "ability to adapt." Survey respondents in the North Santiam do not believe they have a strong ability to adapt to changes in supply and demand (Table 14) and are uncertain whether they can capitalize on changes (Table 14).

To further improve the survey tool, several water management tools should be added. Improving the list of tools is important because quantitative results for support for water management tools proved a strong indicator of challenges facing each watershed. For example, in the North Santiam trust in federal government was not especially high and there was significantly lower support in regulatory allocation of stored water, both salient topics in interviews. The management tools on the questionnaire used for this study are focused largely on water quantity management, rather than quality and total ecosystem functioning. Water management tools that were mentioned in interviews include land purchases for floodplain restoration, water quality trading, and defining “waste” in statute. Additional tools were also uncovered through this research, including the implementation of water shares, instead of water rights and public interest review for water rights.

CHAPTER 6: CONCLUSION

Water resources in the Willamette Basin are facing increasing pressure from population growth, and climate change, and legally recognized needs for threatened and endangered fish species. An ongoing study to allocate stored water in the Willamette Project Reservoirs illustrates that the Basin is responding to scarcity and seeking the last available surface water supplies. This research has demonstrated the challenge of managing water with legacy policy issues and legacy environmental issues. Decisions over how water will be allocated have not yet been made, but limits in adaptive governance capacity indicate that low trust in federal government and inadequate financial resources may hinder the ability of groups to adapt to a new reallocation scheme. OWRD intends to convert minimum perennial stream flows following the reallocation of stored water (OWRD, n.d.), which may result in established water users having their water use regulated for the first time.

Despite these challenges, there are numerous examples of high adaptive governance capacity in the Basin, suggesting that current restoration efforts and coordination across watershed councils, USFS, restoration groups, tribes, and municipalities are adding resiliency in portions of the Basin. In the North Santiam, water managers responded to drought pressures and species listing by forming a collaborative drought planning group, in the Middle Fork the Confederated Tribe of Grand Ronde worked with USACE to modify fish ladders for pacific lamprey passage, in the McKenzie River EWEB is building trust and resilience with landowners while achieving flood protection and river restoration, and in the main stem Willamette the Meyer Memorial Trust has increased financial capacity, innovation, and coordination across a diverse group of stakeholders. Survey results provided a quantitative measurement of these successes, and found that adaptive governance capacity varies by watershed, especially regarding trust in specific stakeholder groups and support for regulatory management tools.

6.1 Recommendations for improving adaptive governance capacity

Currently, the reallocation of stored water in the Willamette Basin has the potential to decrease the flexibility in the water management system. Because water users are regulated (not allowed to use their water right) by seniority date (the date they received their water right), lack of flexibility in the system can harm some users while not harming other users. In other words, the current system and a traditional allocation of stored water to different user groups would not encourage users to share the pain in years when there is not sufficient water available for all users. By allocating storage space in the reservoirs vertically, as the reservoirs fill, and assigning each user group a pre-determined volume of stored water with a specific priority date, reallocation could make balancing different needs and changing societal interests across time more difficult in a natural system with increasing variability.

There are several policy tools, which could create increased flexibility in the Willamette Basin water management regime, however no single policy solution will solve all management challenges in the basin and any solution may have unintended consequences (Ostrom, 2005). For example, market-oriented solutions could become an increasingly popular solution to water allocation in the West, decreasing federal involvement and increasing basin-specific solutions (Tarlock, 2001). Tarlock (2001) argues that markets will become an important adaptive tool as the transaction costs of enforcing the prior appropriations doctrine consistently are "unacceptably high, unfair, and disruptive of established uses…the very goal that priority seeks to achieve" (Tarlock 2001, 778). The folly of this approach is that it continues to presume "that complex policy problems are simple problems that can be solved through the adoption of simple designs," and, furthermore, this approach "dichotomiz[es] the institutional world into 'the market' as contrasted to 'the state,'" (Ostrom, 2005, 256). Moreover, applying market solutions solidify the meaning of water as a private good (Swyngedouw, 2005), whereas our legal history views water as a public good, held in trust by the states for the people.

Another policy tool water managers in the basin can examine includes conditioning state water rights to require monitoring and measurement of water use. When older water rights do not include measuring requirements, OWRD "still maintains the authority to require measurement" (Amos, 2014, 13). Also, OWRD has the authority to condition any new water permit (Amos, 2014, 12). OWRD should also examine ways that new water rights for stored water could be conditioned to "share the pain." Finally, the way that state law currently defines "waste" of water gives the OWRD flexibility and discretionary authority to respond to future scarcity (Amos, 2014, 12). An integrated study could model the effects of a more specific definition of "waste" and how it could help share the pain among water users. These solutions, however, are only partial and are politically unpalatable to many groups.

If possible, the Willamette Basin Review Study should integrate an analysis of potential effects of increased water monitoring, a statutory definition of "waste," and implementing water "shares" rather than water "rights" in the allocation of stored water. Environmental interests currently do not have the political power to introduce such legal solutions into current flow models and integrating new studies into the existing study would require copious financial resources, technical expertise, and legal expertise. While financial and technical challenges are surmountable through coordination for grant money and utilizing university support, but providing environmental interests with the power to push for this change is a much more difficult challenge. Thus, if these solutions cannot be examined in the current (almost completed) Willamette Basin Review Study, they should continue as a second part to the Willamette Water 2100 future scenarios studies. Most importantly, the allocation of the stored water behind the Willamette Project reservoirs should not be irreversible, but should be a flexible allocation that leaves additional room for future changes.

Finally, the public trust doctrine is a flexible tool that can be used to manage water while adapting to changing societal needs (Craig, 2009; Wood, 2013). The public trust doctrine is a legal doctrine, which holds that certain resources are not owned by anyone, but are rather held in trust for current and future generations (the beneficiaries) by the government (as trustee). Public trust resources include navigation, commerce, recreation, and fisheries. The doctrine can be a tool of general application for seeking a comprehensive legal approach to resource management. It is a legal right of the public that is enforceable against government that is interpreted with contemporary concerns. The doctrine places restrictions on government, requiring certain resources to be used for a public purpose, prohibiting them to be sold, and requiring that they are available for use by the general public and maintained for particular uses. For example, while San Francisco Bay may be used for docks and marinas to support the regional economy and navigation, the bay may not be used for trash disposal or a housing project (Ferry, 2016; Wood, 2013). The public trust doctrine can ensure that adaptations to water scarcity in the Willamette Basin are in the interest of the general public by requiring open and explicit legislative decisions and requiring that the benefits of a project be clear and desirable to the public. As water scarcity increases, so can the gap between the haves and the have nots (Whitely, Ingram, & Perry, 2008) and the public trust doctrine can be used to protect the public's right to natural resources.

In addition to institutional design, policy changes, and legal tools, possibly the most important way that water managers in the Willamette Basin can enhance adaptive governance capacity is through promoting social learning. There is increasing support for the value of practice-based knowledge (Weber et al., 2014), which supports the use of these field trips to create a shared understanding and shared knowledge among the group of the challenges that everyone faces together in managing water for multiple uses. For example, the current WATER study group and Willamette Basin Review Study group should coordinate field trips to museums, farms, urban wastewater treatment facilities, dams, fish hatcheries, and restoration sites. Each stakeholder group should organize a field trip for the other study group members. Together, the group can learn about the history of the Willamette River from the loss of upland oak habitats to the great flood of 1862 and the construction of the Willamette Project Reservoirs. They could also help the group to understand the legacy of state and federal laws which influence water law, which could also motivate the group to consider ways to transform legal tools, rather than be confined by them.

Devising Seminars are another tool, which can be utilized among stakeholder groups as well as among the various study teams in the Willamette Basin. Devising seminars are on-binding seminars that are focused on idea generation and encouraging individuals to step outside of their roles and imagine management challenges from an alternative perspective and include elements of role-play (Susskind & Rumore, 2015). These have been used in various New England towns to build climate resiliency and increase awareness of climate vulnerability among residents and facilitate shared decision-making (Susskind & Rumore, 2015).

Finally, relatively low trust in federal government indicates that current efforts of USACE and NMFS to engage certain stakeholder groups are not currently successful. This may be due to inequitable approaches around finding participants, (Johnston et al., 2010), or the inability of participants to come to the table because of financial, transportation, or other burdens (Johnston et al., 2010). Federal agencies should make efforts to further improve participatory approaches to resource management to improve perceptions of social equity and environmental sustainability (Morales & Harris, 2014), and to encourage civic engagement (Weber, 2003).

6.2 Further research on adaptive governance capacity

The ideal theory is explanatory, predictive, and parsimonious. This is somewhat of a pipe-dream in policy theory (Smith & Larimer, 2017), however elements of the adaptive governance capacity theory should be further explored to move closer to this ideal. For example, conflict can both lead to cooperation and can lead to distrust, which hinders cooperation (Ansell & Gash, 2008). A survey tool that is designed to measure adaptive governance capacity at the watershed or basin level needs to be parsimonious to avoid low response rates and wasting respondents' time. Thus, further research is needed to determine whether conflict has a significant impact on adaptive governance capacity. If conflict is not a significant element of capacity, it should be excluded from survey instruments, which are already extensive and time-consuming for busy water managers and public officials.

Second, the literature is divided on the scale at which collaborative resources management should occur (Getches, 1996). The watershed-level approach has been praised, but needs to be scaled up in order to incorporate the full life-cycle of anadromous fish species, which rely on continuous, uninterrupted habitat, rather than a patchwork of riparian land management, stream temperatures, river morphology, and flow regimes. Without flexibility in state and federal water allocations, local collaborative approaches cannot extend beyond the watershed-level. Further research should examine barriers to adaptive governance capacity in larger river basins, as this study has done, to better understand strategies for improving adaptive governance capacity at larger scales.

6.3 Concluding thoughts

A recent water users survey in the Willamette Basin illustrate several shared values among different stakeholder groups. For example, when asked about "the acceptability of different ways of distributing water among competing uses at times of limited water availability, approximately 40% of water users indicated that sharing excess water was highly acceptable whereas only 18% indicated that using the most economical approach is highly acceptable. These findings suggest that water users care more about each other's needs than economic growth. Additionally, while agriculture and environmental needs may seem at odds in the basin, 55% of surveyed agricultural landowners indicated that they were highly interested in participating in land conservation practices for flood protection and over 30% indicated that they were highly interested in participating in conservation practices for wetland conservation, stream protection, maintaining riparian buffers, and restoring habitat and native species (Morzillo, 2015). Finally, this research has shown that values are not as disparate as they may seem: most water managers agree that the availability of clean, potable water and a highly functioning river ecosystem are their top management priorities.

At the end of the day, water management in the Basin needs to balance multiple needs, which water managers acutely recognize. Balancing needs does not simply mean sharing the pie, however, it means sharing the pie equitably. Equity "can only be served through processes of decision making that reflect the full range of values with which water is associated," (Ingram, Feldman, & Whitely, 2008, 271). Conflict is not resolved, rather it is transformed into an opportunity for change and that conflict is both linear and circular (Lederach, 2003). The linearity of conflict "requires us to articulate how we think things are related, how movement is created, and in what overall direction things are moving (Lederach, 2003, 45), whereas the circularity of conflict "reminds us that processes of change are not on-directional." In a deeply thoughtful and beautiful words, Lederach (2003) writes that,

> Circularity suggests that we need to think carefully about how social change actually happens. Often, we look at change through a rear-view mirror, observing the pattern of how something got from one place to another. But, when we are in the middle of change, and when we are looking forward toward what can be done, the process of change never seems clear or neat. The circle reminds us that change is not evenly paced, nor is it one-directional (41).

Adaptive governance capacity calls us to strengthen our capability to see conflict as an opportunity and move forward with empathy and a yearning for understanding, alongside our foes.

BIBLIOGRAPHY

Amos, A. (2006). The use of state instream flow laws for federal lands: Respecting state control while meeting federal purposes. *Environmental Law, 36, 4,* 1-45.

Amos, A. (2013). Developing the law of the river: The integration of law and policy into hydrologic and socio-economic modeling efforts in the Willamette River Basin. *Kansas Law Review*, *62*, 1-50.

Amos, A. (2014). Dam removal and hydropower production in the United States-Ushering in a new era. *Journal of Environmental Law and Litigation, 29,* 1-27.

Ansell, C., & Gash, A. (2008). Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory, 18,* 543-571.

Atkins, J., & Wenger, M. (2016). *Secretary of state audit of the Oregon Water Resources Department: Enhancing sustainability efforts and agency planning needed to better address Oregon's water supply needs* (pp. 1-36, Rep. No. 2016-33). Salem, OR: State of Oregon.

Bastasch, R. (1998). *Waters of Oregon: A source book on Oregon's water and water management*. Corvallis, OR: Oregon State University Press.

Bateman, B. (2014). The future of water law: What happens when climate changes the rules? *Water Resources Impact, 16,* 14-15.

Bernard, H. R. (2011). *Research methods in anthropology: Qualitative and quantitative approaches* (5th Ed.). New York, NY: Altima.

Bigelow, D., & Plantinga, A. (2016). Population, income & land use. Retrieved July 09, 2017, from http://inr.oregonstate.edu/ww2100/analysis-topic/population-income-land-use

Brondizio, E. S., Ostrom, E., & Young, O. R. (2009). Connectivity and the governance of multilevel socio-ecological systems: The role of social capital. *Agro-resources et écosystèmes, 34,* 253-279.

Brown, A., Langridge, R., & Rudestam, K. (2016). Coming to the table: Collaborative governance and groundwater decision-making in coastal California. *Journal of Environmental Planning and Management*, *59*, 2163–2178.

Bureau of Reclamation, U.S. Department of the Interior. (2008, July 11). *The Willamette River Basin project biological opinion and Reclamation's water marketing program* [Press release].

Butlin, J. (1987). Our common future. In *World commission on environment and development* (284-287). London: Oxford University Press.

Chamley, S., Long, J. W. & Lake, F. K. (2014). Collaboration in national forest management. In *Science synthesis to support socioecological resilience in the Sierra Nevada and southern Cascade Range* (n.p.). Tech. no. PSW-GTR-247. Web. 16 June 2015.

Conley, A. & Moote, M. (2003). Evaluating collaborative natural resource management. *Society and Natural Resources, 16,* 371-386.

Connelly, D. R., Zhang J., & Faerman, S. (2008.) The paradoxical nature of collaboration. In Bingham, L. B. & O'Leary, R. (Eds.), *Big ideas in collaborative public management* (17-35). New York, NY: Routledge.

Cooper, R. M. (2002). *Determining surface water availability in Oregon* (Open File No. SW 02-002). Salem, Oregon: Oregon Water Resources Department.

Cosens, B. A., and M. K. Williams. (2012). Resilience and water governance: Adaptive governance in the Columbia River basin. *Ecology and Society, 17, 4,* n.p.

Craig, R. K. (2009). Adapting to climate change: The potential role of state common law public trust doctrines. *Vermont Law Review*, *34,* 781-853.

Crow, D. A., & Baysha, O. (2013). "Conservation" as a catalyst for conflict: Considering stakeholder understanding in policy making. *Review of Policy Research, 30*, 302-320.

Dalton, M. M. Mote, P. W. & Snover A. K. (2013). *Climate change in the northwest Implications for our landscapes, waters, and communities.* Washington, D.C.: Island Press.

Daniels, S. E., & Walker, G. B. (2001). Crafting effective policy in a contentious and complex world. In Daniels, S. E. & Walker, G. B. *Working through environmental conflict: The collaborative learning approach* (1-14). Westport, CT: Praeger.

David H. Getches, (2001). The metamorphosis of western water policy: Have federal laws and local decisions eclipsed the states' role? *Stanford Environmental Law Journal, 3,* 53.

Edwards, C. (2017, May 23). Spending cuts in president Trump's 2018 budget. Retrieved July 09, 2017, from https://www.cato.org/blog/spending-cuts-president-trumps-2018-budget?gclid=COSdze_a_NQCFUKSfgod2d8BVg

Emerson, K. & Gerlak, A. K. (2014). Adaptation in collaborative governance regimes. *Environmental Management*, *54,* 768–781.

Eugene Water and Electric Board. (n.d.). Pure water partnership. Retrieved July 08, 2017, from http://www.purewaterpartners.org/162/Eugene-Water-Electric-Board

Faerman, S. R., McCaffrey, D. P., and van Slyke, D. M. (2001). Understanding inter-organizational cooperation: Public-private collaboration in regulating financial market innovation. *Organization Science, 12,* 372-388.

Ferranto, S.; Huntsinger, L.; Getz, C.; Lahiff, M.; Stewart, W.; Nakamura, G.; Kelly, M. (2013). Management without borders? A survey of landowner practices and attitudes toward cross-boundary cooperation. *Society and Natural Resources, 26,* 1086–1100.

Ferrey, S. (2016). *Environmental law* (7th ed.). New York: Wolters Kluwer.

Fortmann, L., Ballard, H. (2011). Sciences, knowledges, and the practice of forestry. *European Journal of Forest Research, 130,* 467-477.

Folke, C., Carpenter, S., Elmqvist, T., Gunderson, L., Holling, C. S., Walker, B. (2002). Resilience and sustainable development: Building adaptive capacity in a world of transformations. *Ambio, 31,* 437–440.

Garrick, D. & Aylward, B. (2012). Transaction costs and institutional performance in market-based environmental water allocation. *Land Economics, 88,* 536–560.

Getches, D. H. (1996). Changing the river's course: Western water policy reform. Proceedings from Lewis & Clark Law School Symposium. Portland, OR: Environmental Law.

Gregory, S., & Hulse, D. (2002). *Willamette River Basin atlas: Trajectories of environmental and ecological change* (2nd Ed.). Corvallis, OR: Oregon State University Press.

Gregory, S., Ashkenas, L., Oetter, D., Minear, P., Wildman, K., Christy, J., … Alverson, E. (2002a). *Willamette River Basin atlas: Trajectories of environmental and ecological change* (2nd Ed.). Corvallis, OR: Oregon State University Press.

Gregory, S., Ashkenas, L., Oetter, D., Minear, P., Wildman, K., Christy, J., … Alverson, E. (2002b). *Willamette River Basin atlas: Trajectories of environmental and ecological change* (2nd Ed.). Corvallis, OR: Oregon State University Press.

Guruswamy, L., & Tarlock, A. D. (n.d.). Sustainability and the future of western water law. *In Search of Sustainable Water Management*.

Hanak, E., & Chen, A. (2007). Wet growth: Effects of water policies on land use in the American west. *Journal of Regional Science, 47*, 85-108.

Harden, Blaine (1996). *A river lost: the life and death of the Columbia*. New York: Norton.

HDR Engineering, Inc. (2008). Statewide water needs assessment Oregon Water Supply and Conservation Initiative. Retrieved on June 4, 2017 from http://www.oregon.gov/owrd/Pages/LAW/owsci_info.aspx

Holling, C.S. (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics*, *4,* 1-23.

Hollings, C. S. (1978). *Adaptive environmental assessment and management* (First). Toronto: JWS.

Holyoke, T. T., Brown, H., Henig, J. R. (2012). Shopping in the political arena: Strategic state and local venue selection by advocates. *State & Local Government Review, 44,* 9-20.

House, K. & Graves, M. (2016, August 26) Draining Oregon. Retrieved from http://www.oregonlive.com/environment/index.ssf/page/draining_oregon_day_1.html

House, K. (2015, March 20). Feds declare drought emergency in 13 Oregon counties, releasing aid money. Retrieved from http://www.oregonlive.com/environment/index.ssf/2015/03/feds_declare_drought_emergency.html.

Hulse, D., Gregory, S., & baker, J. P. (2002). *Willamette river basin atlas, Second Edition* (pp. 1-3). Corvallis, OR: Oregon State University Press.

Huntjens, P., Pahl-Wostl, C., Rihoux, B., Flachner, Z., Neto, S., Koskova, R., Schlueter, M., Nabide Kiti, I., Dickens, C., 2008. The role of adaptive and integrated water management (AIWM) in developing climate change adaptation strategies for dealing with floods and droughts – A formal comparative analysis of eight water management regimes in Europe, Asia, and Africa. In: *Deliverable 1.7.9b of the NEWater Project. Osnabrück,* Germany: Institute of Ecosystems Research, University of Osnabruck

Huxham, C., & Vangen, S. (2000). Leadership in the shaping and implementation Of collaboration agendas: How things happen in a (not quite) joined-up world. *Academy of Management Journal, 43,* 1159-1175.

Huxham, C., S. Vangen, C., and C. Eden. (2000). The challenge of collaborative governance. *Public Management Review, 2,* 337 – 358.

Ingram, H. Feldman, D. & Whitely, J. M., (2008). Water and equity in a changing climate. In *Water, place, and equity*. Cambridge, MA: MIT Press.

Jaeger, W. K., Plantinga, A. J., Langpap, C., Bigelow, D., Moore, K. (2017). *Water, economics, and climate change in the Willamette basin, Oregon* OSU Extension Service Publication EM 9157. https://catalog.extension.oregonstate.edu/em9157

Johnston, E. W., Hicks, D., Nan, N., & Auer, J. C. (2010). Managing the inclusion process in collaborative governance. *Journal of Public Administration Research and Theory, 21,* 699-721.

Karkkainen, B. C. (2002). Collaborative ecosystem governance: scale, complexity, and dynamism. *Virginia Environmental Law Journal, 21,* 189-243.

Leach, W. D., & Pelkey, N. W. (2001). Making watershed partnerships work: A review of the empirical literature. *Journal of Water Resources Planning and Management, 127*, 378-385.

Leach, W. D., & Sabatier, P. A. (2005). To trust an adversary: Integrating rational and psychological models of collaborative policymaking. *American Political Science Review, 99*, 491-503.

Lederach, J. P. (2003). *The little book of conflict transformation*. Intercourse, PA: Good Books.

Lejano, R. P., & Ingram, H. (2009). Collaborative networks and new ways of knowing. *Environmental Science & Policy, 1*2, 653-662.

Levin, S. (1998) Ecosystems and the biosphere as complex adaptive systems. *Ecosystems, 1,* 431-436.

Ley, A. J. (2016), Vested interests, venue shopping, and policy stability: The long road to improving air quality in Oregon's Willamette Valley. *Review of Policy Research, 33,* 506–525.

Lind, E.A. & Tyler, T.R. (1988). *The social psychology of procedural justice*. N.Y.: Plenum.

Liu, J., Dietz, T., Carpenter, S. R., Alberti, M., Folke, C., Moran, E., Pell, A. N., Deadman, P., Kratz, T., Lubchenco, J., Ostrom, E., Ouyang, Z., Provencher, W., Redman, C. L., Schneider, S. H., Taylor, W. W. (2007). Complexity of coupled human and natural systems. *Science, 317,* 1513-1516.

Matti, S. & Sandstrom, A. (2011). The rationale determining advocacy coalitions: examining coordination networks and corresponding beliefs. *Policy Studies Journal, 39,* 385-410.

Mauldin, Frank, (2004). Sweet mountain water –City of Salem's struggle to tap Mt. Jefferson water and protect the North Santiam River. Retrieved on June 29 from http://www.salemhistory.net/places/salem_water_department.htm

McKinney, M. & Thorson, J. E. (2015). Resolving water conflicts in the American West. *Water Policy, 17,* 679-706.

Mettler, S., & Sorelle, M. (2014). Policy feedback theory. In *Theories of the policy process* (3rd ed., pp. 151-182). Denver, CO: Westview Press.

Miller, K. A., Rhodes, S. L., & MacDonnell, L. J. (1997). Water allocation in a changing climate: Institutions and adaptation. *Climate Change, 35,* 157-177.

Milly, P. C. D., Betancourt, J., Falkenmark, M., Hirsch, R. M., Kundzewicz, Z. W., Lettenmaier, D. P., and Stouffer, R. J. (2008). Stationarity is dead: Whither water management? *Science, 319,* 573-574.

Molden, D. (2007). *Water for food, water for life: a comprehensive assessment of water management in agriculture*. London: Earthscan.

Morales, M. & L. Harris (2014). Using subjectivity and emotion to reconsider participatory natural resource management. *World Development, 64,* 703-712.

Moran, E. F., & Ostrom, E. (2005). *Seeing the forest and the trees: human-environment interactions in forest ecosystems*. Cambridge, MA: MIT Press.

Morzillo, A. (2015, October). Water users survey. Retrieved July 01, 2017, from http://inr.oregonstate.edu/ww2100/analysis-topic/water-users-survey

Myers, J., C. Busack, D. Rawding, A. Marshall, D. Teel, D.M. Van Doornik, and M.T. Maher, (2006). Historical population structure of Pacific salmonids in the Willamette River and lower Columbia River basins. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-73, 311 p.

National Oceanic and Atmospheric Administration (NOAA). (2008). 2008–2023 Willamette River Basin Project Biological Opinion. NOAA Fisheries Log Number F/NWR/2000/02117. Seattle, WA: NOAA, National Marine Fisheries Service.

National Oceanic and Atmospheric Administration (NOAA), (2016). Biological opinion for the Federal Emergency Management Agency's National Flood Insurance Program in the State of Oregon. Seattle, WA: NOAA, National Marine Fisheries Service.

Neuman, J. C. (1998). Beneficial use, waste, and forfeiture: the inefficient search for efficiency in western water use. *Environmental Law*, *28,* 919.

Nie, M. (2008). The underappreciated role of regulatory enforcement in natural resource conservation. *Policy Sciences, 41, 2,* 139-164.

NOAA, (2012, September 25). Willamette River Biological Opinion. Retrieved July 29, 2017, from http://www.westcoast.fisheries.noaa.gov/fish_passage/willamette_opinion/

NOAA (2016). Endangered and threatened marine species under NMFS' jurisdiction. Retrieved June 09, 2016, from http://www.nmfs.noaa.gov/pr/species/esa/listed.htm#fish

North Santiam Watershed Council. (n.d.). North Santiam Drought Contingency Planning. Retrieved July 08, 2017, from http://northsantiam.org/projects/north-santiam-drought-contingency-planning-2016-2017/

NSCEDC – Grow Santiam. (n.d.). Retrieved July 08, 2017, from http://growsantiam.org/

OAR § 340-041-0350.

OAR § 690-315-346.

OAR § 690-502-0030.

OAR § 690-502-0110.

OAR § 690-502-0020.
OAR § 690-502-0060.
OAR § 690-502-0080.
O'Brien, M. (2010). "Review of Collaborative Governance: Factors crucial to the internal workings of the collaborative process," Report for the Ministry of Environment (New Zealand) (April).
Opotow, S. & Weiss, L. (2000). Denial and the process of moral exclusion in environmental conflict. *Journal of Social Issues*, *56,* 475–490.
Oregon Farm Bureau (n.d.). "Advocacy." Retrieved July 09, 2017, from http://oregonfb.org/advocacy
ORS § 537.346.
ORS § 536.595.
ORS § 390.805 to 390.940.
Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science, 325,* 419-422.
Ostrom, E. (2005). *Understanding institutional diversity*. New Jersey: Princeton University Press.
Ostrom, Elinor. 1990. *Governing the commons: The evolution of institutions for collective action*. New York, NY: Cambridge University Press.
OSU Extension Service. (n.d.). SB 1010 brochure. Retrieved July 08, 2017, from http://extension.oregonstate.edu/
OWRD, n.d. Willamette Basin Review: Reservoir Study. Retrieved June 18, 2017.
OWRD. Water Resources Development Program. (2017, May 23). Retrieved July 07, 2017, from http://www.oregon.gov/OWRD/pages/Water_Resources_Development_Program.aspx#Program_Overview
OWRD (2016, June 16). Final Order approving a change in character of use in the matter of transfer application T-12120. Retrieved February 21, 2017 from http://apps.wrd.state.or.us/apps/wr/wrinfo/wr_transfer_centric.aspx?transfer_nbr=12120&transfer_char=T
Pakenham-Stevenson, A. (2017). Assessing the adaptive governance capacity of western water communities (dissertation). Retrieved from Oregon State University thesis archives. http://hdl.handle.net/1957/61714
Payne, H., (2014). Lake Lanier and the Corps: How adaptive management could help. *Idaho Law Review, 51,* 279-292.
Panye, S. & Baker, J. (2002). *Willamette River Basin atlas* (2nd Ed.). Corvallis, OR: Oregon State University Press.
Payne, S. & Goicochea Duclos, J., (2002). *Willamette River Basin atlas,* (2nd Ed.). (pp. 67, 68). Corvallis, OR: Oregon State University Press.
Pahl-Wostl, C., Holtz, G., Kastens, B., & Knieper, C. (2010). Analyzing complex water governance regimes: The management and transition framework. *Environmental Science & Policy, 13*, 571-581.
Pahl-Wostl, C., E. Mostert, and D. Tàbara. (2008). The growing importance of social learning in water resources management and sustainability science. *Ecology and Society, 13,* 24.

Pahl-Wostl, C., (2009). A conceptual framework for analyzing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change, 18,* 354–365.

Perkowski, M. (2016, March 16). Feds divvying up Willamette Valley dam water. *Capital Press,* Retrieved from http://www.capitalpress.com/Oregon/20160316/feds-divvying-up-willamette-valley-dam-water

Polasky, S., Carpenter, S., Folke, C., & Keeler, B. (2007). Decision-making under great uncertainty: environmental management in an era of global change. *Trends in Ecology & Evolution, 26, 8,* 398-404.

Rogers and Weber (2010). Thinking harder about outcomes for collaborative governance arrangements. *American Review of Public Administration*, *40, 5,* 546 -567.

Rose, J. (2016, January 06). Oregon ghost town rises from drought-drained Detroit Lake. Retrieved July 02, 2017, from http://www.oregonlive.com/history/2016/01/oregon_ghost_town_rises_from_d.html

Sabatier, P. A., & Weible, C. M. (n.d.). *Theories of the policy process*. Boulder, CO: Westview Press.

Silke, A. and Kersi H. (2007). The network approach in P. A Sabatier (ed.) *Theories of the policy process* (2nd Ed.), Boulder (CO): Westview.

Sirianni, C. (2009). *Investing in democracy: Engaging citizens in collaborative governance*. Washington, D.C.: Brookings Institution.

Smith, K. B., & Larimer, C. W. (2017). *The public policy theory primer* (3rd ed.). Boulder, CO: Westview Press.

Sproles, E., Nolin, A. Rittger, K. & Painter, T. (2012). Climate change impacts on maritime mountain snowpack in the Oregon Cascades. *Hydrology and Earth System Sciences Discussions, 9, 11,* 13037-3081.

Stakhiv, E. Z. (2008). Cogitations on the education of water resources managers. *Journal of Contemporary Water Research & Education,139*(1), 6-11.

Stern, M. J. & Coleman, K. J. (2015) The multidimensionality of trust: Applications in collaborative natural resource management. *Society & Natural Resources*, *28, 2,* 117-132.

Susskind, L. E., & Romer, D. (2015). Using devising seminars to advance collaborative problem solving in complicated public policy disputes. *Negotiation Journal*, *12092,* 223-245.

Swyngedouw, E. (2005). Dispossessing H 2 O: The contested terrain of water privatization. *Capitalism Nature Socialism, 16, 1,* 81-98.

Tims, D. (2015, March 07). Wilsonville-to-Hillsboro water line route, just unveiled, is a study in time, patience. Retrieved July 07, 2017, from http://www.oregonlive.com/washingtoncounty/index.ssf/2015/03/post_55.html

Tullos, D., Walter, C., & Moore, K. (2016, August). Reservoir operational performance. Retrieved July 09, 2017, from http://inr.oregonstate.edu/ww2100/analysis-topic/reservoir-operational-performance

USFWS, (n.d.). Species fact sheet pacific lamprey: Lampetra tridentate. Retrieved May 15, 207 from https://www.fws.gov/wafwo/species/Fact%20sheets/Pacific_lamprey_final.pdf

USACE (2017, February 28). *Willamette Valley Water Management*. Proceedings from *2017 Oregon Dam Safety and Reservoir Resilience Conference,* Corvallis, OR: Oregon State University.

USACE Portland District, (n.d.). Willamette River Basin Review feasibility study. Retrieved June 08, 2016, from http://www.nwp.usace.army.mil/About/Currentprojects/WillametteBasinReview.aspx

USACE Press Release: Cougar Reservoir going deep this week *Posted 12/17/2012,* Release no. 12-066.

USACE, (2012). Cougar proposed special operation to improve downstream passage & survival. Retrieved June 17, 2017 from http://www.nwd-wc.usace.army.mil/tmt/documents/FPOM/2010/Willamette_Coordination/WFOP/2016/changes/Fish%20Operations%20Appendix%202016.pdf

USACE (2014). Eugene Springfield metropolitan waterways ecosystem restoration feasibility study integrated environmental assessment. Retrieved June 6, 2017 from http://www.nwp.usace.army.mil/Portals/24/docs/announcements/EA/Springfield Metro Waterways draft FR-and-EA.pdf

USBR, (2013). Willamette Basin Plan of Study draft. Boise, ID: USBR.

Vaske, J. (2008). *Survey research and analysis: Applications in parks, recreation, and human dimensions*. State College, PA: Venture Publishing, Inc.

Van de Wetering, S. & Alder, R. W. (2000). New directions in western water law: Conflict or collaboration? *Journal of Land, Resources, and Environmental Law, 20 (1), 15-20.*

OWRD (n.d.). Willamette Basin Review Reservoir Study. Retrieved July 09, 2017, from http://www.oregon.gov/owrd/Pages/mgmt_res_study.aspx

Water Watch (n.d.). The ten-minute activist. Retrieved July 09, 2017, from http://waterwatch.org/resources/lte-info

Weber, E. P. (2003). *Bringing society back in: Grassroots ecosystem management, accountability, and sustainable communities*. Cambridge, MA: MIT Press.

Weber, E. P., Lovrich, N. P. and Gaffney, M. (2005). Collaboration, enforcement, and endangered species: A framework for assessing collaborative problem-solving capacity. *Society & Natural Resources, 18, 8,* 677-98.

Weber, E. P., & Khademian, A. M. (2008). Wicked problems, knowledge challenges, and collaborative capacity builders in network settings. *Public Administration Review, 68, 2,* 334-349.

Weber, E. P. (2012). Unleashing the potential of collaborative governance arrangements: getting to robust durability in the Blackfoot Valley. *Journal of Sustainable Development, 5*, *7,* 35-47.

Weber, Edward P., Belsky, J., Lach, D., and Cheng, A. (2014). The value of practice-based knowledge. *Society and Natural Resources, 27, 10,* 1074 – 1088.

Weber, E. P., Lach, D., & Steel, B. (2017). *New strategies for wicked problems: science and solutions in the twenty-first century*. Corvallis, OR: Oregon State University Press.

Weber, Edward P. (2014). The third wave: Government led techno-democratic collaboration in New Zealand. Proceedings from *Annual Meeting of the Pacific Northwest Political Science Association,* Bend, OR.

West Water Research (2014). McMinnville water and light market consultation report. Boise, ID: West Water Research.

White, D., & Baker, J. P. (2002). *Willamette River Basin atlas,* (2nd Ed.) Corvallis, OR: Oregon State University Press.

Willamette Riverkeeper, (2017, March 13). Press Release: Conservation organizations send notice of intent to sue to the Army Corps of Engineers Regarding ESA Impacts of Hatchery Summer Steelhead Program. Retrieved June 18, 2017.

Willamette Water 2100. (n.d.). Retrieved August 07, 2016, from http://water.oregonstate.edu/ww2100/project-overview

Willamette Water Supply (2016, October 11). Willamette water supply pipeline construction begins. Retrieved July 07, 2017, from https://www.hillsboro-oregon.gov/Home/Components/News/News/2442/28?backlist=%2Fdepartments%2Fwater

Within Our Reach. (2016). Retrieved July 09, 2017, from http://withinourreach.net/who_attends/

Wolters, E. A., & Hubbard, M. L. (2014). Oregon water: Assessing differences between the Old and New Wests. *The Social Science Journal,51*(2), 260-267.

Wood, M. (2013). *Nature's trust: Environmental law for a new ecological age*. Cambridge, MA: Cambridge University Press.

Wormald, B. (2015, May 11). Religious landscape study. Retrieved July 01, 2017, from http://www.pewforum.org/religious-landscape-study/state/oregon/

Wynne, D. (2017, February 17). Oroville Dam reached capacity faster than previous 16 years. Retrieved from http://www.npr.org/2017/02/17/515597969/oroville-dam-reached-capacity-faster-than-previous-16-years

Yin, R. K. (2014). *Case study research: design and methods*. London: Sage Publication.

16 U.S.C. § 1531, 1536, 1538, (1973).

33 U.S.C. § 701b-8 (1954).

50 C.F.R. §402.02

APPENDIX A: IRB EXEMPTION

Human Research Protection Program
Institutional Review Board
Office of Research Integrity
B308 Kerr Administration Building, Corvallis, Oregon 97331-2140
(541) 737-8008
IRB@oregonstate.edu | http://research.oregonstate.edu/irb

DETERMINATION

Date of Notification	09/28/2016		
Study ID	7680		
Study Title	Characterizing Adaptive Governance Capacity in the Willamette Basin		
Person Submitting Form	Edward Weber		
Principal Investigator	Edward Weber		
Study Team Members	Ingria Jones		
Funding Source	None	Proposal #	N/A
PI on Grant or Contract	N/A	Cayuse #	N/A

DETERMINATION: RESEARCH, BUT NO HUMAN SUBJECTS

The has been determined that your project, as submitted, does meet the definition of research but **does not** involve human subjects under the regulations set forth by the Department of Health and Human Services 45 CFR 46.

Additional review is not required for this study.

Please do not include HRPP contact information on any of your study materials.

Note that amendments to this project may impact this determination.

The federal definitions and guidance used to make this determination may be found at the following links: Human Subject

APPENDIX B: LIST OF ABBREVIATIONS

Abbreviation	Full Name
Action Agencies	USACE, BPA, and USBR
BA	Biological Assessment submitted by the Action Agencies to NMFS and USFWS
BiOp	Willamette Project Biological Opinion
BPA	Bonneville Power Administration
CBD	Center for Biological Diversity
CTGR	Confederated Tribes of Grand Ronde
CTSI	Confederated Tribes of Siletz Indians
CTWS	Confederated Tribes of Warm Springs
CWA	Clean Water Act
DEQ	Oregon Department of Environmental Quality
EFH	Essential fish habitat
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
EWEB	Eugene Water & Electric Board
FERC	Federal Energy Regulatory Commission
MAF	Million Acre Feet
NMFS	National Marine Fisheries Service
NOAA	National Oceanic & Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRDC	National Resources Defense Council
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODFW	Oregon Department of Fish and Wildlife
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
Water Watch	Water Watch of Oregon
WATER	Willamette Action Team for Ecosystem Restoration
WRI	Willamette Restoration Initiative

APPENDIX C: TRUST IN STAKEHOLDER GROUPS

Table 44. Trust in stakeholders: Main stem

Stakeholder group	N	Mean	Std Deviation
Municipal water/potable water	22	3.59	1.10
Tribal	21	4.00	0.76
Irrigation	22	2.91	1.12
Crops producer (i.e. farmer)	22	2.86	1.13
Hobby farmer	22	2.73	0.88
Ranching	22	2.64	1.05
Environmental or conservation group	22	3.95	1.05
Recreation/ Tourism	22	3.41	0.80
Watershed council	22	4.18	1.01
Aquaculture	18	2.50	1.04
Landowner/resident	22	2.95	0.72
Municipal government	23	3.39	0.78
Hydroelectric	22	2.59	1.10
Federal government	23	3.39	0.89
State government	23	3.52	1.04
Scientist	22	4.32	0.72

Trust in stakeholder groups was measured on a five-point scale from strongly distrust (1) to strongly trust (5).

Table 45. Trust in stakeholders: North Santiam

Stakeholder group	N	Mean	Std Deviation
Tribal	5	3.6	0.89
Irrigation	7	3.57	1.27
Crops producer (i.e. farmer)	7	3.43	1.51
Hobby farmer	7	3.57	0.79
Ranching	7	3.29	1.11
Environmental or conservation group	7	3	1.16
Recreation/ Tourism	7	3	1
Watershed council	7	4.14	0.9
Aquaculture	7	3	0.71
Landowner/resident	7	3.29	0.76
Municipal government	7	4.43	0.79
Hydroelectric	7	3.29	1.5
Federal government	7	3	1
State government	7	3.43	0.79
Scientist	7	3.14	1.35

Trust in stakeholder groups was measured on a five-point scale from strongly distrust (1) to strongly trust (5).

Table 46. Trust stakeholders: McKenzie

Stakeholder group	N	Mean	Std Deviation
Municipal water/potable water	9	4.67	0.50
Tribal	7	4.14	0.69
Irrigation	8	2.88	1.36
Crops producer (i.e. farmer)	9	3.00	1.32
Hobby farmer	9	3.00	1.00
Ranching	9	2.56	1.33
Environmental or conservation group	9	4.11	0.60
Recreation/ Tourism	9	3.78	0.97
Watershed council	9	4.44	1.33
Aquaculture	5	2.60	0.55
Landowner/resident	9	2.78	0.97
Municipal government	9	3.67	0.87
Hydroelectric	9	3.11	1.17
Federal government	8	3.63	0.74
State government	9	3.78	0.44
Scientist	9	4.33	0.71

Trust in stakeholder groups was measured on a five-point scale from strongly distrust (1) to strongly trust (5).

Table 47. Trust stakeholders: Middle Fork

Stakeholder group	N	Mean	Std Deviation
Municipal water/potable water	5	3.60	0.55
Tribal	4	4.00	0.00
Irrigation	3	4.00	0.00
Crops producer (i.e. farmer)	4	4.00	0.00
Hobby farmer	4	2.50	0.58
Ranching	4	4.00	0.00
Environmental or conservation group	4	3.50	1.00
Recreation/ Tourism	3	3.33	1.13
Watershed council	5	4.80	0.45
Aquaculture	3	2.67	1.16
Landowner/resident	4	3.00	1.16
Municipal government	5	3.40	0.89
Hydroelectric	5	3.00	1.00
Federal government	5	3.60	0.89
State government	5	4.00	1.23
Scientist	5	4.80	0.45

Trust in stakeholder groups was measured on a five-point scale from strongly distrust (1) to strongly trust (5).

APPENDIX D: SUPPORT FOR WATER MANAGEMENT TOOLS

Table 48. Support for water management tools: Main stem

Management tool/strategy	N	Currently use	N	Support voluntary use	N	Support regulatory use
Instream flow protection	7	28%	13	52%	16	64%
Habitat restoration	9	36%	15	80%	14	56%
Temporary non-diversion agreements	2	8%	20	80%	9	36%
Water leases and transfers	4	6%	19	76%	11	44%
Permanent water agreements	3	12%	16	64%	12	48%
Reallocating stored water to allow for municipal use	3	12%	13	52%	13	52%
Water markets	2	8%	17	68%	9	36%
Water pricing	4	16%	12	48%	11	44%
Conserved water projects	2	8%	15	0%	12	48%
Water delivery efficiency projects	3	12%	18	72%	12	48%
On-farm efficiency projects	2	8%	18	72%	14	56%
Demand driven water delivery	1	4%	13	52%	6	24%
Changing point of diversion for withdrawal	3	12%	12	48%	12	48%
Increased storage/optimization of existing storage	2	8%	14	6%	7	28%
Groundwater recharge projects	2	8%	18	72%	12	48%
Switching the source of water	3	12%	13	52%	11	44%
Water use monitoring and measurement devices	4	16%	12	48%	19	76%
Policies for reducing demand	3	12%	15	60%	15	60%
Long-term integrated basin planning	5	20%	15	60%	15	60%
Demand projections for potable water supply	5	20%	13	52%	15	60%
Demand projections for agricultural water supply	2	8%	14	56%	15	60%
Management agreements	2	8%	17	68%	10	40%

Table 49. Support for water management tools: North Santiam

Management tool/strategy	N	Currently use	N	Support voluntary use	N	Support regulatory use
Instream flow protection	5	71%	5	71%	2	29%
Habitat restoration	1	14%	5	71%	3	43%
Temporary non-diversion agreements	0	0%	6	86%	1	14%
Water leases and transfers	2	29%	6	86%	0	0%
Permanent water agreements	2	29%	6	89%	0	0%
Reallocating stored water to allow for municipal use	0	0%	4	57%	1	14%
Water markets	0	0%	5	71%	0	0%
Water pricing	1	14%	3	43%	0	0%
Conserved water projects	1	14%	6	86%	1	14%
Water delivery efficiency projects	1	14%	6	86%	3	43%
On-farm efficiency projects	2	29%	7	100%	2	29%
Demand driven water delivery	1	14%	3	43%	0	0%
Changing point of diversion for withdrawal	1	14%	4	57%	1	14%
Increased storage/optimization of existing storage	1	14%	4	7%	0	0%
Groundwater recharge projects	4	14%	7	100%	1	14%
Switching the source of water	1	14%	3	43%	1	14%
Water use monitoring and measurement devices	2	29%	6	86%	1	14%
Policies for reducing demand	1	14%	5	71%	2	29%
Long-term integrated basin planning	3	43%	5	71%	2	29%
Demand projections for potable water supply	1	14%	6	86%	2	29%
Demand projections for agricultural water supply	1	14%	6	86%	2	29%
Management agreements	1	14%	3	43%	2	29%

Table 50. Support for water management tools: McKenzie

Management tool/strategy	N	Currently use	N	Support voluntary use	N	Support regulatory use
Instream flow protection	3	33%	3	33%	6	67%
Habitat restoration	4	44%	5	56%	5	56%
Temporary non-diversion agreements	0	0%	7	78%	4	44%
Water leases and transfers	2	22%	5	56%	4	44%
Permanent water agreements	0	0%	5	56%	4	44%
Reallocating stored water to allow for municipal use	1	11%	5	56%	4	44%
Water markets	0	0%	6	67%	3	33%
Water pricing	0	0%	4	44%	4	44%
Conserved water projects	0	0%	6	67%	4	44%
Water delivery efficiency projects	1	11%	4	44%	5	56%
On-farm efficiency projects	1	11%	4	44%	6	67%
Demand driven water delivery	0	0%	5	56%	4	44%
Changing point of diversion for withdrawal	2	22%	5	56%	4	44%
Increased storage/optimization of existing storage	0	0%	4	44%	5	56%
Groundwater recharge projects	0	0%	6	67%	5	56%
Switching the source of water	1	11%	7	78%	3	33%
Water use monitoring and measurement devices	3	33%	7	78%	7	78%
Policies for reducing demand	0	0%	4	44%	6	67%
Long-term integrated basin planning	1	11%	4	44%	7	78%
Demand projections for municipal/potable water supply	2	22%	3	33%	7	78%
Demand projections for agricultural water supply	0	0%	5	56%	7	78%
Management agreements	0	0%	6	67%	5	56%

Table 51. Support for water management tools: Middle Fork

Management tool/strategy	N	Currently use	N	Support voluntary use	N	Support regulatory use
Instream flow protection	2	40%	3	60%	3	60%
Habitat restoration	3	60%	3	60%	0	0%
Temporary non-diversion agreements	0	0%	4	80%	1	20%
Water leases and transfers	1	20%	3	60%	2	40%
Permanent water agreements	1	20%	3	60%	2	40%
Reallocating stored water to allow for municipal use	0	0%	3	60%	1	20%
Water markets	0	0%	3	60%	1	20%
Water pricing	0	0%	2	40%	1	20%
Conserved water projects	1	20%	3	60%	3	60%
Water delivery efficiency projects	1	20%	2	40%	2	40%
On-farm efficiency projects	0	0%	3	60%	2	40%
Demand driven water delivery	0	0%	1	20%	2	40%
Changing point of diversion for withdrawal	1	20%	3	60%	1	20%
Increased storage/optimization of existing storage	0	0%	3	60%	0	0%
Groundwater recharge projects	1	20%	2	40%	1	20%
Switching the source of water	1	20%	2	40%	1	20%
Water use monitoring and measurement devices	1	20%	4	80%	2	40%
Policies for reducing demand	0	0%	3	60%	1	20%
Long-term integrated basin planning	2	40%	3	60%	3	60%
Demand projections for municipal/potable water supply	1	20%	3	60%	4	80%
Demand projections for agricultural water supply	1	20%	4	80%	3	60%
Management agreements	0	0%	3	60%	2	40%