Weber River Watershed Plan

2014

Executive Summary

Our watershed is defined by the people that live, work, and play within its boundaries, as well as the social, ecological, financial and societal benefits that it provides. The Weber River Watershed has experienced a long history of human-influenced changes and alterations in order to enhance human well-being. Many of these actions have enhanced water transportation and delivery, developed sources of hydropower, reduced flood hazards, and provided agricultural, municipal and industrial water supplies (National Research Council 1992), all of which are essential to our survival and quality of life. At the same time, some of those enhancements have had unforeseen impacts to aquatic ecosystems, which also contribute greatly to our collective quality of life.

The biggest challenge that we face is to balance these critical services, such as providing a safe, reliable and sustainable water supply, while restoring and protecting the ecological values of our watersheds. This is a difficult balance to achieve. However, progress can and will be achieved through cooperation, combined with genuine respect and appreciation for each other's values, even when those values are at times, in opposition.

This challenge will become increasingly complex in the future, as long-term trends suggest that our water supply has steadily decreased during recent years, and locally available climate data suggest that future water supplies will continue to decline. In addition, our demand on these increasingly scarce water resources is expected to rise significantly in the future, as population growth throughout the watershed and nearby Weber Basin

Water Conservancy District service areas is expected to increase from 500,000 residents to 1.8-million residents when our communities are fully developed.

The Weber River Partnership has been developed to address these challenges. This partnership is informal at its outset, but the long term vision of this partnership is growth through inclusion, long-term sustainability, and achieving real and lasting improvements to our water supply and the ecological health of our river systems. This partnership is made up of talented professionals who are passionate and dedicated to our rivers, including representatives from:

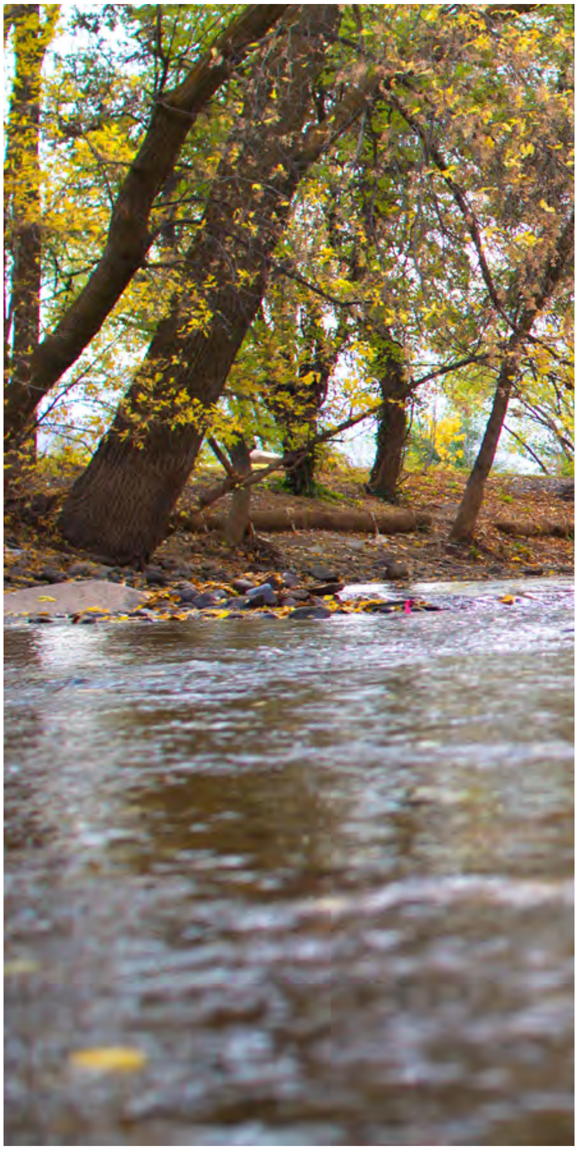
- Weber Basin Water Conservancy District
- Snyderville Basin Water Reclamation District
- Trout Unlimited
- Morgan County
- Utah Division of Wildlife Resources
- Utah Division of Water Quality
- Kamas Valley Conservation District
- U.S. Natural Resources Conservation Service
- PacifiCorp
- Ogden City
- Utah State University

Fig 1.1: The Weber River in the Morgan Valley, Utah.

This group believes that effectively protecting, managing and restoring the natural resources throughout the watershed is essential to ensure the long-term sustainability of the natural environment, economy, and lifestyles that make our watershed a unique and desirable place to live, work, and play. This group works through sound science, outreach, education, and most importantly, through respectful, cooperative and collaborative planning to accomplish mutual goals. Through coordination and respectful dialogue, this partnership will make positive and long lasting changes to our waterways and our water supplies.

Watershed Values and Challenges

The goal of this plan is to recognize both the human and ecological values that our watershed provides, identify and assess challenges and threats to those values, and develop strategies to protect and enhance those values into the future. Restoration and protection actions will be rooted in the universally shared values that were identified through the planning process, which includes:



Collective Quality of Life

Water is critical to the daily economy of life, as well as the active and leisurely aspects of life. As a result, a diverse set of user groups including residents, farmers, ranchers, hikers, bikers, anglers, birdwatchers, and boaters, to name a few, rely on the Weber River watershed to live and to thrive.

Water Quantity

Water in this watershed is used for municipal, agriculture, industrial, power generation, and wildlife purposes, and is one of two major water supplies for the Wasatch Front, serving approximately 21% of Utah's population with drinking and irrigation water. All of us drink water, so all of us have a vested interest in safe, reliable and sustainable drinking water supplies.

Water quality

Only 44% of assessed water bodies in the Weber River watershed meet designated water quality standards.

Nineteen of those water bodies have been officially designated as “impaired”. Improving the quality of the water in the watershed is a priority for all user groups.

Agriculture

Agriculture provided the primary sustenance and livelihoods for early pioneer settlers in this watershed. The physical, economic and socio-political legacy of this history is still apparent throughout the watershed today, and those social values will continue to play an important role in the well-being of this watershed and its inhabitants for generations to come.

Recreational Fishing

Recreational fishing continues to be an important part of Utah’s culture and economy,

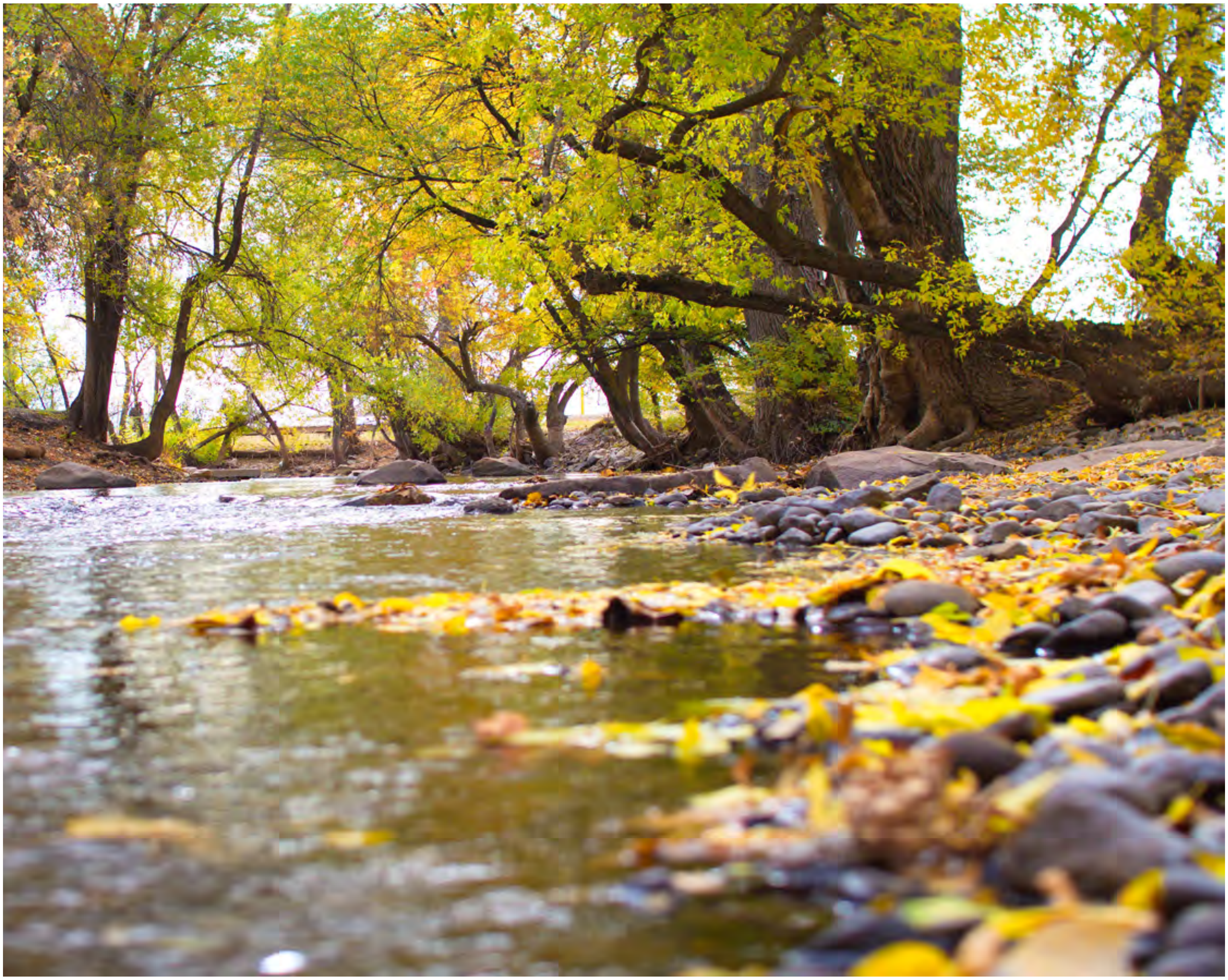


Fig 1.2 View of the Ogden River, in downtown Ogden, Ut.

as 483,806 fishing licenses were purchased in 2011, which equates to an economic impact of over $259-million annually to Utah's economy. The Weber River watershed supports five fisheries that are designated as "Blue Ribbon Fisheries", as well as ten additional fisheries that are currently under review or are considered potential "candidates" for Blue Ribbon Fisheries status.

Water-based recreation

Many people from communities within and around the watershed participate in water-based recreation activities, including motorized and non-motorized recreational sports such as boating, kayaking, canoeing, tubing, paddle boarding, swimming, and bird watching. Opportunities to recreate in this watershed are numerous and diverse, and comprise one of the largest user groups in this watershed and beneficiaries of its overall health.

Community and Economic Development

Although water is not always recognized explicitly for its value, it is a critical resource for every community and its economy. Proper stewardship of this precious resource will ensure that growth can continue within the watershed without sacrificing the collective quality of life of its residents and those who visit the watershed.

Conservation Targets

These shared values are clear evidence that all of us are bound by the health of our watershed and our shared interests. We track the health of our watershed, and therefore the health of our shared values, by monitoring our progress toward key conservation targets. Those conservation targets include indicators of:

Fig 1.3: View of the Weber River valley near Mountain Green, Utah.

1. Water supply and conservation
2. Management and conservation of important fish species
3. Six distinct "Ecological Systems" that store and deliver those waters and provide the habitats that are essential for aquatic and terrestrial wildlife to thrive

Strategies

In order to adress the threats to these conservation targets, the partnership has identified the following strategies and objectives:

Strategy 1-Communications

- Recruit broad and inclusive stakeholder participation to help grow this partnership
- Increase collaboration amongst resource managers to cooperatively implement the strategies outlined in the restoration plan
- Develop a strategic communication and public outreach and education plan
- Identify and cultivate leaders throughout the watershed who participate in the partnership and help implement its strategies
- Increase collaboration with Utah State University and Weber State University to advance our technical understanding of our waterways and our interactions with them
- Organize and host an inaugural watershed symposium where resource experts and managers can share information and develop coordinated projects
- Create a neutral, non-agency or organization specific webpage that is respectful of everyone's values so that information and progress toward shared goals can be shared with the public
- Leverage the success of the Ogden River Restoration Project as a model of a community and partner-driven restoration project that balances the values of everyone who lives, works and plays in our watershed

Fig 1.4: Volunteers restoring riparian habitats.

Strategy 2-Policy Initiatives

- Improve stream alteration application, permitting and related impact-analysis processes
- Design, host and participate in relevant project tours, lectures and workshops to ensure that everyone's values are respectfully considered when designing and implementing projects that affect our waterways
- Participate in State-level efforts to comprehensively review and improve
- Utah water law
- Review and if necessary, implement protective angling regulations to protect important fish populations

Strategy 3-Land and water use

- Find opportunities to improve and secure river flows that improve aquatic and terrestrial wildlife habitats while also achieving broader water storage and delivery goals
- Connect and enhance fish migration corridors to improve the long-term resiliency of important fish populations
- Support smart growth initiatives that balance the need for future growth with water conservation and habitat protection
- Work with NGOs and private landowners to support farmland preservation
- Improve storm water management practices in rural and urban settings so we can improve the health of our waterways

Strategy 4- Habitat Restoration

- Identify and prioritize locations and opportunities for grazing exclusions or riparian pasture areas to improve fish and terrestrial wildlife habitats, reduce stream-bank erosion and related risks to landowners, and improve water quality
- Enhance partnerships amongst private landowners, city, county and state governments and non-governmental organizations to develop larger-scale restoration, protection and water conservation projects

"Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principle measure of how we live on the land"

-Luna Leopold

Acknowledgements

This restoration plan and strategy is the result of many people and organizations, both within and outside the Weber River watershed. This plan augments existing studies and strategies developed to understand and protect this watershed. Many groups deserve recognition for their contributions to the watershed. A few of them are:

- Bonneville Environmental Foundation
- East Canyon Watershed Committee
- National Resource Conservation Service
- Pacificorp
- Snyderville Basin Water Reclamation District
- Summit Land Conservancy
- Trout Unlimited
- United States Bureau of Reclamation
- United States Environmental Protection Agency
- United States Fish and Wildlife Service
- Utah Association of Conservation Districts and Local Conservation Districts
- Utah Department of Agriculture and Food/Agricultural Non-point Source Program
- Utah Department of Environmental Quality/Division of Water Quality
- Utah Department of Natural Resources/Division of Water Rights
- Utah Department of Natural Resources/Division of Wildlife Resources
- Utah Open Lands
- Utah State University
- Various Municipalities and Local Governments
- Weber Basin Water Conservancy District
- Weber River Technical Advisory Committee
- Weber River Water Users Association

We thank all the watershed pioneers that laid the groundwork for this plan. It is within that context of gratitude and respect that we present this plan, which we hope will guide all of us in our collective efforts to make our watershed a better place to live, work and play for many generations to come.

With gratitude and optimism,

The Weber River Partnership

Contents

The Weber River Partnership

The Weber River Partnership is made up of talented professionals who are passionate about the Weber River watershed. Participants include representatives from Weber Basin Water Conservancy District, Snyderville Basin Water Reclamation District, Trout Unlimited, Utah Division of Wildlife Resources, Utah Division of Water Quality, Kamas Valley Conservation District, Natural Resources Conservation Service, PacifiCorp, and Ogden City. Participation is expected to grow in the future as the partnership continues to coalesce.

This group believes that effectively protecting, managing and restoring the natural resources throughout the watershed is essential to ensure the long-term sustainability of the natural environment, economy, and lifestyles that make the Weber River watershed a unique and desirable place to live, work, and play. This group works through sound science, cooperation, outreach, education, and collaborative planning to accomplish these goals, and is well-suited to make positive and long lasting changes in the watershed. The planning group is organized into two sub-groups.

Weber River Partnership Vision Statement

"To ensure the long-term sustainability of the natural environment, economy, and lifestyles that make the Weber River watershed a unique and desirable place to live, work, and play."

Fig 1.5 View of the Wasatch Front from the Ogden Valley

Planning Advisory Team

This team is a group of key stakeholders from throughout the watershed whose primary purpose is to provide watershed-scale, long-term and interdisciplinary expertise and socio-political context and oversight of this watershed plan and its implementation. This team identifies the core Social Values throughout the entire watershed and ensures they are accounted for in the final Restoration Plan. This team will provide instrumental guidance to implement and update the plan. This team includes:

- Adam Brewerton - Utah Division of Wildlife Resources
- Brad Nelson - Weber Basin Water Conservancy District
- Chris Keleher - Utah Department of Natural Resources
- Erin Bragg - Summit Land Conservancy
- Eve Davies - PacifiCorp
- George Sommer - Blue Ribbon Fisheries Advisory Council
- Justin Anderson - Ogden City
- Lee Rasmussen - Blue Ribbon Fisheries Advisory Council
- Mark Anderson - Weber Basin Water Conservancy District
- Mike Luers - Snyderville Basin Water Reclamation District
- Patrick Belmont - Utah State University
- Reed Cozens - Utah Division of Water Rights
- R Logan Wilde - Morgan County
- Scott Paxman - Weber Basin Water Conservancy District
- Thomas Hoskins - Natural Resources Conservation Service

Restoration Planning and Implementation Team

This team provides the technical expertise and develops, implements, and revises the plan under the guidance of the Advisory Team. It is composed of:

- Ben Nadolski, Paul Thompson, and Kent Sorenson – Utah Division of Wildlife Resources
- Paul Burnett – Trout Unlimited
- Jake Powell – Kamas Valley Conservation District
- Kari Lundeen – Utah Division of Water Quality
- Facilitator: Robert Warren – Bonneville Environmental Foundation

The Weber River Watershed

A watershed is defined as an “entire area that contributes both surface and underground water to a particular lake or river” (Williams et al. 1997), but increasingly, watersheds can also be defined by the people that live, work and play within their boundaries, as well as the social, ecological, financial and societal services and values that they provide (Fight et al. 2000). The Weber River Watershed (Figure 1.4) has experienced a long history of human-influenced changes and alterations to enhance human well-being. These actions have enhanced water transportation and delivery, developed sources of hydropower, reduced flood hazards, provided agricultural, municipal and industrial water supplies, (National Research Council 1992) created transportation corridors, developed economic assests, and fostered the growth of the cities we live within, all of which are essential to our survial and quality of life. However, many of those enhancements have not been realized without considerable impacts to aquatic ecosystems, which provide immense natural wealth and human benefit. For example, aquatic ecosystems recycle nutrients, purify water, attenuate flood hazards, maintain stream flows,

Fig 1.6 View of Mount Ogden from Jacob’s Creek, Utah.

recharge groundwater, provide habitat for wildlife, and offer recreational opportunities for humans. While historical improvements to human well-being are critical to our collective existence and quality of life, society has also begun to recognize the value of balanced and sensible development and ecological stewardship.

The goal of this plan is to recognize both the human and ecological values that the Weber River Watershed provides, identify and assess challenges and threats to those values, and develop strategies to protect and enhance watershed values into the future.

"watersheds can be defined by the people that live, work and play within its boundaries, as well as the social, ecological, financial and societal services and values that they provide..."

Watershed Planning Goals

The planning teams established the following over arching goals for this partnership and restoration plan:

1. Develop a sustainable, long-term vision for the Weber River watershed that inspires collaboration and coordination to achieve watershed goals
2. Understand the underlying reasons for reach-scale and watershed-scale degradation of ecosystems in the Weber River watershed
3. Leverage the resources of the many partners and stakeholders throughout the watershed to more effectively prioritize and address issues and challenges
4. Plan and implement programs, projects and policies at a scale where net-positive change can occur throughout the watershed
5. Do so in a cooperative way that will provide accountability and adaptability to all watershed restoration actions in the future

Achieving our Goals

It was through working towards those goals that the group sought the advice of watershed leaders and experts from around the nation, and reviewed the restoration sciences and conservation planning literature extensively. This provided tremendous insight and advice and ultimately, the group decided to enlist the help of the Bonneville Environmental Foundation to formalize a new restoration planning process, and to create a restoration plan that would help the group accomplish their 5 primary goals.

The Bonneville Environmental Foundation's mission is to "facilitate the widespread adoption of sustainable, planet-friendly practices" through relentless commitment to and guidance from core values, which are 1) partnership, 2) intentional innovation, 3) knowledge, 4) sustainable balance, 5) stewardship and 6) integrity. The Bonneville Environmental Foundations Model Watershed Program "works with key partners to build and support a strategic and lasting approach to restore water quality and fish and wildlife habitat in the nation's rivers and streams." Along with the principles, tools, and guiding philosophy of the Model Watershed Program, a number of additional conservation tools were used to develop a restoration framework for the Weber River watershed. Most notably, Conservation Action Planning (CAP) tools were used extensively, which were developed by the Nature Conservancy and are an integrated, science-based approach to ecological planning and restoration. Conservation Action Planning has guided the implementation of more than 1,000 conservation projects worldwide, and is:

> "a biologically driven process that guides project teams to identify effective conservation strategies. This innovative system helps conservation practitioners focus on the most important protection needs, and allows them to identify the most cost effective and inclusive strategies for lasting success. Conservation Action Planning also provides an objective, consistent and transparent accounting of all information developed through the process," (Bear River CAP 2013).


Fig 1.7: The Weber River near Henefer, Utah.

Watershed Description

The Weber River and its tributaries encompass approximately 1.5 million acres of land in northern Utah, including portions of Summit, Weber and Davis counties and all of Morgan County (Figure 1.8). The watershed is bordered on its north and east by the Bear River Basin, on its south by the Jordan River Basin, and on its west by the Great Salt Lake. Most of the watershed lies within the Wasatch and Uinta Mountains Ecoregion (Woods et al. 2001). The headwater portions of this watershed include a rugged higher elevation alpine zone, uinta subalpine forest, Wasatch montane zone, semiarid foothills, and mountain valleys, which range from 4,500 to 11,000 feet in elevation. Conversely, the lower portions of the watershed lie within sections of salt desert, Wasatch Front footslopes, wetlands, and the Great Salt Lake with an elevation of approximately 4,200 feet.

The Weber River flows from its headwaters west and north until it flows into Rockport Reservoir, which is one of two major impoundments of the mainstem of the Weber River. Downstream of Rockport Reservoir, the Weber River parallels Interstate-80 for approximately 10-miles until it flows into Echo Reservoir, the second and final impoundment of the mainstem of the Weber River. From the outflow of Echo Reservoir, the Weber River is laterally confined by Interstate-84 as it flows through extensive agricultural lands in Henefer and Morgan Valleys and the moderately urbanized areas of Morgan City and other nearby communities. Downstream of Morgan Valley the Weber River enters Weber Canyon where it is further confined by the narrow canyon setting and Interstate-84, until it flows into the highly urbanized and industrial areas of Ogden City and other neighboring municipalities. As described by UDWR (2009b), the terminus of the Weber River is determined by the time of year, water supply and local water demands. Typically, the river flows through extensive agricultural areas in the lowest portions of the watershed, then into Ogden Bay Waterfowl Management Area on the eastern marshes of Great Salt Lake via the natural stream channel. At times however, the majority of the rivers flows are

diverted out of the watershed and stored in Willard Bay Reservoir via the Slaterville Diversion, or pumped and diverted to other portions of the watershed to provide essential services to nearby communities.

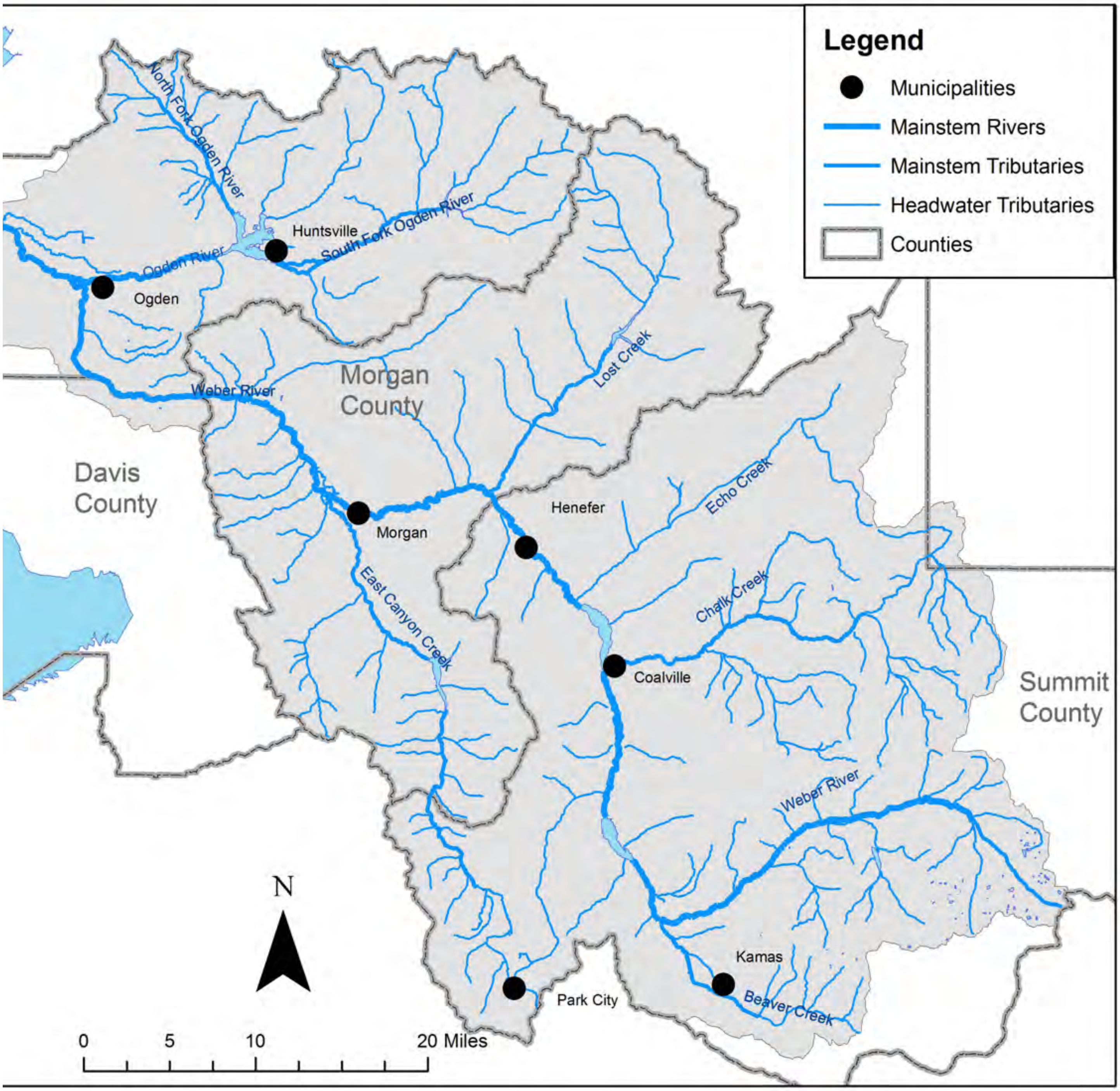


Fig 1.8: Map of the Weber River watershed.

A History of Previous Restoration Efforts in the Watershed

Formal watershed protection and restoration actions in Utah started in earnest in the 1980's, with a primary emphasis in the Weber River watershed (Figure 1.4). That emphasis led to swift actions on-the-ground, which were undertaken in response to long-standing and deeply entrenched threats to the watershed, such as chronic and widespread stream dredging and channelization, and nearly ubiquitous stream bank armoring using nonnative materials, which most often included angular concrete rip rap and car bodies. At that time, most, if not all restoration work was done to protect or enhance fish and wildlife habitats, and most of that work was coordinated and conducted by Aquatic Biologists with the Utah Division of Wildlife Resources. Most of that work was small in scale, structural in approach (i.e., made primarily of rock), and was designed to reduce stream bank erosion, primarily on privately owned lands, while also improving in-stream fish habitat. That approach to stream bank protection and restoration was novel at that time, in that it offered private landowners a viable and financially supportive alternative to rip rap and car bodies as a stream bank protection measure, while also providing actual or perceived benefits to aquatic habitats. Rip-rap materials are still being used today to stabilize stream banks, but its frequency and occurrence of use has reduced dramatically in recent decades, which is likely due, at least in part, to the effects of this new approach.

Many of those projects and structures seemed to perform well, especially in the short-term, although quantifiable evidence to support the projects goals and objectives were lacking both then and now. Nevertheless, over the years the development and use of those structures has proliferated, and based largely on professional judgment and observation, the use of those structures has been refined and improved upon.

During the early 1990's, as momentum, on-the-ground experience and popularity for this new approach began to grow, the Utah Division of Wildlife Resources coordinated and lead a small and informal coalition of stream restoration practitioners from various State and Federal agencies in Utah. Over the years the work of that coalition accomplished varying degrees of stream enhancement or stream

Fig 1.9: Historic photo of car bodies installed along the banks of the Weber River.

bank stabilization, with most of their work continuing to occur in and along the Weber River and other nearby watersheds in northern Utah. In retrospect, those actions reflected not just a local movement, but a nationwide trend (National Research Council 1992) towards swift remedial actions on-the-ground, without first understanding the limiting ecological variables in the watershed, nor fully appreciating the broad and complex science and practice of stream and aquatic habitat restoration (Roper et al. 1997).

During that time however, the science and practice of "stream restoration" was still in its infancy, so in hindsight, pioneering restoration practitioners were not afforded the luxury of clear direction and substantive science to direct their efforts. In some regard, those practitioners were both developing and applying the science and principles of stream restoration simultaneously, which were unfortunate, yet necessary circumstances. As a result, most of those pioneering projects were reluctantly implemented without rigorous training, a strategic focus, or a well-rounded understanding of the multi-disciplinary scope and scale of stream restoration. Nevertheless, those projects were a monumental step forward in the way that stream bank erosion was addressed, and the way that aquatic biologists addressed watershed-scale threats to aquatic ecosystems. Most of those projects however, were implemented at a small reach-scale, some of them no longer maintain their place in the river, and many of them didn't solve the long-term, watershed-scale problems they were presumably intended to address, although project-specific goals and objectives were rarely articulated or recorded.

Fig 1.10: View of Pineview Reservoir over Huntsville,Utah.

With a desire to improve and the ever increasing need to "do more with less", the successes of that approach should be applauded, yet balanced by its inherent weaknesses and shortcomings. When considered in retrospect, along with careful review of those projects through the lens of contemporary knowledge, it is clear that those pioneering projects were rooted in three critical assumptions, which were: 1) that stream shading, pool frequency and pool complexity were the primary limiting factors for aquatic wildlife; 2) that the structures would stay in place long enough to restore the subsurface hydrology that is necessary to allow natural riparian succession and re-establishment to take place, thus providing for natural stream channel stability; and 3) while re-establishment was occurring, private landowners would change the way they managed their land in riparian areas so that similar issues would not arise in the future. Since that time, it is clear that those assumptions were often violated, that each project is unique, and that no single approach can be applied to every project.

"[We] must remain mindful of the restorative actions that [we] take, and simultaneously do not take, to ensure that [our] attention is not "riveted by the dramas that matter least and apathetic to the dangers that matter most."

Many stream restoration practitioners have realized that given the complexity, scope, and scale of the environmental issues at hand, agencies, organizations, and individuals need to work together to not only properly prioritize, develop, and implement projects but also to evaluate whether the projects were successful and whether they have achieved the desired outcomes.

Therefore, researchers and practitioners and by extension, society as a whole, are forced to make difficult choices; our resources are finite and our challenges are big, so "every sensible thing we do is another sensible thing we don't…research shows that when human beings make decisions, they tend to focus on what they are getting and forget about what we are forgoing." (Gilbert 2011). Within the context of watershed restoration, practitioners must remain mindful of the restorative actions that they take, and simultaneously do not take, to ensure that their attention is not "riveted by the dramas that matter least and apathetic to the dangers that matter most." (Gilbert 2011). That is, among the many pressures and challenges throughout the Weber River watershed, which ones deserve the most attention and investment of our increasingly finite restoration resources?

Around 2002, various local, state, and federal government agency representatives, non-profit organization leaders, landowners, and business leaders met to discuss this issue, and sought to identify long-term solutions to various challenges throughout the watershed. That group formed the Weber River Watershed Coalition, and today the most significant contribution from that group continues to be the 2003 Weber River Watershed Action Strategy (WRAS) (WRWC 2003). That document identified water quality issues and opportunities for in-stream and riparian habitat restoration throughout the watershed, and provided the first long-term, watershed-scale strategy for addressing those challenges. That restoration plan was a significant step towards a holistic vision for the future of the Weber River watershed, which eventually gave rise to the Weber River Technical Advisory Committee, commonly know as the Weber River TAC. The Weber River TAC continued to meet periodically to work toward the goals outlined in the original WRAS document. Over time however, those efforts did not always transcend the individuals on the committee, so the long-term continuity of that group has faded. The Weber TAC is now loosely organized and meets only sporadically to discuss issues in the watershed. Several members associated with the original Weber River TAC saw a need to re-establish a common vision for the watershed and to reinvigorate the progress that was made, which eventually led to the development of this plan.

Fig 1.11: View of the Gateway Canal.

Things that matter to all of us...

The Weber River and its tributaries provide habitats, opportunities and resources that are essential to our survival, our way of life and our collective quality of life. Those habitats, opportunities and resources form the backbone of our shared priorities and values (i.e., social values), and provide the framework for this plan by defining what is important to those who live, work and play in this watershed.

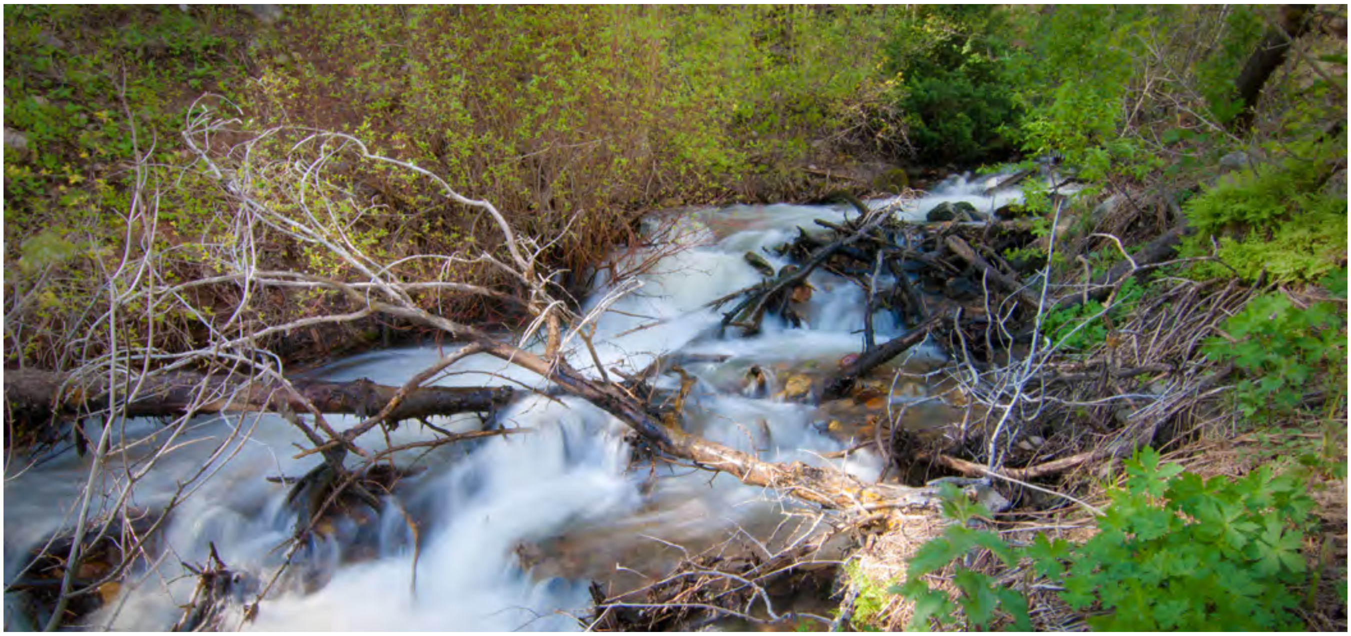


Fig 2.1: Jacob's Creek, a tributary of the Weber River.

Quality of Life

Water is a key component in both the rural and urban lifestyles in this watershed. Water is not only a part of the daily economy of life, but is vital to the active and leisurely aspects of life as well. Water is a precious resource in the west and for many reasons people are drawn to its presence. High quality water bodies and their rich ecological areas support diverse lifestyles and livelihoods, and are a source of aesthetic and recreational pleasure for many people. As a result, a diverse set of user groups including farmers, ranchers, hikers, bikers, anglers, birdwatchers, and boaters, to name a few, all find enjoyment in or near the water bodies in the Weber River watershed.

Water Quantity

Although Native Americans had long practiced and improved upon the art of irrigation, water quantity and irrigation development were essential elements of European American pioneering and colonization of the western United States, including Utah. Upon arriving into the Salt Lake Valley for the first time on July 24th, 1847, Mormon pioneers were immediately challenged by the dry and barren soil conditions of their new settlement. In fact, on the first day of their arrival, “the brethren had already turned out City Creek and irrigated the dry barren soil, this being the first irrigation ever performed by anyone in these mountains in these ages,” and within 14-days of their arrival, “fifteen of the brethren commenced building a dam a little above the camp so as to bring water around and inside the camp” (Sadler and Roberts 1994 and references therein). The presence and abundance of cool clean water, along with these pioneering irrigation practices and those that followed are often credited for the early development of modern day Salt Lake City and other nearby communities (Sadler and Roberts 1994). It is clear that pioneering irrigation practices in and around the Salt Lake Valley set the template for modern day water storage, delivery, law, and practices in the Weber River watershed.

> ***“The Weber River and its tributaries provide habitats, opportunities and resources that are essential to our survival, our way of life and our collective quality of life. ”***

Fig 2.2: Dewatering downstream of the Stoddard Diversion.

After nearly a century of human expansion throughout northern Utah, modern, large-scale water development in the Weber River watershed began in 1927 with the construction of Echo Dam on the Weber River, followed shortly thereafter by the construction of Pineview Dam on the Ogden River. Those water development projects gave rise to the Weber Basin Project, which had its planning origins throughout the 1940's, but began in earnest in 1952. Today, in addition to Echo and Rockport Reservoirs on the mainstem of the Weber River, there are six main tributary and trans-basin impoundments in the watershed, Smith and Morehouse, Lost Creek, East Canyon, Willard Bay, Causey, and Pineview Reservoirs. There are also various other small (i.e., 1-50 surface acres) lakes and reservoirs, mostly located on private property (UDWR 2009a and 2009b). The total storage capacity of the major reservoirs in this watershed is approximately 525,330 acre-feet. Water storage and management in this watershed are managed primarily by the Weber Basin Water Conservancy District and the Weber River Water Users Association, in coordination with local, state, and federal governmental agencies, as well as non-profit and for-profit organizations and private property owners. Water in the Weber River watershed is used for municipal, agriculture, industrial, hydroelectric power generation, recreation, and wildlife purposes, and is one of two major water supplies for the Wasatch Front, serving approximately 21% of Utah's population with drinking and irrigation water (WRWC 2003).

The Weber River has four major tributaries: East Canyon Creek, Chalk Creek, Lost Creek and the Ogden River, and several smaller, perennial tributaries that join the Weber River or its tributaries along its course. East Canyon Creek originates in the increasingly developed and urbanized portions of Park City, flows to the north where it enters East Canyon Reservoir,

Fig 2.3: High flows at the Pacificorp powerplant diversion, spring, 2011.

then flows through diverse physical settings including urban, semi-urban, rural and agricultural communities. The areas surrounding the Chalk Creek and Lost Creek drainages are sparsely populated, primarily privately owned agricultural lands. The most significant tributary of the Weber River, the Ogden River, originates on the eastern slopes of the Wasatch Range, the southern slopes of the Bear River Range and the southwestern Monte Cristo Range. It flows through the Ogden Valley and is impounded at Pineview Dam. From Pineview Dam, the Ogden River flows west through Ogden Canyon, through Ogden City, then joins the Weber River a short distance east of Interstate-15 near the Marriot-Slaterville Diversion.

Water in this watershed serves approximately 21 % of Utah's population with drinking and irrigation water

According to Weber River Watershed Coalition (2003), annual precipitation in the watershed averages nearly 30 inches and varies from approximately 13 inches in the lowlands to over 60 inches in the mountains, receiving more precipitation than any other watershed in Utah, due mainly to the mountainous region in which the drainage is located. The majority of the water supplied to the Weber River Basin comes in the form of snow, and ground water is recharged naturally through such sources as streams, or springs, and artificially by operations that directly inject water into aquifers and divert water into percolation basins.

Annual precipitation varies significantly in this watershed from year-to-year, but long-term trends suggest that water supply has steadily decreased during recent years, and locally available climate data suggest that future water supplies will continue to decline. In addition, human demand on increasingly scarce water resources is expected to rise significantly in the future, as population growth throughout the watershed and nearby Weber Basin Water Conservancy District service areas is expected to increase from 500,000 residents to 1.8-million residents if the watershed is fully developed (WBWCD 2011). For these reasons, the Weber Basin Water Conservancy District is developing an emergency water supply response plan for this watershed (WBWCD in draft), and has set a target goal of at least 25% water conservation by 2025 (WBWCD 2013). Even if that conservation goal is met, demand is still expected to exceed available water supply by 2070. Proactive development of water supply projects both within and outside the watershed will need to be carefully considered. Those projects are likely to have significant impacts to the Weber River watershed, so proactive, collaborative and strategic restoration partnerships in this watershed will be critical in the future.

Water Quality

Congress revised the Clean Water Act (CWA) in 1972 with the over arching goal to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The CWA requires the Utah Division of Water Quality (UDWQ) to designate beneficial uses for each water body in the state. The UDWQ then monitors, assesses, and regulates Utah's water bodies to determine whether the beneficial uses are being met. In accordance with the CWA, UDWQ submits an Integrated Report to Congress on every even numbered year. The Integrated Report summarizes the overall condition of Utah's waters (per Section 305[b] of the CWA) and includes a list of water bodies that are not meeting the water quality standards for their designated beneficial uses (known as the 303(d) list). Waters on the 303(d) list require development of a Total Maximum Daily Load (TMDL). Total Maximum Daily Loads are completed as watershed-scale studies that identify the causes of impairment and pollutants of concern, quantify pollutant loading from respective sources, and establish timelines and strategies to reduce pollution and achieve water quality endpoints.

Based on Utah's 2010 Integrated Report, 56% of the assessed water bodies throughout the Weber River watershed currently meet their beneficial uses as defined and classified in Utah Administrative Code R317-2-6 and R317-2-13. The most common use designations in the Weber River Watershed are Classes 1C (domestic/drinking water), 2B (infrequent primary contact recreation [e.g., fishing and wading]), 3A (coldwater fishery/aquatic life) and 4 (agricultural uses [crop irrigation and stock watering]). However, 19 waters in the Weber River Watershed (almost half) do not meet their beneficial uses, and are therefore listed as

impaired (UDWQ 2010). Of those 19 impaired waters, UDWQ has developed and the U.S. Environmental Protection Agency (EPA) has approved TMDLs encompassing six impaired water bodies: East Canyon Creek, East Canyon Reservoir, Chalk Creek, Echo Creek, Pineview Reservoir and Silver Creek. In addition to these completed and approved TMDLs, a draft TMDL has been developed for Echo and Rockport Reservoirs (expected approval date: April 2014).

Agriculture

In the Weber River watershed, agriculture provided the primary sustenance and livelihoods for early pioneer settlers. The physical, economic and socio-political legacy of this history is still apparent throughout the watershed today, and those social values will continue to play an important role in the well-being of this watershed and its inhabitants for generations to come. Agricultural producers own and maintain a large proportion of the watershed: approximately 75% to 85% (UDWR 2009a and b) of the watershed is privately owned, and much of that land is used for agricultural purposes. Those traditional agricultural practices face many challenges however, including the continued encroachment of suburban sprawl, volatile food markets, increasingly stringent environmental regulations, and a need for a new generation of ranchers and farmers that are willing to confront those challenges. While those economic, development and social pressures and demands continue to increase in the future, the need to provide locally sustainable food sources will also continue to grow.

The viability and stability of local food sources is directly tied to the availability of

Fig 2.4: The Weber River in the Morgan Valley, Utah.

sustainable water resources to irrigate crops in the semi-arid environment of this watershed. Irrigation water, primarily agricultural, is the single largest use of water in this watershed (WBWCD 2011). Water conservation on agricultural lands is challenging, as there is little economic, legal or practical incentive for irrigation water users or private irrigation companies to conserve water (WBWCD 2011). Water conservation practices and systems for agricultural operation can be costly, and increasing production pressures and volatile food markets often make those systems cost prohibitive. In addition, current Utah water law is based on a "use it or lose it" premise, which means that water users must divert their entire water right, whether

"agricultural producers represent a constituency that has the ability to make lasting positive changes to the watershed, while also preserving and sustaining the rich legacy of agriculture in this watershed."

they need it or not, or risk losing that water right altogether. In combination with economic constraints, those legal implications further discourage water conservation practices and systems while simultaneously threatening long-standing water rights, agricultural operations, and community and individual well-being. Therefore, flood irrigation is often employed as it requires little infrastructure and maintenance while leveraging long-standing land management experience, crop selection, tradition, and the ability to effectively use the agriculture-related water rights that are allocated throughout the watershed. Therefore, land management practices that influence grazing operations, chemical applications and soil health, to name a few, can have a large-scale and long-lasting impact on the watershed. As owners of large tracts of land with daily operations and decisions that impact the land both positively and negatively, agricultural producers represent a constituency that has the ability to make lasting positive changes to the watershed, while also preserving and sustaining the legacy of agriculture in this watershed.

Recreational Fishing

Recreational fishing and other wildlife-related recreation activities are popular past times throughout the U.S., as approximately 90 million people participate in those activities each year. Those activities equate to approximately $144.7 billion dollars of related economic expenditures each year (USFWS 2011). Of those participants, approximately 33 million people participate in recreational fishing nationwide, totaling approximately 41.8 billion dollars of annual fishing-related revenue (USFWS 2011). Recreational fishing continues to be an important part of Utah's culture and economy, as 483,806 fishing licenses were purchased in 2011, which was a 17% increase in participation since 2005, and in 2011 those anglers spent approximately $259 million on recreational fishing-related expenditures (UDWR 2012). Approximately 78% of all Utah anglers are willing to travel more than 40 miles for a one-day fishing trip and approximately 57% of non-resident anglers (i.e., anglers that live outside of Utah) are willing to travel more than 250 miles for a multiple-day fishing trip in Utah (UDWR 2012). In addition, anglers are willing to travel further and spend more time and money at fisheries that are designated as "Blue Ribbon Fisheries" (Kim and Jakus 2013), which are rivers, lakes or reservoirs that provide highly-satisfying fishing and outdoor experiences for diverse groups of anglers and enthusiasts. As a reflection of that trend, of the $259 million dollars spent by all Utah anglers annually in 2011, $184 million was spent visiting Utah's Blue Ribbon Fisheries.

"of the $259 million dollars spent by all Utah anglers annually in 2011, $184 million was spent visiting Utah's Blue Ribbon Fisheries"

Fig 2.5: Fly fisherman in the Weber River near Morgan, Utah.

The Weber River watershed supports locally and regionally important recreational fisheries, including five fisheries that are officially designated as Blue Ribbon Fisheries by the Utah Division of Wildlife Resources Blue Ribbon Fisheries Advisory Council, as well as ten additional fisheries that are currently under review or are considered potential “candidates” for Blue Ribbon Fisheries status. Blue Ribbon Fishery status indicates that a water has met quantifiable criteria for quality fishing, quality outdoor experience, quality fish habitat and economic benefits (UDWR 2012).

The mainstem Weber River is the second most visited stream fishery in the State of Utah.

According to UDWR (2013), the mainstem Weber River is the second most visited stream fishery in the State of Utah, second only to the world-renowned trout fishery in the Green River, but ahead of the well-renowned Provo River fishery in Wasatch County. The mainstem Weber River also supports the three most sought after fish species in the State of Utah: rainbow trout, brown trout and cutthroat trout (UDWR 2012). In 2011, of those anglers that visited the officially designated Blue Ribbon Fisheries in Weber and Summit counties, approximately 56% (Weber County) and 75% (Summit County) of them traveled from out of county areas, and the Blue Ribbon Fisheries in Weber and Summit counties combined for approximately $10.34 million and $8.77 million of combined industry output and value added economic benefits in 2011, respectively (Kim and Jakus 2013). The expenditures associated with those fisheries provide approximately 150 jobs in those two counties alone, which combine for approximately $4.41 million of total labor income for those employees.

In summary, recreational fishing is an important social and economic pastime in Utah and most especially, in the Weber River watershed. For those reasons, for the benefit of anglers and non-anglers alike, recreational fishing opportunities should be protected and when possible, expanded in this watershed to provide additional economic and recreational benefits to those people who live in the watershed, as well as those who visit the watershed (also see the economic development section).

Water-based Recreation

Water-based recreation has been an important component of the watershed since its settlement, and demand for recreation in this watershed has increased at levels unforeseen by early watershed planners; “the need for recreational use pushed in the original Weber Basin Bill was borne out by the public, who voted with boats, water skis, picnic baskets and fishing poles" (Sadler and Roberts 1994). To this day, many people from communities within and around the watershed participate in water-based recreation activities, including motorized and non-motorized recreational sports such as boating, kayaking, canoeing, tubing, paddle boarding, swimming, and bird watching. Opportunities to recreate in this watershed are numerous and diverse, and comprise one of the largest user groups in this watershed and beneficiaries of its overall health.

"the need for recreational use pushed in the original Weber Basin Bill was borne out by the public, who voted with boats, water skis, picnic baskets and fishing poles"

Water-based recreation is most concentrated in the reservoirs, with most participation occurring at Pineview, Echo, Rockport, Willard, and East Canyon Reservoirs. Other water-based recreational opportunities are scattered throughout the watershed, including commercial tubing and rafting operations in the mainstem reaches of the Weber River from Morgan Valley upstream to Henefer Valley. Ogden City, which is situated near the lowermost portions of the watershed, is aggressively pursuing outdoor and water based recreation activities, as they continue to position themselves as the "hub" of outdoor recreation in Utah and the Intermountain West. Ogden City is actively preparing a strategic outdoor recreation plan that will identify many forms of water-based recreational opportunities that exist in and around Ogden City, and potential actions to take and partners to collaborate with in order to improve those recreational resources and opportunities.

The growing interest in water-based recreation provide a unique opportunity for collaboration towards shared watershed-scale restoration and protection goals with other user groups.

Fig 2.6: Recreational boating at Pineview Reservoir

Community and Economic Development

As a result of human-related activities, hydrologic flow conditions throughout the western United States have changed markedly in the last half of the 20th century, and those changes have led to current, and likely continued, water shortages throughout many western states. The availability of a clean, drinkable and sustainable water supply is one of the primary limiting factors in continued community and economic development in the west. Although water is not always recognized explicitly for its value, it is a critical component of any community and its economy, especially in a semi-arid western U.S. watershed like the Weber River and its tributaries.

Water is required to expand communities and allow for growth. The successful implementation of this plan will assist communities in strategically utilizing water resources so that growth can continue. Recognition of the value and true cost of water in the Weber River Basin is an important component to the plan. Proper stewardship of this resource will help ensure that growth can continue within the watershed without sacrificing the collective quality of life of its residents and those who visit the watershed.

As with many western watersheds, the lower elevations are the most heavily populated, while the upper watershed contains mostly rural communities surrounded by large expanses of largely agriculture, range, and forested landscapes. These upper expanses of the watershed provide the primary supply and storage locations for the more populated lower watershed.

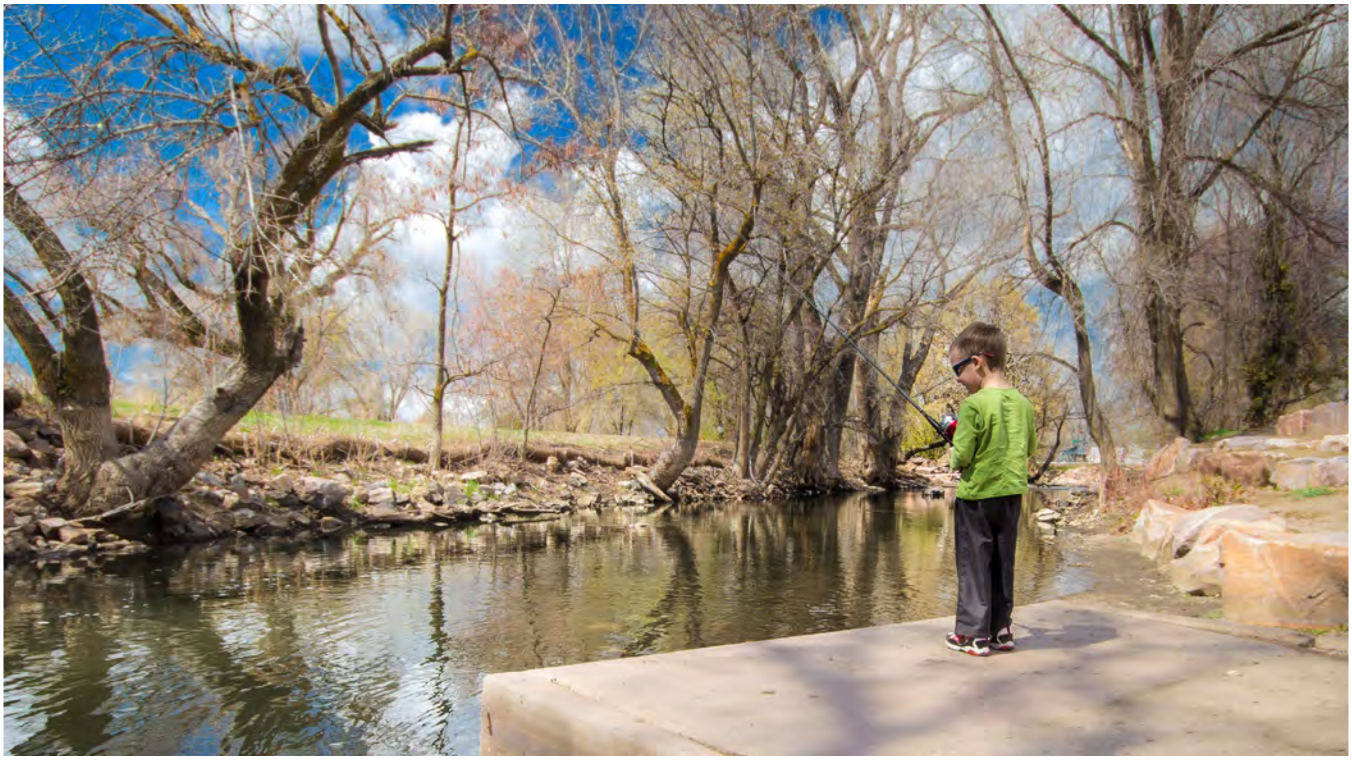


Fig 2.7: A young river steward fishing at a recently restored reach of the Ogden River

This creates a geographical and social disconnect between the source of water and the end user of water. This disconnection is apparent during drought years when depleted reservoir storage is often virtually unnoticed to the far-away populous, making the effects of water conservation seem distant and beyond their ability to influence. The implications of water use, water quality, and water conservation at the watershed-scale is an issue shared by many, which represents an opportunity for widespread collaboration with many stakeholders throughout the watershed to protect shared resources and to achieve shared goals.

"The availability of clean, drinkable and sustainable water supplies is the primary limiting factor in continued community and economic development... Although water is not always recognized explicitly for its value, it is a critical component of any community and its economy"

Fig 2.8: One of many low-head irrigation diversion dams in the Weber River watershed.

Conservation Targets

Water Resources

Stated simply, water is our most universal and fundamental need. Every social value in this watershed is supported by and dependent upon our water supply. Therefore, to improve the health of our watershed it is appropriate that above all else, key indices of water supply be used to develop strategies that increase our water supply, enhance the efficiency and effectiveness of water delivery, and where possible, simultaneously balance the needs of other social values throughout the watershed.

As stated previously, the Weber River and its tributaries supply approximately 21% of all Utah residents with drinking water, and demand for that water is increasing as Utah's population continues to grow, levels of precipitation remain increasingly uncertain, and water delivery mechanisms, policies and practices grow in complexity. Further compounding these issues, local climate data suggests that future water supplies will continue to decline. These

threats, especially when combined with the need to sustain all of the social values throughout the watershed, highlight the need to enhance the water conservation measures that are already underway. Regardless of individual and organizational priorities, key indices of water supply, delivery efficiency and water conservation will provide important insight into the current and future health of our watershed.

> ***"Regardless of individual and organizational priorities, key indices of water supply, delivery efficiency and water conservation will provide important insight into the current and future health of our watershed."***

Fig 3.1: View of Smith and Moorehouse Reservoir.

Aquatic Species

Bluehead Sucker

Of particular conservation importance in the Weber River watershed is the bluehead sucker (*Catostomus discobolus*), which is native to portions of the upper Snake, Colorado, Weber, and Bear river drainages in Utah, Wyoming and Colorado (Sigler and Miller, 1963; Sublette et al. 1990). As summarized by Webber et. al. (2012), bluehead suckers still persist in some portions of their native range. In Idaho and Wyoming, bluehead suckers currently occupy portions of the upper Snake River and Bear River. The size and distribution of those populations is still unclear, but current distribution and abundance appears to be patchy. In Utah, portions of the Bear, Ogden, and Weber River drainages in the Bonneville Basin were historically occupied by bluehead suckers. However, despite extensive sampling by the UDWR since 2004, extant populations of bluehead suckers have been documented only in the Weber River and most recently in the Raft River (Thompson and McKay 2012).

The population of bluehead suckers in the Weber River is unique and until recently, was understudied and not well understood. Since that time, patchily distributed populations of bluehead sucker have been documented in the Weber River, and Hopken et al. (2013) concluded that the bluehead sucker in the Weber, Bear, and upper Snake rivers are distinquishable from populations in the Colorado River Basin. In response to these findings, the UDWR, in cooperation with many range-wide partners (UDWR 2006a and b), are implementing aggressive conservation actions to ensure the long term persistence of this population.

Since the discovery of this population, ongoing investigations continue to increase our knowlege about this speies; based on this information combined with research findings in other portions of its range, it is presumed that like many similar riverine fishes, factors that threaten bluehead suckers in the Weber River include hydrograph alteration through the historical and ongoing development of dams and irrigation diversions, destruction and fragmentation of micro and macro habitats, an altered thermal regime, and the introduction of nonnative fish

Fig 3.1: Sub-adult bluehead sucker captured in the Weber River.

species (Webber et al. 2012). Small irrigation-diversion dams are numerous throughout many watersheds of western U.S., including the Weber River. These irrigation diversions not only divert water from rivers, but in some cases they can fragment and isolate populations and permanently entrain fish into irrigation canals and associated water delivery infrastructure. More specifically, irrigation diversion structures can create fish migration barriers, which can block access to preferred spawning and rearing habitats in mainstem and tributary reaches, which ultimately leads to population fragmentation. Through time, population fragmentation can lead to reduced population size and resultant genetic bottlenecks, which can further decrease the overall fitness of a population.

"Combined direct and indirect effects of dams, irrigation diversions and physical degradation of in-stream habitats threaten bluehead suckers."

Often working in combination with the deleterious effects of dams and diversions, degradation of in-stream habitats represents a serious threat to the persistence of bluehead suckers in the Weber River. As summarized by Webber et al. (2013), in the Colorado River Basin, larvae of bluehead suckers drift after emergence from the egg stage and inhabit backwaters and shallow riffles as juveniles. Adults appear to prefer more complex habitats with larger substrate particles, faster flowing water, and shallow riffle habitats. However, many of these preferred habitats in the Weber River have been eliminated due to past construction activities and channelization of streams under the auspices of 'flood protection.' This alteration of geomorphology and hydrology potentially contributes to factors limiting distribution and abundance of the bluehead sucker, and should be taken into consideration during watershed-scale stream restoration planning and implementation activities.

As summarized by Webber et al. (2013), in addition to the combined direct and indirect effects of dams, irrigation diversions and physical degradation of in-stream habitats, introduced species of fish also threaten bluehead suckers through predation, competition, and hybridization. Predation by nonnative species on bluehead suckers is well documented and can limit abundance and distribution of populations. Nonnative fish also have the potential to compete for the same food resources as bluehead suckers. Hybridization of bluehead suckers with white (*Catostomus commersonii*), flannelmouth (*Catostomus latipinnis*), and mountain suckers (*Catostomus platyrhynchus*) has been documented in the Colorado River Basin , as well as with Utah suckers (*Catostomus ardens*) in the Weber River. Hybridization can rapidly reduce fitness in a population of fish and has led to extinction of many species and populations of plants and animals worldwide.

Bonneville Cutthroat Trout

The cutthroat trout (*Oncorhynchus clarkii*) is a salmonid species native to portions of western North America, and has the broadest distribution of any native western trout species (Behnke 1992). Natural dispersal of cutthroat trout combined with geographic isolation events led to the evolutionary divergence of multiple cutthroat trout subspecies in the interior west. Currently, there are eight putative subspecies of cutthroat trout in western North America (Behnke 1992), including the Bonneville cutthroat trout (*Oncorhynchus clarkii utah*; Smith et al. 2002).

Extant populations of Bonneville cutthroat trout persist in portions of Utah, Idaho, Wyoming, and Nevada (Gresswell 1988), and have experienced reductions in historically occupied habitats, with contemporary populations primarily relegated to resident populations in headwater tributary streams (Lentsch et al. 1997). Many factors have contributed to this decline, including habitat degradation (Binns and Remmich 1994), disease (de la Hoz Franco and Budy 2004), hybridization (Weigel et al. 2003), and negative interactions with nonnative fish species (Griffith 1988). Currently, Bonneville cutthroat trout are managed range-wide through a cooperative, multi-partner Conservation Agreement and Strategy (Lentsch et al. 2000), and are managed throughout Utah via a statewide Agreement and Strategy (Lenstch et al. 1997).

Throughout the range of Bonneville cutthroat trout, individual populations are managed differently, depending upon their respective levels of genetic purity or genetic introgression. More specifically, a population with <90% native alleles is managed as a "sport fish population", a population with ≥90% native alleles is managed as a "conservation population", and those with ≥99% native alleles are managed as a "core conservation population." In addition to genetics, special conservation consideration is also given to populations that display unique life-history traits.

The genetic status of cutthroat trout in the Weber River watershed is largely a reflection of geologic history (Evans et. al. 2013 and references therein), including historical and large-scale stream capture events and drainage reconfigurations, which have resulted in the mixing of multiple native cutthroat trout stocks or strains. The most prominent event was the capture of the Bear River from the Snake River Drainage into the Lake Bonneville Basin aproximately 20,000 years ago. This allowed what is presently referred to as "Bear River"

Fig 3.2: A Bonneville cutthroat trout from the Weber River.

Bonneville cutthroat trout to genetically mix with Bonneville cutthroat trout. Since this basin-wide genetic transfer occurred recently, relative to the evolutionary history of cutthroat trout in the Intermountain region, the two strains of Bonneville Cutthroat Trout are genetically distinguishable only at the molecular level.

Genetic status in most cases is also influenced by human activities. In the case of the mainstem of the Weber River, tissue samples from cutthroat trout primarily indicate a mix of native cutthroat trout with one or more non-native *Oncorhynchus* species, which is the result of past fisheries management practices, including the stocking of non-native rainbow trout and Yellowstone cutthroat trout, and subsequent hybridization of non-native and native stocks. In contrast with the mainstem, samples analyzed from tributaries of the Weber River are largely reflective of natural history, as well as some evidence of past management, while a handful of populations also show some degree of non-natural hybridization with Colorado River cutthroat trout, Yellowstone cutthroat trout and rainbow trout.

Until recently, cutthroat trout in the Weber River watershed were known to occur only in headwater tributary streams and sparsely distributed mainstem habitats. However, a recent and ongoing cooperative investigation by the UDWR and Utah State University (unpublished UDWR and USU data) has documented a metapopulation of Bonneville cutthroat trout throughout comparatively large portions of the Weber River and its tributaries. As a result of

Fig 3.3: Bonneville cutthroat trout stranded during low flows in the Weber River.

that investigation, it is evident that a rare and unique form of “fluvial” life-history expression persists in this metapopulation, which greatly increases the conservation importance of this metapopulation, but also complicates those actions taken to protect and restore the rare combination of genetic purity and life-history expression.

The cutthroat trout in the Weber River watershed display very rare and unique life-history traits that warrant additional conservation consideration.

Since the capture of the Bear River into the Bonneville Basin was a natural geologic event, populations of cutthroat trout in the Weber River and its tributaries that exhibit genetic characteristics consistent with “Bear River” or “Bonneville” cutthroat trout, or some mix of both, while also lacking non-native genetic markers, are considered to be, and therefore managed as conservation populations. Therefore, the cutthroat trout in the Weber River watershed are a mix of sport fish, conservation and core conservation populations, some of which display rare and unique life-history traits that warrant additional conservation consideration.

Fig 3.4: View of East Fork Chalk Creek, a tributary of the Weber River.

Ecological Systems

To better understand the physical, hydrologic, biological, ecological, social, economic and political attributes of the Weber River and its tributaries, the watershed has been divided into six distinct Ecological Systems to facilitate planning and assessments (Figure 3.3), including 1) the Upper Weber River Ecological System, 2) the Chalk Creek - Silver Creek Ecological System, 3) the East Canyon Creek Ecological System, 4) the Lost Creek-Echo Creek Ecological System, 5) the Ogden River Ecological System, and 6) the Lower Weber River Ecological System. The delineation of these Ecological Systems is based on a number of considerations, including the use of commonly accepted and standardized Hydrologic Unit Maps developed by the United States Geological Survey, consistency with existing and ongoing watershed assessment activities (e.g., UDWR 2009a and b and UDWQ 2010), as well as various physical, social and biological boundaries throughout the watershed. These assessments have been completed for each Ecological System based on existing data, literature, as well as detailed analyses of the most recent Geographic Information Systems data made available by the Utah Automated Geographic Reference Center.

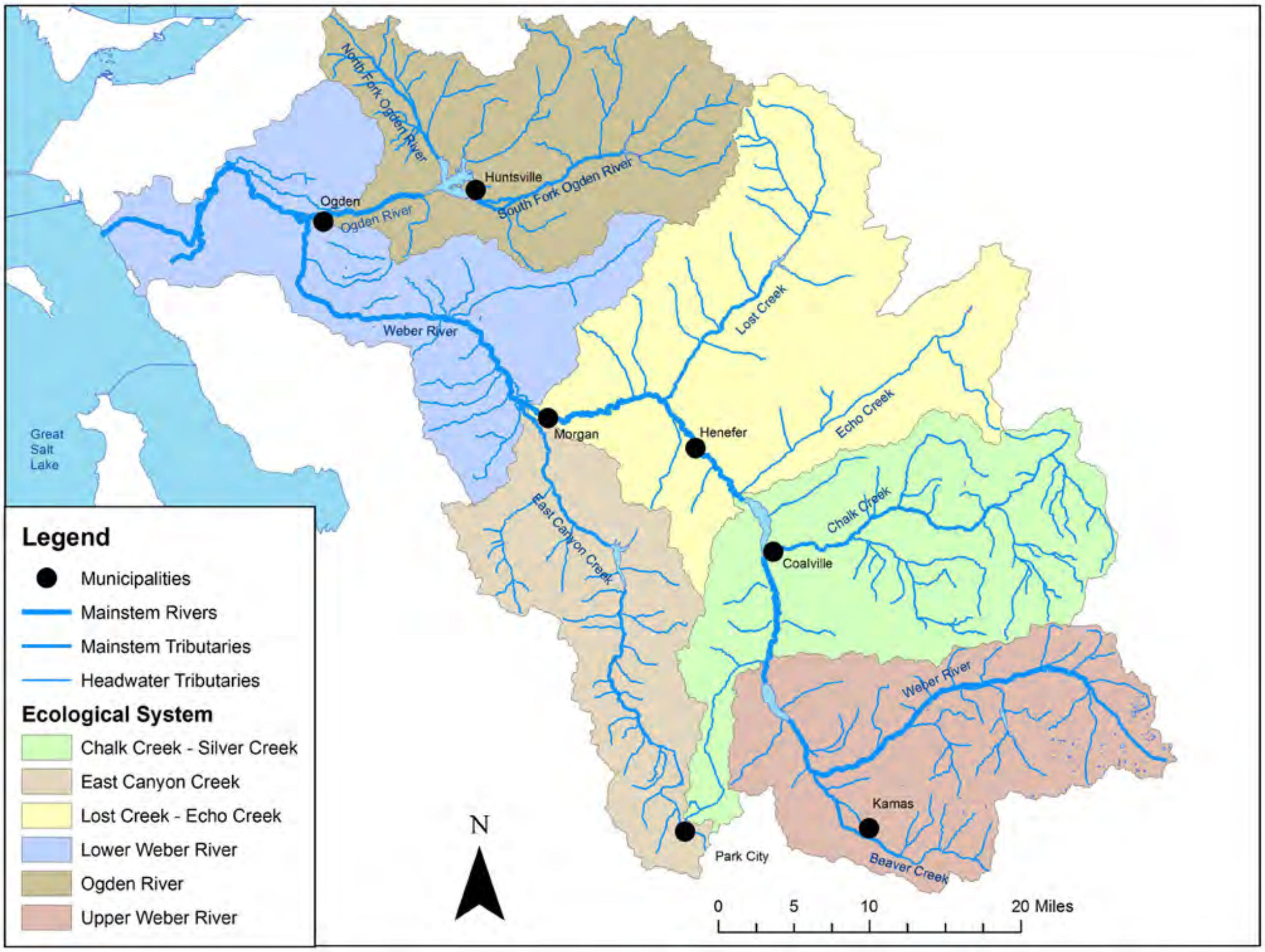


Fig 3.5: Map of all six Ecological Systems and tributaries.

Concise Geological Formation Description[1]	Upper Weber	Chalk and Silver Creek	East Canyon Creek	Henefer Valley, Lost and Echo Creek	Lower Weber	Ogden River
Limestone and Dolomite	16.30	0.46	7.45	7.69	4.49	12.58
High Silica Metamorphic/Igneous	12.35	4.22	18.46	0.73	32.23	12.48
Low Silica Metamorphic/Igneous	14.07	0.00	0.00	0.17	0.99	14.41
Older Alluvium Deposits	1.15	0.33	0.09	0.31	0.04	1.44
Younger Alluvium Deposits	32.69	13.58	13.77	4.40	51.06	19.82
Sandstone	17.07	37.81	50.22	72.63	11.18	38.64
Shale	6.36	40.26	10.01	14.07	0.01	0.05
Mudstone/Siltstone	0.00	3.33	0.00	0.00	0.00	0.56

[1]Data was derived from the Utah AGRC and combined with Wyoming geologic formation data to represent a small portion of the Chalk Creek Watershed that occurs in Wyoming. Formations were generalized into coarse geological formations. Alluvial deposits were defined as Older (Formed prior to the Quaternary Period) and Younger (Formed within the Quaternary Period).

Table 3.1: Percentage of land area composed of different geological formations by Ecological System.

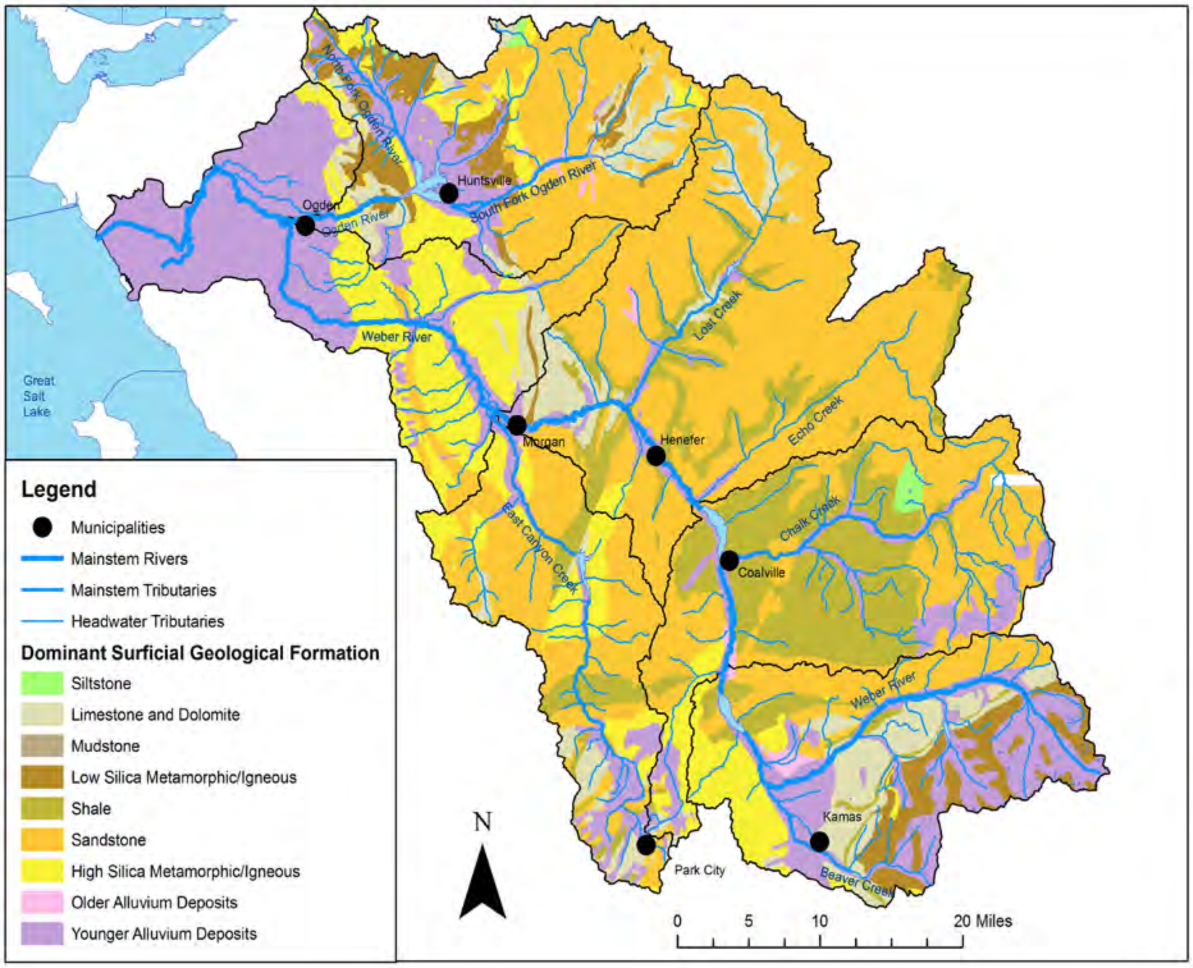


Fig 3.6 Map of dominant surficial geological formations in the Weber River watershed.

Upper Weber River Ecological System

The Upper Weber River Ecological System (Figure 3.5) encompasses 332-square miles of drainage area in the uppermost portions of the watershed (Table 3.2). This Ecological System ranges in elevation from 5,800 feet above mean sea level to over 11,000 feet and encompasses portions of Summit County, including the towns of Kamas, Peoa and other nearby communities and settlements. Of the 332-square miles of drainage area in this portion of the watershed, approximately 54% is privately owned. The U.S. Forest Service is also a significant landowner, managing approximately 44% of the land (Table 3.5).

This ecological system includes approximately 31 miles of Weber River mainstem from the headwaters downstream to the confluence with Silver Creek, as well as approximately 171 miles of tributary streams, including approximately 19 miles of Beaver Creek, the largest tributary stream in this Ecological System (Table 3.4). Two major irrigation storage reservoirs are located within this Ecological System, including Smith and Morehouse Reservoir and Rockport Reservoir, which impound 1,360 and 75,730 acre-feet of water at full pool elevation, respectively (UDWQ 2013).

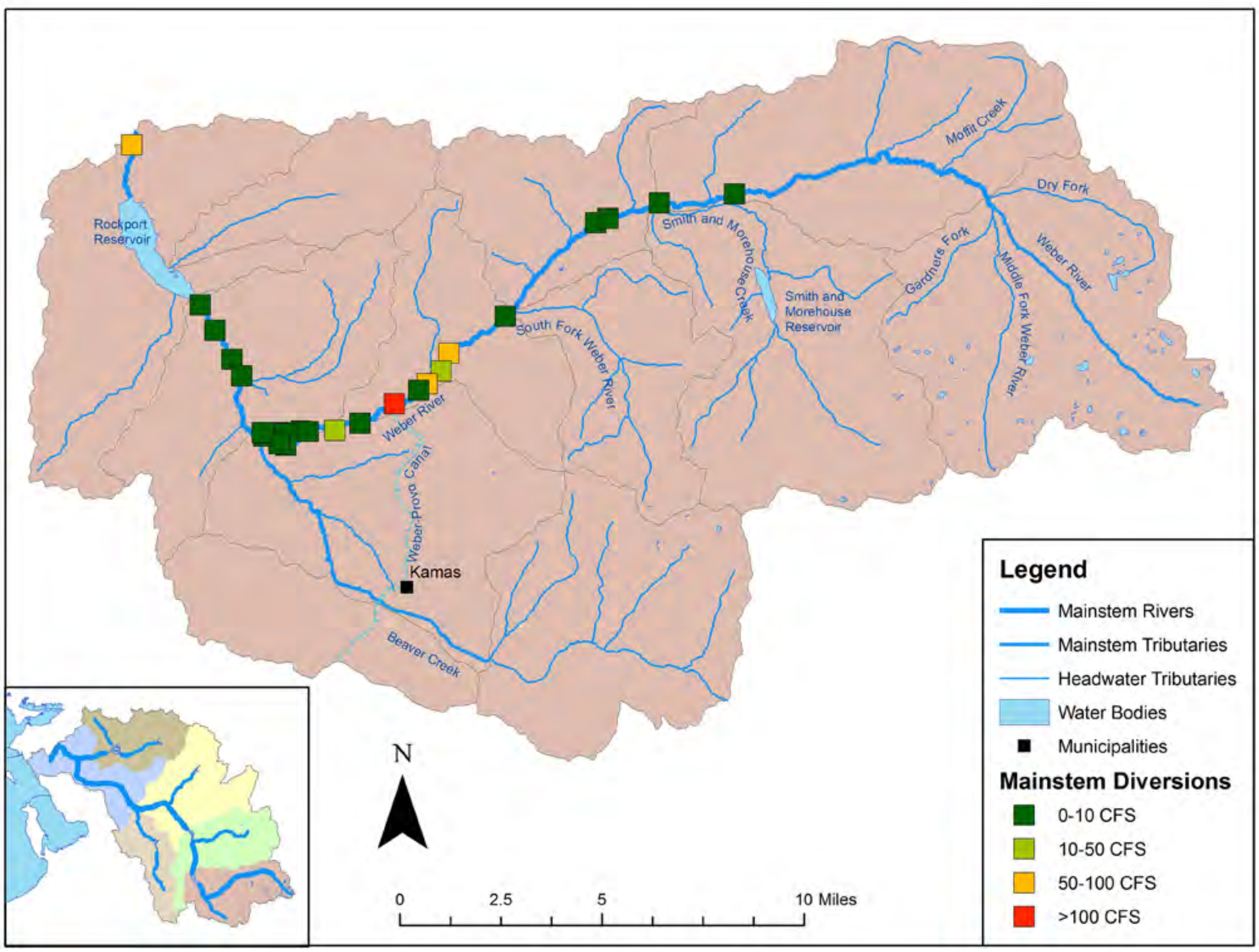


Fig 3.7: Map of Upper Weber Ecological System, including locations and rates of major irrigation delivery systems.

"The watershed was divided into six ecological systems with distinct physical attributes but with relatively similar sizes."

Ecological System	Area (Square Miles)
Upper Weber	331.87
Chalk Creek - Silver Creek	373.75
East Canyon Creek	245.34
Lost Creek - Echo Creek	504.37
Ogden River	333.21
Lower Weber River	343.96

Table 3.2: Total area of each Ecological System.

The dominant vegetation types in this ecological system include shrub steppe, aspen, mixed conifer and northern oak (Table 3.6). Approximately 8.2% of the total land area has been converted for agricultural, industrial or urban development.

Water Quantity

Precipitation in this ecological system averages approximately 27-inches per year (Table 3.3). Water from this Ecological System is used extensively for irrigation and municipal use via approximately 20 discrete points of diversion. The most significant water withdrawal in this Ecological System is the trans-basin delivery of water to the Provo River watershed

Fig 3.8: Image of the Weber-Provo diversion structure in Kamas.

via the Weber-Provo River Diversion and its associated canal system, which delivers up to 700 cubic feet/second to the Provo River System to meet irrigation and power demands. The Weber-Provo diversion greatly impacts the in-stream flow regime downstream all the way to Rockport Reservoir.

Water Quality

Water quality was assessed throughout most of this Ecological System in 2010 (UDWQ), and the majority of the Assessment Units in the Upper Weber Ecological System meet their designated beneficial uses, except for Rockport Reservoir. Rockport Reservoir does not meet its Class 3A beneficial use (cold water aquatic life). The impairment is caused by low dissolved oxygen due to excessive nutrient inputs. A draft TMDL for Rockport Reservoir is under development and will be available in December 2013.

Agriculture

This portion of the watershed has a rich history and culture of agricultural activities. However, in recent decades much of the farmland in this ecological system has been converted to low-density residential and municipal uses, along with the water rights that were formerly tied to those agricultural operations.

Recreational Fishing

The Upper Weber River Ecological System is home to a diverse community of native and nonnative species, including regionally important coldwater and warm water recreational fisheries. The short reach of the Weber River downstream of Rockport Reservoir is designated as a Blue Ribbon Fishery by the Utah Division of Wildlife Resources Blue Ribbon Fisheries Advisory Council and is a popular non-native brown trout and mountain whitefish fishery.

Water-based Recreation

Most of the water-based recreation in this Ecological System occurs at Rockport Reservoir. Rockport Reservoir is bordered by Rockport State Park, which is 770-acres and is owned and managed by the Utah Division of Parks and Recreation. This park hosts approximately 157,000 visitors each year.

Chalk Creek - Silver Creek Ecological System

The Chalk Creek - Silver Creek Ecological System (Figure 3.7) encompasses 376-square miles of drainage area in the upper portions of the watershed (Table 3.2). This Ecological System ranges in elevation from approximately 5,500 to 10,800 feet above mean sea level and encompasses portions of Summit County, including the town of Coalville and other nearby communities and settlements. Of the 332 square miles of drainage area in this portion of the watershed, approximately 99.3% is privately owned (Table 3.5).

This Ecological System includes approximately 10 miles of mainstem Weber River from the Silver Creek confluence to Echo Reservoir, as well as approximately 214 miles of tributary streams. This includes approximately 22miles of Chalk Creek and Silver Creek: the two largest tributary streams in this Ecological System (Table 3.4). The only major irrigation storage reservoir within this Ecological System is Echo Reservoir, which impounds approximately 74,000 acre-feet of water at full pool elevation (UDWQ 2013).

The dominant vegetation types in this ecological system include shrub steppe,

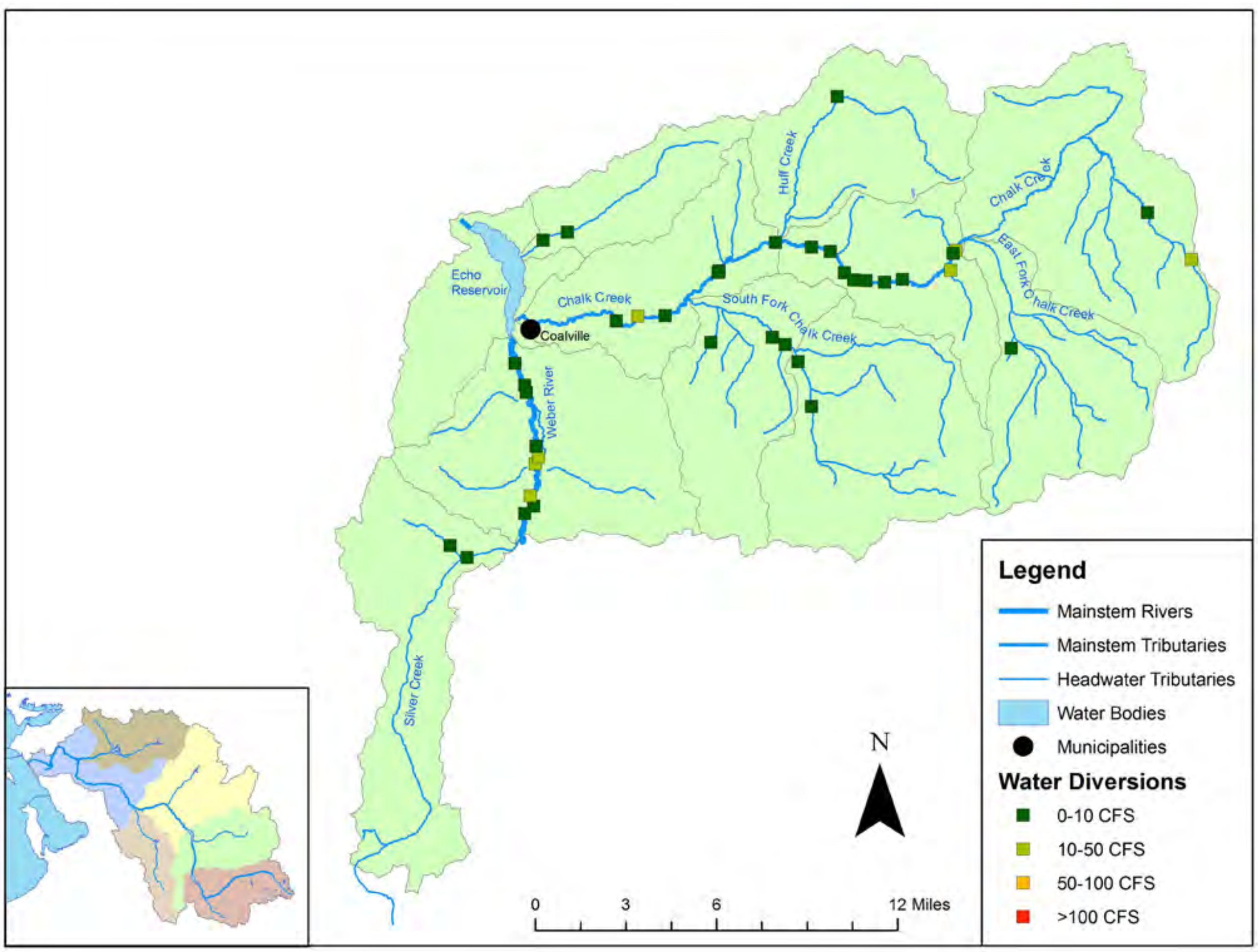


Fig 3.9: Map of Chalk Creek - Silver Creek Ecological System, including locations and rates of major irrigation delivery systems.

aspen, and northern oak. Approximately 7.3% of the total land area has been converted for agricultural, industrial or urban development (Table 3.6).

Water Quantity

This Ecological System is the most arid system in the Weber River watershed. Precipitation in this portion of the watershed averages approximately 21-inches per year, and over 60% of the ecological system receives less than 20-inches of annual precipitation. Water from this Ecological System is used extensively for agricultural irrigation via approximately 20 discrete points of diversion, including 10 small diversions in the Weber River mainstem. A majority of the agricultural producers practice flood irrigation, however many water users in the Chalk Creek watershed have converted to sprinkler irrigation systems. Municipal and industrial water use is currently limited to the human population centers within this Ecological System. The largest water diversion in this Ecological System is the Chalk Creek pressurized system, which diverts up to 30 cfs from the Chalk Creek mainstem. During dry years this diversion has the capacity to nearly dewater the lower reaches of Chalk Creek. A guaranteed minimum flow out of Rockport Reservoir ensures continuous flow within the mainstem Weber River in this ecological system.

Water Quality

Of the assessed water bodies in this Ecological System, Echo Reservoir, Chalk Creek and its tributaries, and Silver Creek are listed as impaired. For each of these waterbodies, the cold water aquatic life beneficial use is impaired. The causes vary in each waterbody. In Echo Reservoir, the cause of the impairment is low dissolved oxygen related to excessive nitrogen and phosphorus (SWCA, 2013). A draft TMDL for Echo Reservoir will be available in

Average precipitation is a silent driver of much of the land use patterns within a watershed. The timing and form of this precipitation affects the hydrologic cycle in each ecological system.

Ecological System	Average Precipitation (Inches)[1]
Upper Weber River	27.2
Chalk Creek - Silver Creek	21.0
East Canyon Creek	27.2
Lost Creek - Echo Creek	23.5
Ogden River	36.2
Lower Weber River	26.9

The average precipitation is based on average precipitation from 1971-2003 based on the PRISM climate mapping system (http://www.prism.oregonstate.edu/).

Table 3.3: Average precipitation for each Ecological System.

2014. This will include an implementation plan outlining strategies to address water quality impairments.

In the 1990's, Chalk Creek and its tributaries were listed as impaired based on sedimentation and high levels of total phosphorus. A Coordinated Resource Management Plan was developed and approved as a TMDL by EPA in 1994. Since then, over $4 million dollars have been spent in the Chalk Creek watershed on projects that reduce stream bank erosion, stabilize stream channels, reestablish riparian corridors, and reduce irrigation impacts by converting from flood irrigation to sprinkler irrigation. Based on data collected by UDWQ from 2000 to 2010, nutrient concentrations have been reduced by an order of magnitude in the Chalk Creek watershed (from approximately 11,307 kg/yr total phosphorus to 1,056 kg/year total phosphorus; SWCA, 2013). While improvements in water quality have been documented, sedimentation and habitat degradation continue to impact Chalk Creek tributaries.

Silver Creek does not meet its beneficial uses in classes 1C (domestic/drinking water), 3A (coldwater fishery/aquatic life) and 4 (agricultural uses [crop irrigation and stock watering]) due to levels of arsenic, cadmium, Total Dissolved Solids (TDS) and zinc. The primary sources of cadmium, zinc, and arsenic come from legacy mining practices in the Park City

Fig 3.10: Photo of Chalk Creek near Coalville, Utah.

area. Sources of TDS include geologic formations and road salting during the winter months. A TMDL for cadmium and zinc was approved by the EPA in 2004 (UDWQ 2004). Additional TMDLs for arsenic and TDS are pending.

Due to Silver Creek's mining history, efforts to restore water quality have been focused on removing the extensive mine tailings present within and adjacent to the stream channel throughout the upper Silver Creek watershed. Strategies to restore water quality in this reach are currently under the jurisdiction and management of EPA, in consultation with the Utah Division of Environmental Response and Remediation and other state, federal, and local stakeholders.

Agriculture

Historically, land use in this portion of the watershed has been agricultural. However, in recent decades much of the farmland along the Weber River in this portion of the watershed has been converted to low density residential and small farming operations. The headwaters of Silver Creek are under significant municipal development pressure, as are the water rights and uses that were formerly tied to the agricultural an mining operations. Agricultural production continues to be the predominant land use in the Chalk Creek watershed. Several large conservation easements in the South Fork subwatershed will preserve this agricultural legacy.

Recreational Fishing

The Chalk Creek - Silver Creek Ecological System is home to a diverse community of native and nonnative species, including regionally important coldwater and warmwater recreational fisheries. Like the Upper Weber River Ecological System, the reach of the Weber River from the outlet of Rockport Reservoir downstream to where Interstate-80 crosses the Weber River is designated as a Blue Ribbon Fishery by the Utah Division of Wildlife Resources. That same reach of the Weber River, as well as the lower reaches of Chalk Creek, support one of a few conservation population strongholds of bluehead sucker in the Weber River (Thompson and Webber 2009), and Chalk Creek and its tributaries support one of the largest remaining genetically pure metapopulations of Bonneville cutthroat trout in existence (Thompson 2000).

Water-based Recreation

Echo Reservoir is a popular destination for water-based recreation. Boating access at Echo Reservoir is serviced by a single boat ramp that is owned and operated by a private concessionaire. Small-scale commercial kayaking, tubing and rafting companies also operate in this reach of the mainstem Weber River.

East Canyon Creek Ecological System

The East Canyon Creek Ecological System (Figure 3.10) comprises 245 square miles of drainage area and encompasses the entire East Canyon Creek watershed (Table 3.1). This Ecological System ranges in elevation from approximately 5,000 to 9,800 feet above mean sea level and encompasses the western portions of Morgan and Summit County, including Park City and Morgan municipal areas. Of the 245 square miles of drainage area in this portion of the watershed, approximately 92% is privately owned (Table 3.5).

This ecological system includes approximately 32 miles of mainstem East Canyon Creek, as well as approximately 97 miles of tributary streams. Major tributary catchments include Kimball Creek, Sheep Canyon and Hardscrabble Creek. Most tributaries of East Canyon Creek are small, first-order streams (Table 3.4). East Canyon Reservoir is the only major irrigation storage reservoir located within this Ecological System, which impounds 51,200 acre-feet of water at full pool elevation, (UDWQ 2012).

The dominant vegetation types in this ecological system include shrub steppe, northern oak and aspen (Table 3.6). Approximately 8.8% of the total land area has been converted for agricultural, industrial or urban development.

Water Quantity

Precipitation in this ecological system averages approximately 27 inches per year.

Fig 3.11: Photo of East Canyon Creek at Kimball Junction

Water from this Ecological System is used extensively for municipal use in the upper watershed and agricultural use in the lower watershed through at least 27 points of diversion on the mainstem and a complex array of pipelines and water delivery systems. Not including developed springs, 6 mainstem diversions exceeding 5 cfs capacity occur within this ecological system. The most significant water withdrawal in this Ecological System appears to be the west Richville Canal, which has the capacity to divert 38 cfs. Low flows within East Canyon Creek continue to pose challenges for water quality as well as water managment (Park City and Snyderville Basin Water Supply Study).

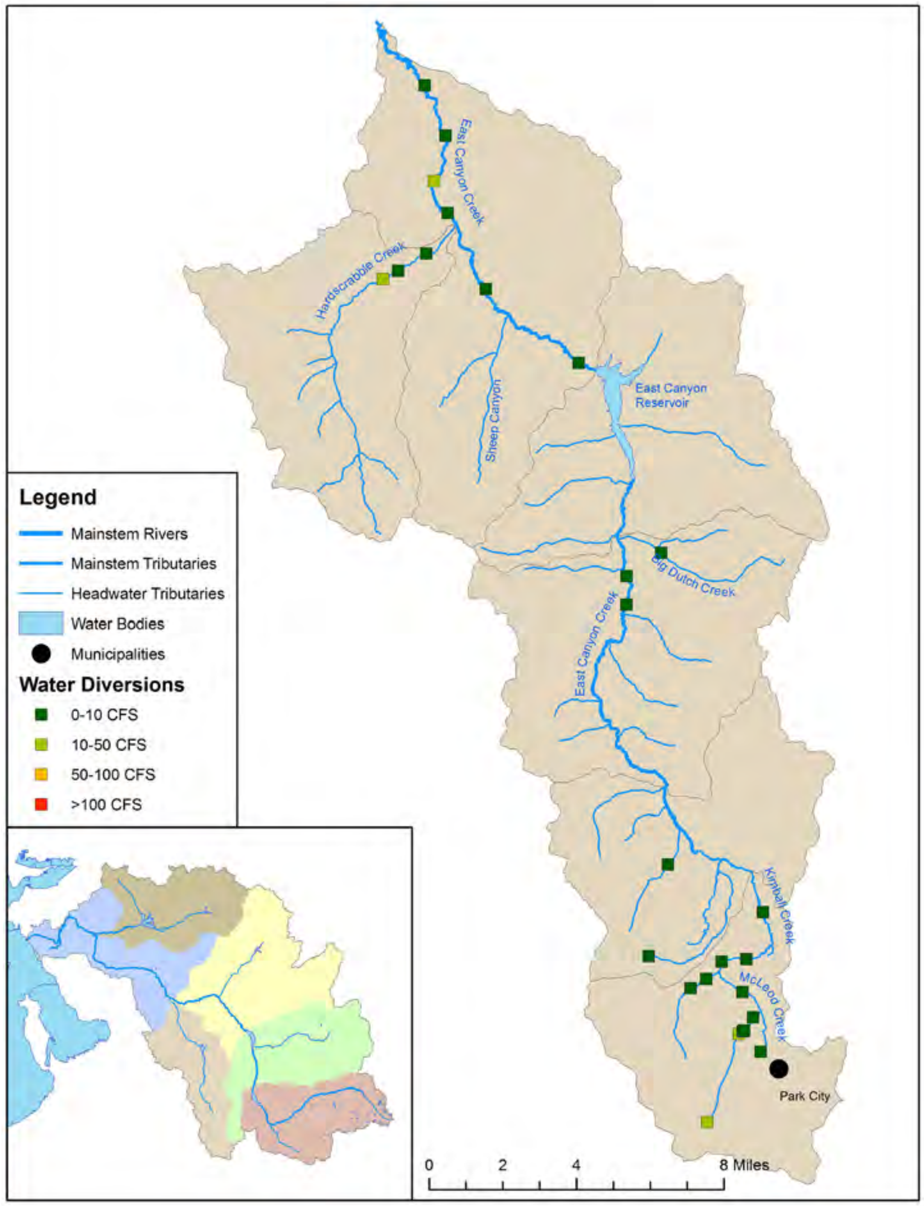


Fig 3.12: Map of East Canyon Creek Ecological System, including locations and rates of major irrigation delivery systems.

Water Quality

In the East Canyon Creek Ecological system, lower East Canyon Creek (downstream of East Canyon Reservoir to the confluence with the Weber River) and Hardscrabble Creek meet their beneficial uses (UDWQ 2010).

However, in East Canyon Reservoir and East Canyon Creek upstream of the reservoir, the Class 3A cold water fishery beneficial uses have been listed “impaired” since 1998. TMDLs for East Canyon Creek and Reservoir completed in 2000 determined that the impairment was caused by low levels of dissolved oxygen, which were due to excessive inputs of total phosphorus (from both wastewater treatment effluent and sedimentation; UDWQ 2000). Since 2000, phosphorus concentrations in the creek and loads to the reservoir have been reduced by several types of projects, including upgrades to the wastewater treatment plant, streambank stabilization to reduce erosion, and nutrient and sediment management strategies for golf courses, the ski industry, and the construction industry.

In 2010, the TMDL's were revised for both East Canyon Creek and Reservoir. The 2010 TMDL found that in East Canyon Creek water column nutrients have been reduced to such an extent that the water quality impairments are now primarily due to temperature, excessive algal and macrophyte growth, and insufficient stream flow. Projects in the East Canyon watershed continue to address excessive sedimentation by stabilizing streambanks, but additional emphasis has been placed on shading the stream corridor and increasing stream flow in order to reduce temperatures and improve aquatic habitat (SWCA 2010).

Agriculture

This portion of the watershed has a rich history and culture of agricultural activities. However, in recent decades a majority of the agricultural land around Park City has been converted to municipal and industrial uses, along with the water rights. Few agricultural operations exist in the upper portions of this Ecological System. A majority of the agricultural land in the lower portions of the Ecological System is actively productive, but development pressures continue from Morgan City, Park City and surrounding suburbs.

Recreational Fishing

East Canyon Reservoir provides the most important coldwater/warmwater fishery in this ecological system. Angling opportunities are limited in the upper watershed because of chronic low flow conditions and limited access. Nevertheless, many of the headwater tributaries support isolated populations of Bonneville cutthroat trout. Hardscrabble Creek supports a Bonneville Cutthroat Trout stronghold population.

Water-based Recreation

Most of the water-based recreation in this Ecological System occurs at East Canyon Reservoir. East Canyon Reservoir is bordered by East Canyon State Park, which encompasses 1,400-acres and is owned and managed by the Utah Division of Parks and Recreation. This park hosts approximately 83,000 visitors each year.

Lost Creek – Echo Creek Ecological System

The Lost Creek – Echo Creek Ecological System (Figure 3.11) is the largest ecological system, encompassing 504 square miles of drainage area throughout the middle portions of the Weber River watershed (Table 3.2). This Ecological System ranges in elevation from approximately 5,000 to 8,500 feet above mean sea level and encompasses northern Summit County and eastern Morgan County, including the towns of Morgan, Henefer and Croydon. Of the 504 square miles of drainage area in this portion of the watershed, approximately 93.4% is privately owned (Table 3.5). The Utah Department of Natural Resources is a major landowner (6.19%), primarily through management of the Henefer-Echo Wildlife Management Area.

This Ecological System includes approximately 23 miles of mainstem Weber River, as well as approximately 144 miles of tributary streams, including 14 miles of Lost Creek, which is the largest tributary stream in this Ecological System (Table 3.4). Lost Creek Reservoir, with the storage capacity of 22,510 acre-feet, is the only major irrigation storage reservoir located within this Ecological System.

The dominant vegetation types in this ecological system includes shrub steppe, northern oak and aspen (Table 3.6). Approximately 4.2% of the total land area has been converted for agricultural, industrial or urban development.

Water Quantity

Precipitation in this Ecological System averages approximately 23 inches per year (Table 3.3). Water from this Ecological System is used extensively for agriculture and to a smaller degree, municipal uses through more than 50 points of diversion. Nine mainstem diversions have the capacity to take more than 5 cfs, and the largest diversions (greater than 30 cfs) occur near Morgan .

Water Quality

Of the assessed water bodies in this Ecological System, Echo Creek and the main-stem Weber River from the confluence with East Canyon Creek upstream to Echo Reservoir are not meeting their beneficial uses (DWQ 2010). Echo Creek's Class 3A cold water fishery has been listed as "impaired" due to sedimentation since 2004. While there is no water quality standard for sedimentation specifically, sediment is harmful to aquatic life because it buries habitats, spawning areas, eggs, and macroinvertebrates that serve as a food source for fish. Water column sediment can also impair the growth of beneficial plants and reduce visibility for fish as they forage.

A TMDL for Echo Creek was completed and approved by the EPA in 2006. Strategies

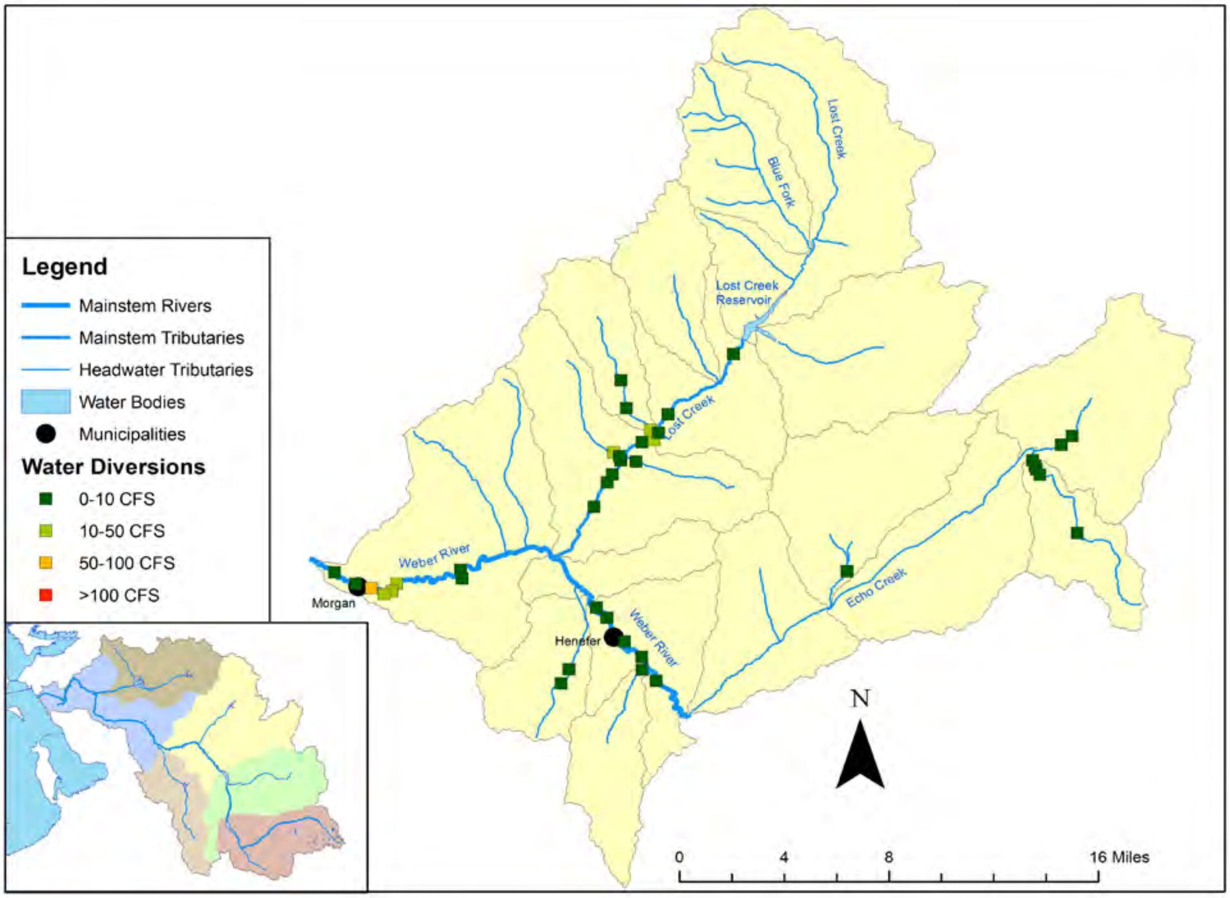


Fig 3.13: Map of Lost Creek - Echo Creek Ecological System, including locations and rates of major irrigation delivery systems.

for addressing this “impairment” have included a sediment detention project on Rees Creek (a tributary to Echo Creek), bank stabilization and re-establishment of woody riparian vegetation, and installation of grade stabilization structures. Of all the projects implemented, the Rees Creek project has had the most documented success – average removal of total suspended sediment has been as high as 92%, with load reductions of up to 115,000 pounds per day of sediment during spring runoff.

In 2008 the Class 3A cold water fishery in the Weber River from the confluence with East Canyon Creek to Echo Reservoir was listed as impaired based on unhealthy benthic macroinvertebrate populations. Habitat modification, pollutants, or flow modifications due to water management can all cause an unhealthy macroinvertebrate populations. A study to identify the source(s) of impairment of this segment is pending.

Agriculture

This portion of the watershed has a long history of agricultural activities. Many of these agricultural activities continue, particularly in Lost Creek and Henefer Valley. Agricultural

Ecological System	Headwater Tributary	Mainstem River	Mainstem Tributary	Total
Upper Weber River	143.7	30.9	19.0	193.6
Chalk Creek - Silver Creek	190.8	9.6	22.3	222.7
East Canyon Creek	97.5		31.6	129.1
Lost Creek - Echo Creek	129.6	22.9	13.8	166.3
Ogden River	144.5	9.9	25.5	180.0
Lower Weber River	107.3	55.0	0.0	162.3
Watershed Totals	813.4	128.4	112.3	1054.1
The three habitat classes identified were Mainstem River (Weber and Ogden River Mainstems), Mainstem Tributaries (e.g. East Canyon, Lost, Chalk Creek, Etc.) and Headwater Tributaries.				

Table 3.4: Tributary comparison by ecological system.

land located near Morgan is under increasing municipal development pressure. The majority of agricultural producers continue to rely mainly upon flood irrigation within this Ecological System.

Recreational Fishing

The Lost Creek – Echo Creek Ecological System is home to a variety of native and nonnative species. Non-native Brown trout are the dominant sport fish species in the Weber River and Lost Creek, however, Echo Creek and other small tributaries support populations of native Bonneville cutthroat trout. Native Bluehead sucker have been observed in the Weber River Mainstem and lower portions of Echo Creek. The Weber River mainstem within Henefer

Fig 3.14: Photo of Lost Creek near Guildersleeve Canyon

Valley and the Upper Weber Canyon are heavily used by anglers. Lost Creek Reservoir provides a locally important coldwater recreational fishery.

Water-based Recreation

Most of the water-based recreation in this Ecological System occurs on the Weber River from Henefer downstream to Taggart, which is frequently used by rafters during the summer months. Several makeshift put-ins and take-outs have been developed along the Weber River. A single, small boat ramp offers a limited recreational opportunity at Lost Creek Reservoir; however, wake restrictions preclude large-scale boat use on the reservoir.

Each ecological system's position in the watershed creates a unique assemblage of stream types. These networks provide an indication of the placement of each ecological system in the watershed as well as the potential challenges and opportunities each system may be experiencing.

Ogden River Ecological System

The Ogden River Ecological System (Figure 3.14) encompasses 333 square miles of drainage area and includes the entire Ogden River watershed (Table 3.2). This Ecological System ranges in elevation from approximately 4,300 to 9,500 feet above mean sea level and encompasses eastern Weber County, including Huntsville and central portions of Ogden City. Of the 333 square miles of drainage area in this ecological system, approximately 73.2% is privately owned. The U.S. Forest Service owns a large amount of land (21.9%) in the headwaters as well as the Wasatch Range (Table 3.5).

This ecological system includes approximately 10 miles of the Ogden River mainstem, and approximately 170 miles of tributary streams. This includes approximately 26 miles of the South and North Forks of the Ogden River, which are the largest tributary streams in this Ecological System (Table 3.4). Pineview and Causey Reservoirs, with the storage capacity of 110,150 and 7,800 acre-feet, respectively, are the major irrigation storage reservoirs located within this Ecological System.

The dominant vegetation types in this ecological system include shrub steppe, aspen, northern oak and mountain shrub (Table 3.6). Approximately 8.2% of the total land area has been converted for agricultural, industrial or urban development.

Water Quantity

The Ogden River Ecological System is, by far, the wettest in the Weber River watershed. Precipitation in this ecological system averages approximately 36 inches per year. Water from this ecological system is used to support municipal water needs and agriculture in Box Elder County. Water is diverted out of the Ogden River through more than 20 water diversions. Ten water diversions have the capacity to take more than 5 cfs, and the largest diversion is the Ogden-Brigham Canal, which diverts up to 155 cfs out of Pineview Dam.

Water Quality

Of the assessed units in the Ogden River Ecological System, Pineview Reservoir and the Ogden River downstream of Pineview Reservoir are not meeting their beneficial uses. Pineview Reservoir's Class 3A cold water fishery was listed as "impaired" in 2000 based on low dissolved oxygen, total phosphorus, and excessive temperature in the late summer when the reservoir is stratified. A TMDL was developed and later approved by the EPA in 2002. That study found there are many contributing factors to the "impairment", such as irrigation withdrawal and nutrient loading from septic systems and animal wastes (Tetra Tech 2002). Implementation of the TMDL has included septic system awareness programs and animal waste reduction projects. Because there was insufficient data to calculate internal nutrient loading in the reservoir at the time the TMDL was developed, several additional studies have been conducted by the Utah Water Research Laboratory (Dr. Darwin Sorensen) funded in part

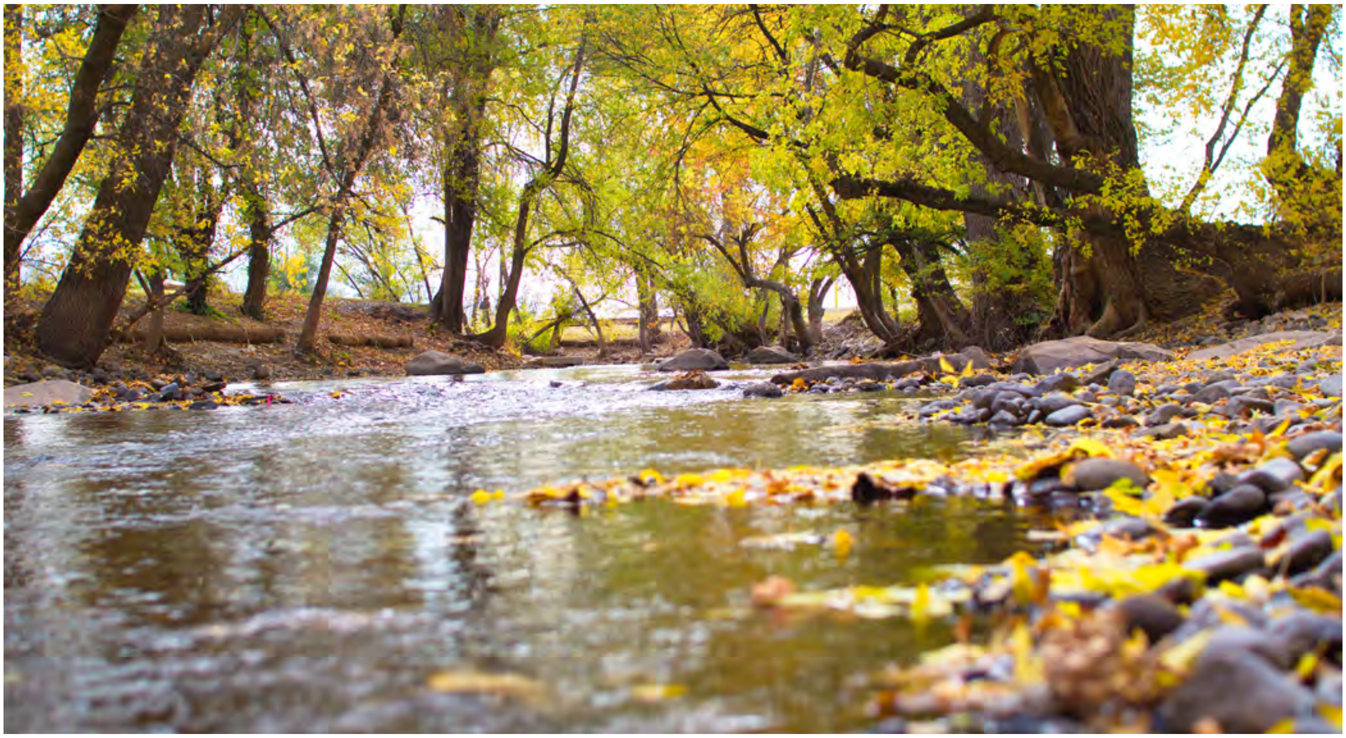


Fig 3.15: Photo of an area of recent restoration along the Ogden River in downtown Ogden, Utah

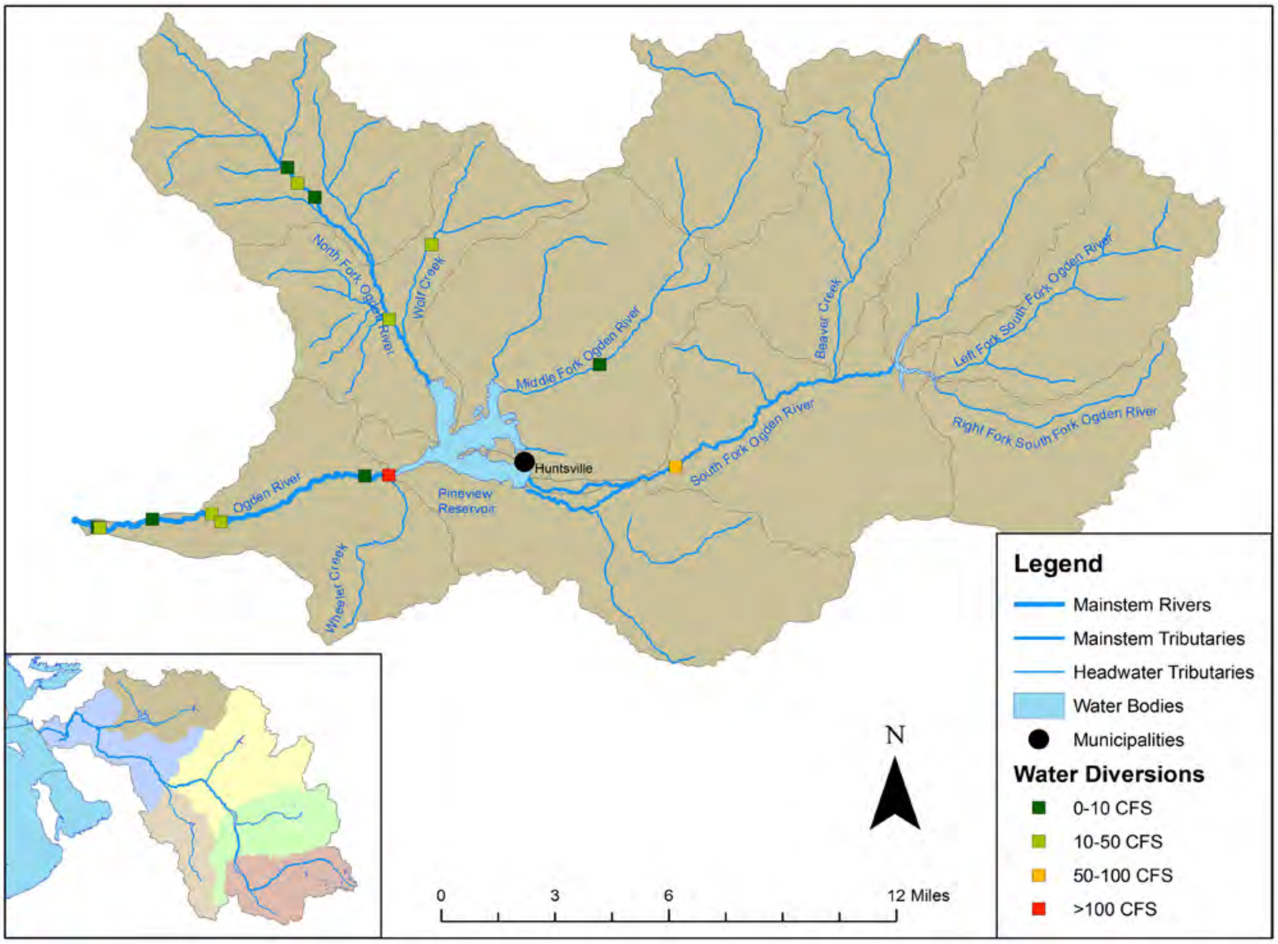


Fig 3.16: Map of Ogden River Ecological System, including locations and rates of major irrigation delivery systems.

by Weber Basin Water Conservancy District. These studies are ongoing and may ultimately be referenced in a revised TMDL. To address the temperature impairment, the TMDL recommended a change in beneficial use of the reservoir from Class 3A cold water fishery to Class 3B warm water fishery. This change is pending.

The Ogden River from the confluence with the Weber River upstream to Pineview Reservoir was listed as "impaired" on the 2008 303(d) list based on unhealthy benthic macroinvertebrate populations. A lack of a healthy macroinvertebrate population can be caused by factors such as habitat modification, pollutants, or modification of flow due to water management. A study to identify the source(s) of impairment of this segment is pending.

Agriculture

Although historically most of this Ecological System has been in agricultural production much of the agricultural land in Ogden Valley has been converted to low density residential and hobby farming communities. The remaining agricultural producers typically rely upon flood irrigation within this Ecological System.

Recreational Fishing

The Ogden River is a very popular brown trout fishery, although it has historically been highly degraded due to urban blight and hydromodification. In 2009, a major restoration effort was undertaken in the Ogden River by Ogden City, along with support from many partners including the Utah Division of Water Quality, Utah Division Wildlife Resources, the Central Weber Sewer Improvement District, and others. At a cost of over $6-million, 1.1-miles of the most degraded habitat was restored. These actions transformed the Ogden River into Utah's newest Blue Ribbon Fishery.

The South Fork of the Ogden River provides a high quality fishing experience that supports brown trout and Bonneville Cutthroat trout. Pineview and Causey Reservoirs provide unique warm and cold water fishing experiences, and many of the headwater tributaries in the Ogden River Ecological System support Bonneville cutthroat trout conservation populations.

Water-based Recreation

A majority of the traditional water-based recreation in this Ecological System occurs on Pineview and Causey Reservoirs. Pineview Reservoir has three public boat ramps and is heavily used by boating enthusiasts throughout the summer. Due to boat wake restrictions and its relatively modest size, Causey Reservoir is a destination for non-motorized boating enthusiasts. The Ogden River mainstem in the restored reach has proven to be a very popular summer swimming area and recreational destination for local families.

> ***Land ownership in the Weber watershed is almost 83% private. This land ownership dynamic requires additional attention to forming working partnerships with a diverse group of landowners.***

Lower Weber River Ecological System

The Lower Weber River Ecological System (Figure 3.16) encompasses 344 square miles of drainage area and includes the entire Lower Weber River from the confluence with East Canyon Creek down to the Great Salt Lake (Table 3.2). This Ecological System ranges in elevation from approximately 9,600 to 4,210 feet above mean sea level and encompasses western Morgan County, western Weber County and extreme northeastern Davis County.

Major municipalities include Morgan, Peterson, Mountain Green, South Weber, and Ogden City. Of the 344 square miles of drainage area in this Ecological System, approximately 80.3% is privately owned. The U.S. Forest Service is also a major landowner (12.6%), primarily through management of land along the Wasatch Range (Table 3.5).

This ecological system includes approximately 42 miles of mainstem Weber River, as well as approximately 120 miles of tributary streams. Most of the tributaries to the Weber River are steep, low-order streams. The largest tributary streams in this Ecological System are Cottonwood Creek and Peterson Creek (Table 3.4). Although not specifically in this Ecological System, Willard Bay Reservoir plays an important role in water management throughout this Ecological System. Water is diverted from the Weber River and delivered and stored trans-basin in Willard Bay.

The dominant vegetation types in this ecological system include northern oak, shrub steppe, mountain shrub, and aspen (Table 3.5). Approximately 36.3% of the total land area has been converted for agricultural, industrial or urban development.

Water Quantity

The Lower Weber River Ecological System averages approximately 27 inches of precipitation per year (Table 3.3). Water from this Ecological System is used to support the Weber and North Davis municipal area, as well as extensive agricultural land in the western portions of both Davis County and Weber County. Water is diverted out of the lower Weber

Land Ownership	Upper Weber River	Chalk Creek - Silver Creek	East Canyon Creek	Lost Creek - Echo Creek	Lower Weber	Ogden River	Watershed Total
Bureau of Land Management	0.09	0.13	0.07	0.30	0.00	12.58	0.12
Bureau of Reclamation	0.00	0.00	0.18	0.00	0.00	12.48	0.02
Utah Department of Natural Resources	1.57	0.54	2.76	6.19	6.53	14.41	3.88
Department of Defense	0.00	0.01	0.00	0.00	0.58	1.44	0.09
Private	53.87	99.32	92.34	93.35	80.33	19.82	82.90
Utah School & Institutional Trusts Lands and Administration	0.13	0.00	0.36	0.15	0.00	38.64	0.15
U.S. Forest Service	44.34	0.00	4.30	0.02	12.57	0.05	12.83

Table 3.5: Land ownership for each Ecological System.

River and its tributaries through more than 45 water diversions. Thirteen water diversions have the capacity to take more than 5 cfs out of the Weber River, and five of the thirteen have the capacity to divert more than 300 cfs. The two largest diversions are the Slaterville Diversion (1300 cfs potential capacity) and the Stoddard Diversion (up to 700 cfs capacity).

Water Quality

In the Lower Weber Ecological System, the Weber River upstream of Cottonwood Creek is meeting its beneficial uses. However, the Weber River from the Great Salt Lake through the confluence with Cottonwood Creek are not meeting its beneficial uses. Both waters were listed as impaired in 2008 based on unhealthy macroinvertebrate populations.

Agriculture

Agriculture is a very significant and important component of the Ecological System. Much of the agricultural land in the Ecological System occurs along the Weber River in Morgan Valley and along the Weber River in western Weber County. A majority of the agricultural producers in this Ecological System apply water through flood irrigation practices supported by the large irrigation diversions along the Weber River mainstem.

Fig 3.17 View of Ogden City - located in the Lower Weber River Ecological System.

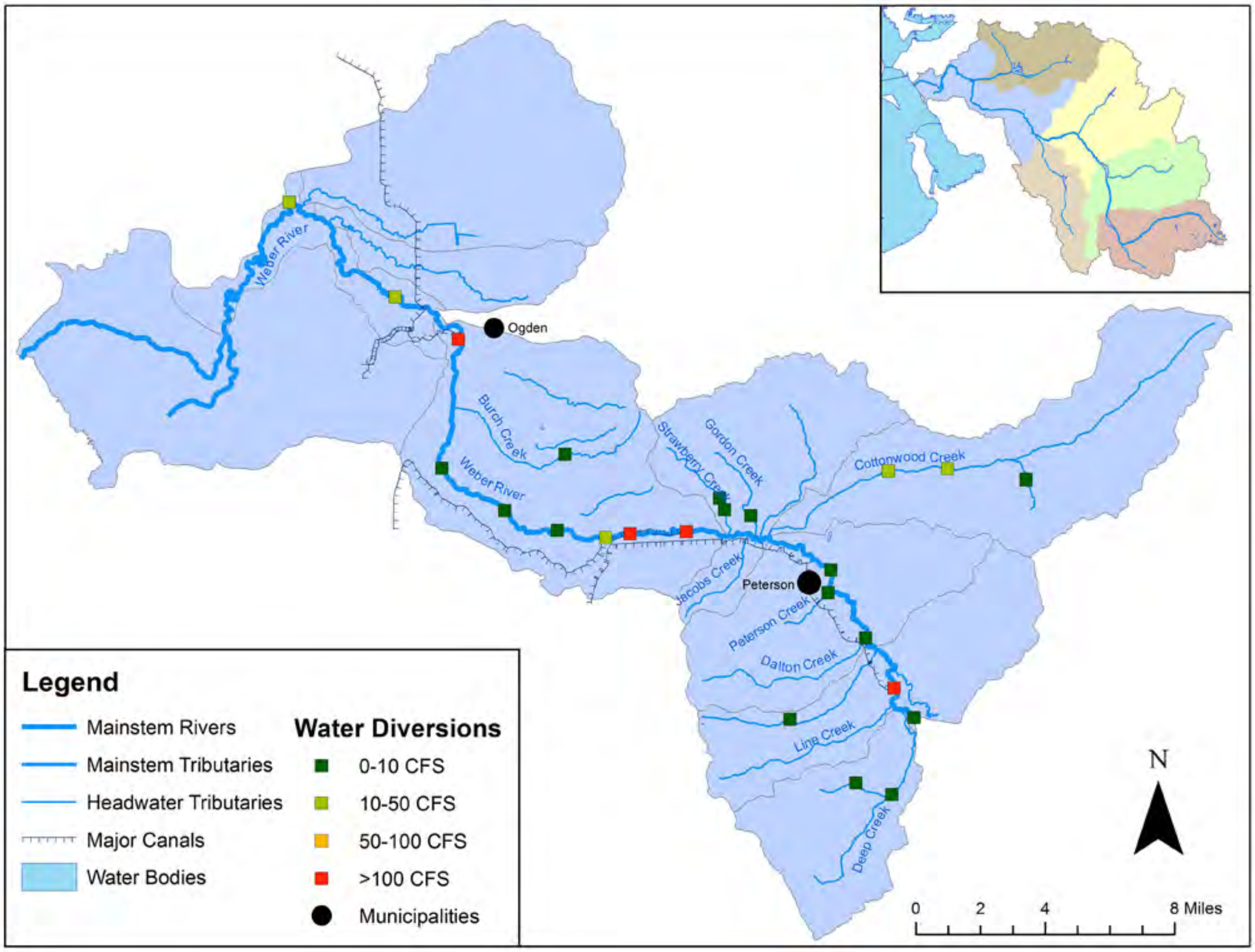


Fig 3.18: Map of the Lower Weber River Ecological System, including locations and rates of major irrigation delivery systems.

Recreational Fishing

The most significant recreational fishery within this Ecological System is the mainstem of the Weber River. The Weber River from the Stoddard Diversion downstream to the spillway of the PacificCorp Weber hydroelectric power plant is designated as a Blue Ribbon Fishery by the UDWR, and supports a diverse fish community comprised of brown trout, Bonneville cutthroat trout and mountain whitefish. The Weber River through Weber Canyon supports a strong Bonneville cutthroat trout population, and the reach from the mouth of Weber Canyon downstream to the Slaterville Diversion is a popular recreational fishery for brown trout and mountain whitefish. Its close proximity to Ogden City and the ease for the public to access the river greatly contribute to the popularity of the lower Weber River as a fishery. During most years, streamflow is very limited throughout almost the entire Weber River mainstem. There are no protected instream flows in this section, and there are major water withdrawals at the Stoddard Diversion, the Pacificorp Hydro Diversion and the Davis and Weber Counties Canal.

Although the tributaries do not individually provide significant fisheries, recent evidence suggests that the individual fish within the Bonneville cutthroat trout population in the Morgan Valley downstream of the Stoddard Diversion require these tributaries to complete their life-histories. Without access to these streams, the Bonneville cutthroat trout population in the Weber River mainstem may not persist. The lower Weber River, specifically the reach from the mouth of Weber Canyon downstream to the Slaterville Diversion supports the largest remaining stronghold of bluehead sucker in the basin.

Water-based Recreation

A small amount of rafting and kayaking occurs within Weber Canyon and downstream reaches of the Weber River. Ogden City's recently completed kayak park provides access to the Weber river for this growing recreation interest group. The remainder of the water-based recreation occurs at Willard Bay Reservoir, an out of basin water storage facility located to the north near Brigham City that receives Weber River water through the Slaterville diversion.

Fig 3.19: View of the Weber River near Mountain Green, Utah.

Land Cover Compositions[1]	Upper Weber River	Chalk Creek- Silver Creek	East Canyon Creek	Lost Creek - Echo Creek	Lower Weber River	Ogden River
Alpine	0.23	0.00	0.00	0.00	0.00	0.00
Aspen	23.63	21.82	25.78	13.59	5.81	19.31
Barren	4.85	0.85	0.23	0.36	1.85	1.46
Converted Land	8.22	7.27	8.08	4.28	36.27	8.17
Grassland	1.57	1.76	1.36	1.90	1.27	2.56
High Desert Scrub	0.00	0.00	0.00	0.00	0.79	0.00
Invasive Grassland	0.04	0.24	0.65	0.89	2.08	2.44
Lodgepole Pine	7.16	0.18	0.06	0.05	0.01	0.06
Lowland Riparian	0.97	0.29	0.90	0.47	2.16	1.18
Mixed Conifer	12.03	2.59	6.66	2.87	4.55	7.50
Mountain Riparian	0.85	1.56	0.29	0.40	0.22	0.67
Mountain Scrub	0.36	1.63	2.59	1.87	6.83	14.79
Northern Oak	10.42	15.18	25.46	15.11	18.45	16.32
Open Water	0.64	0.61	0.33	0.17	2.18	1.28
Pinyon-Juniper	1.92	4.02	1.00	2.74	1.13	1.50
Playa	0.00	0.00	0.00	0.00	0.99	0.00
Ponderosa Pine	0.45	0.00	0.00	0.00	0.00	0.00
Shrub Steppe	24.93	41.54	26.42	55.04	11.21	22.36
Subalpine Conifer	0.03	0.06	0.01	0.00	0.15	0.07
Wet Meadow	1.71	0.39	0.19	0.26	0.20	0.34
Wetland	0.00	0.00	0.00	0.00	3.85	0.00

[1]General landcover classes were based on the habitat types identified in the Utah Comprehensive Wildlife Conservation Strategy and reclassified from the SWREGAP analysis.

Table 3.6: Landcover compositions of the Weber River watershed.

Landcover plays a significant role in the hydrologic behavior of a watershed. The vegetation types and the percentage of converted land figures above are indicators and comparison of the potential hydrology and unique issues that each ecological system might face.

Threats

By evaluating the current watershed conditions, characterizing the social and ecological values, and identifying responsive conservation targets acting as indicators of the health of those values, the conservation planning team identified the threats that were believed to be having the greatest overall impact on the values and ecological indicators in the watershed. This enables us to document the major risks faced by the conservation targets so that meaningful restoration can be enacted over time to preserve the values that are critical to people in the watershed.

The threats to the social and ecological values are complex, sometimes synergistic, and not always obvious. Threats are typically the result of various contributing factors working together, and a single contributing factor can influence more than one threat. Threats and contributing factors were distilled using a conceptual model, which provided the means for identifying the most important conservation strategies.

Identifying the major threats

To fullfill this need a conceptual model was constructed to visually and conceptually guide the watershed planning committee toward linking the core social values and the conservation targets described in previous sections with the most pervasive threats to the focal conservation targets in the watershed. The model helped to elucidate the most fundamental contributing factors that underlie those threats and a suite of opportunities and potential strategies to help mitigate those threats. To better understand and interpret the results of that model, an analysis of the known and potential threats that may affect the conservation targets was conducted in order to identify the primary factors that influence the conservation targets. Those threats were identified and ranked using existing literature relevant to the Weber River watershed and restoration ecology, and augmented by the collective judgment, expertise and working knowledge of the watershed planning committee members.

Characteristics of a Threat

Threats are defined as actions that affect the watershed and have the potential to negatively impact conservation targets, and ultimately the social and ecological values that are important to all people who live, work, and play in the watershed. Most threats that the conservation planning team identified are solvable through the development and maintenance of partnerships to provide cooperative solutions to the threats derived from the complexities of watershed management. In order to identify the most important threats, we characterized them based on three primary properties: scope, severity and irreversibly (i.e. permanence).

The conservation planning team analyzed the three properties for each threat to develop a severity rating depending upon the scale of their primary properties.

Numerous threats were characterized as a result of that process, but in order to focus on the most pervasive threats to the conservation targets, some of the least consequential threats and those that were not deemed technically (e.g., whirling disease), socially (e.g., climate change),and/or financially (e.g., transportation infrustructure) feasible were removed from the analysis and did not receive further consideration. In the end, the fourteen most consequential threats were selected, which the planning committee feels are representative of the full suite of factors that have affected and in most cases, continue to affect the focal conservation targets in the Weber River watershed. Once the list of threats was refined then the scope, severity and irreversibility of all 14 threats was subjectively rated using the following definitions and criteria:

Scope

Scope is most commonly defined spatially as the proportion of the target that can reasonably be expected to be affected by the threat within ten years given the continuation of current circumstances and trends. For ecosystems and ecological communities, scope is generally measured as the spatial proportion of the target's occurrence. For species, scope is measured as the proportion of the target's population.

a. Very High (4): The threat is likely to be pervasive in its scope, affecting the target across all or most (71-100%) of its occurrence or population.

b. High (3): The threat is likely to be widespread in its scope, affecting the target across much (31-70%) of its occurrence or population.

c. Medium (2): The threat is likely to be restricted in its scope, affecting the target across some (11-30%) of its occurrence or population.

d. Low (1): The threat is likely to be very narrow in its scope, affecting the target across a small proportion (1-10%) of its occurrence or population.

Severity

Severity is defined as the level of damage to the target from the threat that can reasonably be expected given the continuation of current circumstances and trends. For ecosystems and ecological communities, severity is typically measured as the degree of destruction or degradation of the target within its spatial scope.

a. Very High (4): Within the scope, the threat is likely to destroy or eliminate the target species, or reduce its population by 71-100% within ten years or three generations.

b. High (3): Within the scope, the threat is likely to seriously degrade/reduce the target or reduce its population by 31-70% within ten years or three generations.

c. Medium (2): Within the scope, the threat is likely to moderately degrade/reduce the target or reduce its population by 11-30% within ten years or three generations.

d. Low (1): Within the scope, the threat is likely to only slightly degrade/reduce the target or reduce its population by 1-10% within ten years or three generations.

Irreversibility (i.e. Permanence)

The degree to which the effects of a threat can be reversed and the target affected by the threat restored.

a. Very High (4): The effects of the threat cannot be reversed and it is very unlikely the target can be restored, and/or it would take more than 100 years to achieve this (e.g., wetlands converted to a shopping center).

b. High (3): The effects of the threat can technically be reversed and the target can be restored, but it is not practically affordable and/or it would take 21-100 years to achieve this (e.g., wetland converted to agriculture).

c. Medium (2): The effects of the threat can be reversed and the target can be restored with a reasonable commitment of resources and/or within 6-20 years (e.g., ditching and draining of wetland).

d. Low (1): The effects of the threat are easily reversible and the target can be easily restored at a relatively low cost and/or within 0-5 years (e.g., off-road vehicles trespassing in wetland).

Ranking the Threats

The results of the threat rankings as established by the planning teams and their impacts on restoration targets are summarized in Table 4.1. These ratings help identify the complex relationship(s) amongst all of the threats, as well as their relative impact(s) on the focal conservation targets. In summary, the overall threat rating for the entire watershed, including the pervasiveness of the 14 primary threats, as well as the degree of risk associated with the species and ecological systems of critical importance was subjectively characterized as “Very High”, by this process. Which suggests that the present and ongoing threats in the Weber River watershed are pervasive in their spatial scope, affect conservation focal targets across all or most of their range or occurrence, and if left unabated those threats are likely to

Threats:		*Summary threat rating across all impacted watershed values*
Community Engagement		
Lack of Watershed-scale Leadership Structure		Very High
Policy		
Permitting		High
Legal Harvest		Low
Restoration Funding Programs		Medium
Land Use		
Land Management, Future Development and Urbanization		High
Infrastructure, Utility Development and Maintenance		Very High
Gas, Oil, and Mineral Development		High
Habitat and Water Management		
Watershed-scale Water Resource Management		Very High
Small Scale Water Resource Management		Very High
Historic and Current Channelization and Flood Control		High
Ecological		
Whirling Disease		Medium
Introduced Trout Species		Medium
Invasive Organisms		Very High
Climate Change		Very High
Summary Rating for the Weber River Watershed		Very High

Table 4.1: Summary threat ratings throughout the watershed.

seriously degrade or in some instances, destroy or eliminate the focal conservation targets throughout the watershed.

Once the primary threats were identified, the conceptual model was re-constructed to visually and conceptually guide the watershed planning committee members toward linking the focal conservation targets with the 14 key threats, the fundamental factors that underlie those threats, as well as a suite of opportunities and potential strategies to help mitigate those threats. The model results highlight many of the priority strategies that are already underway in the watershed, such as protecting in-stream and riparian habitats through riparian exclosures and improving fish passage. Those strategies are the core of the efforts that are occurring in the watershed today, but the model also excluded some actions that are currently underway, which suggests that some ongoing efforts may be excluding much broader and more effective

Given that all of our resources are finite, the list of threats was distilled into a smaller list of threats that if addressed, would have the highest likelihood of success and of improving the overall health of the conservation targets.

strategies that are not being addressed currently. These findings will provide the basis for which restoration priority actions will be chosen, the amount of resources committed to those actions, or in some cases not committed to each action, as well as the sequencing and timing of each action relative to one another.

The conceptual model also supports the notion that the threats throughout the watershed can be very complex within a given context, yet several pathways toward threat abatement are not only discernable, but many of those pathways to restoration are practical and feasible, given the current social, technical and financial context within the watershed. When viewed as a whole, the primary threats to the watershed can be summarized and arranged into five general categories, which are 1) Community Engagement, 2) Policy, 3) Land Use, 4) Habitat and Water Management, and 5) Ecological (Table 4.1). The model enabled us to categorize the threats and develop strategies for addressing them.

Each of those five categories can be viewed as general issues that need to be addressed in order to mitigate or eliminate the primary threats

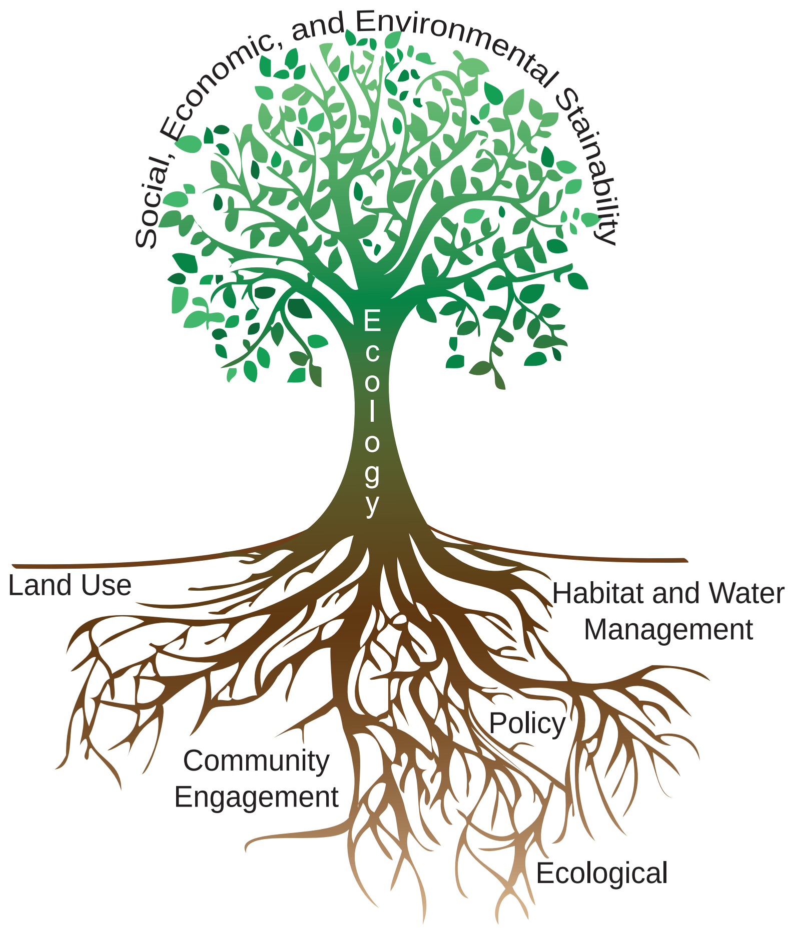


Fig 4.1: Conceptual Diagram of the planning threats and outcomes.

to the conservation targets. Within each of those five general categories, specific and high priority strategies, goals and objectives were identified in order to most efficiently and effectively mitigate or eliminate those threats. In addition, those five categories are presented and discussed in hierarchical order, so those threats and strategies that are listed first are considered "first order" threats and actions, relative to the others, because they have the most pathways and connections to the "second order" threats and actions. In essence, when a "first order" strategy and action is implemented it should also have a combined effect on all subsequent "second order" strategies and actions, thus allowing for a phased, strategic and leveraged approach to restoration that will use the existing resources, capacity and capital in the watershed in order to make the most meaningful, long-term, and watershed-scale restorative effects to the watershed as possible.

Priority Threat Categories

The conceptual model proved to be a useful guidance tool for the restoration team, as it helped to identify many, although not all of the threats throughout the watershed. Throughout the process it became evident however, that some threats were more pervasive in their scope, severity and irreversibility than others. Given that all of our resources are finite, the list of threats was distilled into a smaller list of threats, that if addressed, would have the highest likelihood of success and of improving the overall health of the conservation targets.
Some threats to the watershed were extremely pervasive, such as climate change, yet those threats are socially, fiscally or technically intractable for this partnership to effectively address at this time. However, as this partnership evolves it may have capacity to address these issues in the future.

Rather than describing every threat that remained in the conceptual model, the watershed group decided to identify the most pervasive, yet most solvable threats that would leverage the most significant benefits to our watershed.

> ***"the present and ongoing threats in the Weber River watershed are pervasive in their spatial scope, affect conservation targets across all or most of their range or occurrence, and if left unabated those threats are likely to seriously degrade or in some instances, destroy or eliminate the focal conservation targets throughout the watershed."***

Community Engagement

The threats that fall into this category include societal attitudes and values, institutional presence, and public and partner outreach, coordination and communication.

Lack of Watershed-Scale Leadership Structure

The conceptual model and the watershed partnership repeatedly identified shortcomings in watershed focused collaboration between agencies, municipalities, non-profits, grassroots organizations, and citizens throughout the Weber River watershed. These shortcomings appear to amplify small scale, duplicative efforts that attempt to address watershed scale issues, processes, inefficiencies, lack of communication, and acceptance of expending significant efforts without significant gains in conservation goals. The partnership identified the need for a robust and recognized watershed scale-leadership structure, community-level watershed leaders, associated education and outreach, and a communication strategy to make such a leadership structure sustainable as the most critical component to addressing long-term, large scale conservation targets and social values.

To address this issue, members of the watershed partnership are committed to strengthening their relationship with the people who live, work and play throughout the watershed. Efforts to develop a coordinated and long-term outreach and education plan must be undertaken. Those efforts should consider the results of this conceptual model and watershed plan, as well as the outreach efforts that are already underway in order to have the most meaningful, lasting and widespread impact toward long-term threat abatement. In order to be successful however, the watershed group must increase beyond its current capacity, and identify additional persons and entities that may not be existing members. Additionally, while using its existing capacity, the partnership must make every effort to better organize, leverage and sustain the "time, talents and treasury" of its existing members and leaders. Depending on the ultimate solution that is chosen, this may require some agency and organizational introspection and possible programmatic, perspective and attitudinal shifts, along with continued investments in existing programs and new investments in newly developed programs or institutions. This may be a difficult task to accomplish, especially in a time of limited resources and budget cutbacks. However, the collective judgment and consensus of the planning committee suggests that this action can lead to meaningful, large-scale and long-term improvements to the core values throughout the watershed.

Policy

Permitting Process

Stream alteration permits are required for any type of project that alters the bed or banks of a natural stream. These permits are issued by the State Engineer in the Department of Natural Resources or by the US Army Corps of Engineers. While the permit process allows for review by other regulatory agencies, it does not promote early engagement by agency reviewers. In many cases it is impossible for agency reviewers to offer constructive input on project designs that would protect or enhance watershed values (e.g. fisheries). This means that regulatory agencies, and the public, have very little input in the process. Often valuable and limited programmatic capital is then diverted toward enforcement efforts, rather than constructive project planning and implementation. In addition, given the pressures from a large and growing population base and the need for construction and maintenance of existing infrastructure, the sheer number and frequency of those permit applications will and often do overwhelm the capacity for agencies and organizations to properly review and provide constructive comments on permit applications.

Fig 4.2: Stranded Cutthroat Trout in the Weber River.

In most cases however, the instruments and processes that are already in place do allow for adequate time and attention for agency reviewers, but inter- and intra-agency coordination and communication, as well as programmatic procedures and priorities will need to be improved upon and possibly re-directed in order to effectively mitigate this threat. These changes will require renewed vigor, attention and participation by many partners in the watershed.

Restoration Funding Programs

Throughout the planning process it became apparent that the restorative actions that are currently underway are helping to protect and restore this watershed, but they may not always be the most beneficial actions possible for the watershed. That is, in some cases existing resources and attention could be re-focused on other non-traditional actions that may yield larger-scale, longer-lasting benefits. The planning group realizes however, that many funding programs are geared toward, or in some cases restricted to funding traditional on-the-ground restoration actions, even though other actions may be more beneficial to the watershed.

In some cases, changes to funding programs may not be possible, while other funding programs may be willing to expand their perspectives and funding priorities in order to fund these “new” restoration actions. Each funding program is unique, but in either case new or re-directed resources and attention is needed in order to investigate, pursue and secure the support of new and existing funding programs that will support viable restoration alternatives. These actions will require a significant investment in internal and external outreach, communication and coordination, but these are fundamental needs in order to develop more universal support for leveraged and effective restoration actions.

Legal Harvest

Angling pressure and related legal and illegal harvest and incidental mortality is a threat to the viability of Bonneville cutthroat trout and bluehead sucker. However, it is believed that angling related impacts can be reduced while still continuing to maintain high quality recreational angling opportunities. In this case, fisheries managers may find themselves managing for conflicting purposes or needs, as they seek to balance the management of recreational fisheries that in some cases, may impact native species conservation goals. Nevertheless, this is a challenge that must be addressed in order to protect the core values in this watershed.

Land Use

As discussed previously, 75% to 85% of this watershed is privately owned, and most of that private land is used for agricultural production, or has been moderately to highly urbanized. The manner in which landowners and local municipal and county governments account for land use and population growth can have a profound effect on the short-term and long-term condition of the watershed.

Land Management and Future Development and Urbanization

Population growth throughout the watershed and nearby Weber Basin Water Conservancy District service areas is expected to increase from approximately 500,000 residents currently, up to as high as 1.8 million residents if the watershed is fully developed. That growth will place considerable demand on the basins water supply and delivery systems, as well as the species and habitats that occur throughout the watershed. Much of the current “open space” throughout the watershed, which includes agricultural lands, is expected to be converted to municipal and industrial uses in the future. This conversion will have tremendous implications on the basins water supply and the way that water is delivered to the users in the watershed, and will also be consequential to the overall health of the watershed.

Infrastructure and Utility Development and Maintenance

Portions of the Weber River watershed are already highly urbanized, especially near the Wasatch Front. Maintenance and upgrades to the existing network of civil infrastructure will be needed to accommodate the projected population growth throughout the watershed. Infrastructure maintenance and construction is a critical component of the watersheds collective well-being and core social and ecological values. While infrastructure cannot be avoided, measures can be taken to coordinate, plan and construct that infrastructure in ways that do not threaten the core social or ecological

Fig 4.3: Weber River corridor at Mountain Green.

values throughout the watershed. The stream alteration permitting process and other related impact analysis efforts offers an appropriate nexus for those measures to be implemented, but agencies and resource managers will need to become more engaged in this process in order to effectively and proactively manage the current and future influx of infrastructure-related actions. These actions may require additional resources, or the re-allocation or re-assignment of existing resources in order to fully meet this need. In some cases, this may require in-depth organizational and programmatic review and re-consideration of programmatic priorities.

Gas, Oil, and Mineral Extraction

Portions of the Weber River watershed are rich with natural resources and in some cases, past resource extraction activities have left behind costly and detrimental legacy effects. Ongoing and future resource extraction activities have the potential to generate considerable wealth for nearby communities, but possibly at the peril of overall watershed health. Much like the infrastructure and utility development activities described above, the need and desire to extract these resources cannot be avoided, but measures can be taken to coordinate, plan and extract those resources in ways that balance those needs with the core social and ecological values throughout the watershed. Again, the stream alteration permitting process, along with related impact analysis procedures, offers an appropriate nexus for those measures to be implemented, and again, agencies and resource managers will need to become more engaged in this process in order to effectively and proactively manage the current and future influx of resource extraction activities.

Habitat and Water Management

The threats that fall into this category include physical modification and destruction of aquatic and riparian habitats, as well as actions that effect the timing, duration and magnitude of in-stream flows.

Historic and Current Channelization and Flood Control

There is a long history of individual landowner and community-scale efforts to reduce flood related risks by reducing bank erosion and maintaining existing channel configurations. While some improvements have been made in the practices and approaches to streambank protection, the overwhelmingly preferred approach has been to install structures including car bodies, concrete rubble, rock, etc. Even the most contemporary approach still involves the construction of levees, rock lined stream banks and channel dredging. In some cases these are the most cost effective measures to mitigate the threat of floods, but often they are not.

These remedies may reduce localized erosion and channel migration but they often increase and focus erosional forces to areas downstream. These bank hardening practices are a direct threat to watershed values because they reduce habitat complexity, decrease habitat availability for aquatic species, increase stream temperatures (when associated with riparian vegetation removal), and in some cases, increase the hazard of catastrophic flooding events.


Fig 4.4: Historic Channelization of the Weber River.

Watershed-scale Water Resource Management and Water Rights

The existing system of dams and reservoirs and their associated infrastructure help to store and deliver water to thousands of households, small businesses, and farms. Due to the large scale of these hydraulic features, their operation has implications for the entire watershed. These implications are primarily due to changing the naturally occurring hydrograph i.e. change in the timing and volume of stream flow over time.

A growing population, climate change and the associated changes in water delivery regimes, combined with increased demands for new and growing uses (e.g. recreation, ecological conservation, hydropower generation) will increase the already significant gap between water supply and water demand in this watershed.

In the Weber River drainage there is a general lack of public understanding of the water supply management structure. Water quantity and quality are often taken for granted by most individuals. This is, in part, the result of water management agencies having made available stable, safe, and low cost water. It is the dedicated work and cooperative efforts of these agencies that have thus far prevented any serious public water supply crisis in the watershed. Municipal and private water suppliers are often the only agencies promoting conservation of water, as they derive their income by ensuring that the water supply is stable and uninterrupted. However, better public education regarding where and how customers get their water, would certainly help foster a better respect for the resource. With that said,

Key: Low · Medium · High · Very High

Category	Threats		Aquatic Species		Ecological Systems						
		Water Resources	Bonneville Cutthroat Trout and Mountain Whitefish	Bluehead Sucker and Other Non-game Fish	Lost Creek - Echo Creek	Chalk Creek - Silver Creek	East Canyon Creek	Upper Weber River	Lower Weber River	Ogden River	**Summary Threat Rating**
	Lack of Watershed Scale Leadership										Very High
Policy	Permitting Process										High
Policy	Restoration Funding Programs										Medium
Policy	Legal Harvest										Low
Land Use	Land Management & Future Development										Very High
Land Use	Infrastructure, Utility Development and Maintenance										Very High
Land Use	Gas, Oil, and Mineral Development										High
Habitat Mod.	Historic and Current Channelization and Flood Control										High
Habitat Mod.	Watershed-Scale Water Resource Management										Very High
Habitat Mod.	Development & Maintenance of Smaller Irrigation Systems										Very High
Ecological	Introduced Trout Species										Medium
Ecological	Invasive Organisms										Very High
Ecological	Whirling Disease										Medium
Ecological	Climate Change										Very High
	Summary Target Ratings	High	High	High	Very High	Very High	Very High	Very High	Very High	Very High	Very High

Table 4.2: Summary Table of all 14 threats within their respective threat categories and their respective levels of impact on the core conservation targets (i.e. aquatic species and ecological systems).

domestic and culinary water use practices are change to ensure the health and success of the river. For example the flat fee structures that are currently in place are being replaced by metered water delivery. As demand for this water continues to rise, the water agencies of the Weber Drainage will continue to be critically important to the viability of the conservation targets and the social values throughout the watershed.

In regards to water rights, the Weber River basin drainage is now fully appropriated, meaning that, by law, no additional water sources are available to develop into a new water right. New-comer water interests have found challenges when faced with this fully appropriated concept. Further more, the doctrine of prior appropriation, i.e. first in time, first in right, means that new appropriations would be required to take a back seat to the more snior rights in the basin and in many years the water supply is not sufficient enough to fully satisfy many of these existing rights.

Development and Maintenance of Smaller Irrigation Systems

Numerous in-stream structures that are designed to divert water for agricultural irrigation and domestic use have been constructed throughout the watershed, both on the mainstem Weber River and all its major tributary streams. These water diversion structures can directly impact native fish species by impeding migratory behaviors which reduces their spatial distribution and life history expression, especially for migratory life history types and highly mobile species. In addition, unscreened diversions entrain (i.e. remove fish from the system) juvenile fish which can reduce population abundance and life-history diversity.

Ecological

Introduced Trout Species

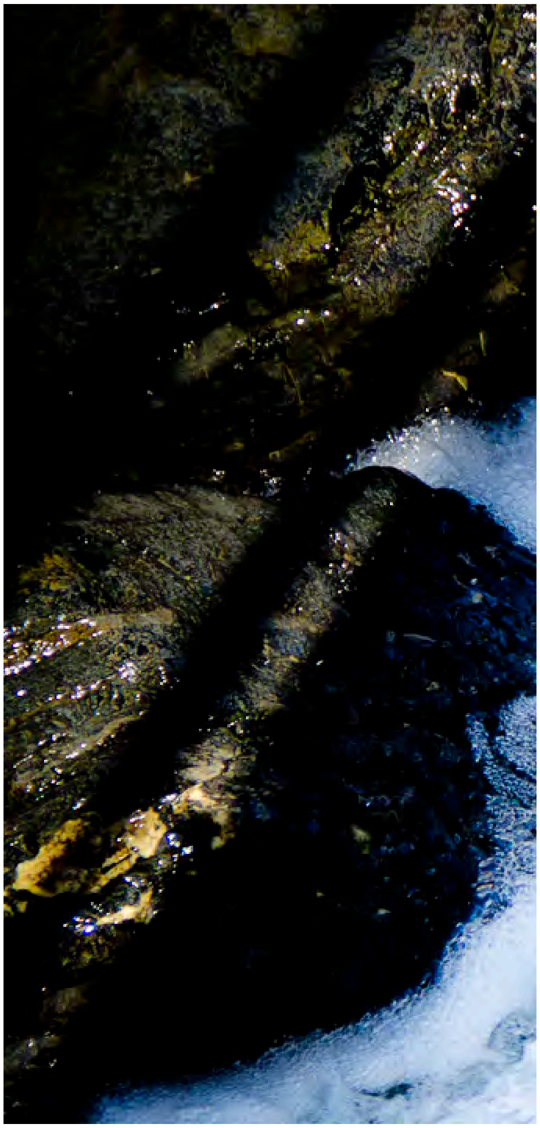
Nonnative fish species, including brown trout and rainbow trout are highly valued by recreational anglers. However, in some cases these species can adversely affect native Bonneville cutthroat trout and bluehead sucker conservation actions through hybridization, direct predation and competition for food and habitats. As described previously, it is believed that angling related impacts to native species can be addressed through balanced management and conservation measures while still continuing to maintain high quality recreational angling opportunities. In this case, fisheries managers often find themselves managing for conflicting purposes or needs, as they seek to balance the management of recreational fisheries that in some cases, may impact native species conservation goals. Nevertheless, this is a challenge that must be overcome in order to protect the core values in this watershed.

Invasive Organisms

Invasive organisms, including aquatic, terrestrial and plant species, is a serious threat to watersheds throughout the world, including the Weber River and its tributaries. Many species have invaded the watershed to date, and in some cases those invasions are not well documented and the spatial and temporal scope of those invasions is not well understood. Nevertheless, the most pressing invasion threats to the watershed are the risk of quagga and zebra mussel infestation, followed by invasive fish species, as well as invasive plant species, most especially Russian olive and tamarisk.

Whirling Disease

Whirling disease is caused by a parasite called *Myxobolus cerebralis*, which was first described in portions of Europe and has since spread throughout much of the world, including North America, Utah and the Weber River watershed. This parasite is known to cause mortality in salmonid fish species, so any actions taken to reconnect habitats in the Weber River watershed should carefully consider the potential risks, impacts and trade-offs of increased whirling disease invasions.



Climate Change

As described above, a changing climate is predicted to impact the way water is delivered (via precipitation patterns) to the watershed. What has historically been a snow dominated system may shift to one dominated by more frequent and intense spring rains and runoff. While this plan cannot address the global scale causes of climate change, it can describe strategies that could allow the management and conservation of reduced water and increased air and water temperatures, done in a manner that enhances the existing ecological and social values of the watershed.

Based on the priority threats and categories that were described previously, the planning group then identified key strategies that would most effectively address the threats within each category. Again, for the sake of continuity and simplicity, those strategies were grouped into four generalized categories, including 1) Communications, 2) Policy, 3) Land and Water Use, and 4) Habitat Restoration.

Fig 4.5: Brown Trout attempting to ascend a fish migration barrier in the Weber River at the Stoddard Diversion.

Strategies

Strategy 1-Communications

Assumptions that led to the Development of this Strategy: This strategy assumes that there is a linkage between ecosystem conservation and the viability of social values (i.e., ecosystem services) that is not sufficiently understood and that this lack of understanding leads to attitudes and behaviors that undervalue the conservation of watershed values. It also assumes that value systems and behaviors can be influenced and changed, that watershed leaders exist or will exist within the watershed, that they have the capacity and an interest in leading the effort, and finally that sufficient strategic overlap and support exists amongst all watershed stakeholders in order to set common goals, objectives, and strategies to achieve long-term outcomes. In addition, it is also assumed that existing institutional cultures, although well-established and possibly difficult to change, can be changed to support unconventional approaches to restoration and conservation. Objectives within this strategy assume that locally relevant information exists but is not always available or known to water and resource managers, that water managers and resource managers are willing and able to collaborate and seek sensible compromise, and that in some instances, water management practices can be changed while still meeting existing or altered delivery and storage obligations.

Risks Associated with the Implementation of this Strategy: Attributing outcomes to communication and outreach activities is very difficult and there is likely a significant time lag before the ultimate outcomes (i.e., large-scale change in knowledge that leads to large-scale changes in behavior) are achieved. Increased activity in this area may lead to a perception among the public that government agencies are shifting toward a role of advocacy rather than resource management. This could discourage the involvement of important stakeholders that need to provide support on other issues. Therefore, although management and regulatory agencies must be involved in order for this strategy to be effective, stakeholders in the watershed should not rely solely on the efforts of agency personnel to accomplish these Strategies and Objectives. The stakeholders, both private and governmental agencies, would be most effective by defining roles and sub-roles (where appropriate) to determine responsibilities, prevent redundant and possibly conflicting efforts and to facilitate communication throughout the watershed. Potential political shifts at all scales creates uncertainty about the ability for public agencies to consistently support the work over the long term. Finally, there may be a perception that additional outreach will lead to increased use and pressure on resources and therefore, a diminished experience for various resource users and consumers.

Communications Objective 1- Recruit broad and inclusive stakeholder participation to help implement the plan. Successful implementation of this plan and progress towards meeting the goals and objectives outlined here will require broad participation from a diverse set of stakeholders including academia, conservation districts, recreational users, and individual watershed leaders, etc. In order to broaden the cross section of stakeholders from that which is currently involved within the watershed, the planning team identified the need to engage in constant communication with people and organizations that were identified as important watershed stakeholders to promote understanding and acceptance of the watershed plan and participation in its implementation and future revisions. Potential and real conflicts can and will occur between stakeholders that represent a variety of interests and values. Those conflicts will need to be identified and proactively mitigated for.

Communications Task 1.1- Watershed Partnership Establish and institutionalize the Weber River Watershed Partnership, made up of recognized resource experts, that provides advice and consultation regarding all aspects of the watershed initiative. The committee should represent a diversity of disciplines and have a good understanding of the basin and existing issues. While doing so, remain mindful of past committees that were developed and are no longer operating or in existence so that the new institution does not suffer a similar fate or alienate past particpants.

Communications Task 1.2- Water and resource manager coordination: (DWR, DEQ, Weber Basin, wastewater treatment plants, BOR, USFS). Water and ecological resource managers will work more frequently, as often as day-to-day, to collaboratively identify opportunities to align water management goals and watershed-scale conservation goals.

Communications Objective Task 1.3 - Identify and cultivate watershed leaders: Identify a diverse set of locally-based leaders that can eventually take more ownership of the watershed initiative and lead the effort over the long-term. Agency personnel must retain their technical leadership roles in the watershed, but grassroots commitment is essential for the long-term restoration and conservation of the watershed.

Communications Task 1.4- Outreach to agency and funding organization leaders: Knowledge of aquatic systems and specific restoration strategies are constantly changing over time. It is important to engage in frequent communication with agency leaders and managers to share the information in this plan, the progression of its implementation and the changing knowledge base within the basin. Sharing this information will continue to engage agency leaders and improve their understanding of the role they can play in supporting the successful implementation of the plan. Communication and outreach to key leaders is required to gain funding support for new and existing programs and management decisions.

Communications Task 1.5- Organize and host an annual watershed symposium: Each year watershed leaders and managers will gather to discuss relevant topics, work plans, issues and projects with the goal of sharing knowledge with fellow watershed leaders, and to encourage input from scientists, practitioners and citizens from outside the watershed.

Communications Task 1.6- Develop and implement an annual workplan: Stakeholders throughout the watershed will initially develop and agree upon an annual work plan. This should prioritize strategies, critical issues and target funding, projects, and resources toward specific tasks and objectives. This work plan will be reported on, reviewed and revised at the annual watershed symposium (see communication task 1.5)

Communications Objective 2- Public outreach, communication, and education: Develop and engage in active public outreach and education activities to increase the public's knowledge and awareness about the ecological impacts of human activities on aquatic ecosystems.

Communications Task 2.1 - Develop a strategic public outreach, education and communication plan: With the help of outreach and education specialists and social scientists, begin developing of a strategic public outreach, education and communication plan for the watershed that will leverage and coordinate the ongoing outreach efforts throughout the watershed, and will identify strategic outreach needs both now and in the future.

Fig 5.1: Watershed stakeholders coordinating at a recent watershed tour

Communications Task 2.2- Create a webpage: While Objective 1.1 is being developed, create a neutral, non-agency or organization sponsored webpage for the watershed with targeted and frequent contributions from key stakeholders so that the larger watershed community can learn about ongoing actions, issues and watershed-related activities.

Communications Task 2.3- Highlight the Ogden River restoration project: Leverage the success, support and popularity of the Ogden River Restoration Project as an on-the-ground starting point for larger-scale restoration and protection practices.

Communications Objective 3- Collaborate with Utah State University and Weber State University: Cultivate and sustain long-term partnerships with academia to support all aspects (e.g., ecological and social) of the watershed initiative. When possible build on existing relationships with the Utah Water Research Laboratory and the Utah Cooperative Fish and Wildlife Research Unit, the Utah State University Cooperative Extension, and Weber State University Communications and Zoology Departments. Collaborate in ways to ensure research is communicated effectively to decision makers and other users. Academia can also provide long-term relationships necessary to fill data gaps and complete research over timescales necessary to achieve and measure outcomes. University collected data and research provides a level of legitimacy with watershed stakeholders.

Communications Task 3.1- Identify and prioritize research needs: Determine which research needs are appropriate for academia to address, then identify potential funding sources and programs to support that research.

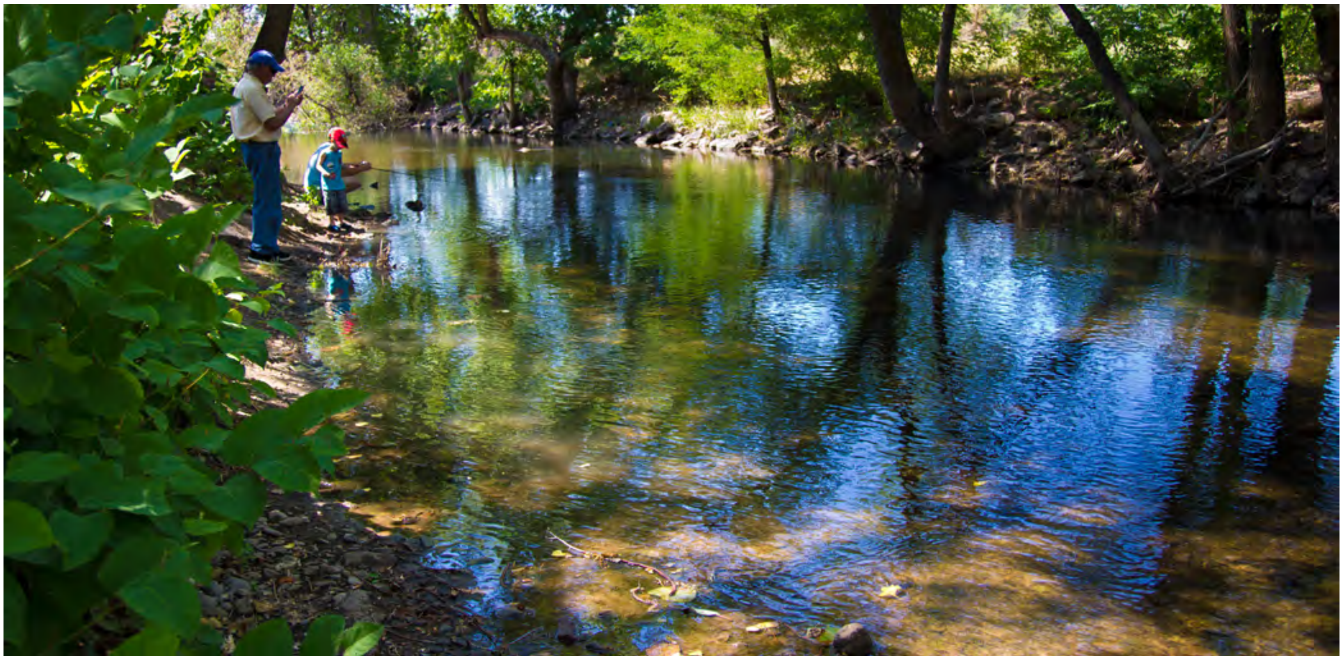


Fig 5.2: Family fishing in the Ogden River.

Strategy 2-Policy

Assumptions that led to the Development of this Strategy: This strategy assumes that there is agreement among management agencies that deficiencies exist within the current policy processes and that the effectiveness of the current processes can be improved. It is assumed that successful application of this strategy relies upon the tractability of making improvements to regulatory processes, and stakeholders have sufficient resolve to commit resources to make substantive changes where appropriate. It is also assumed that agency personnel have time to contribute more intensely to project review and to contribute to policy-level changes, if necessary, that should lead to higher quality applications. This strategy also assumes that improved agency guidance and coordination will lead to applications and actions that are approvable and that minimize damage to habitats throughout the watershed.

Risks Associated with the Implementation of this Strategy: In some cases, permitting processes, specifically stream alterations, may become more complicated and expensive requiring enhanced agency staff capacity, which could be insufficient to engage at a level that is needed to improve project designs. It is possible that the public could perceive increased policy action as excessive government involvement, and if a more costly or complicated permitting process is the result, this strategy could increase the occurrence of unpermitted actions.

Policy Objective 1- Improve Stream Alteration Application, Permitting and Related Impact-Analysis Processes: Improve the way that agency reviewers, regulators and applicants interface with the various permitting processes and related actions that may affect watershed values.

Proactively communicate with natural resource management agencies and applicants to develop timely and supportive guidance for applicants and affected organizations. The permitting processes will be clear and applicants will have information that allows them to proactively integrate design features that protect or enhance watershed values. (Note: Other types of permitting such as stormwater management may require separate approaches)

Policy Task 1.1- Permitting process: Re-develop or revise the permitting process guidelines to include critical facts and points of contact to protect the core watershed values (hard copy and web-based) by 2015. This may require that handbooks or guidelines be developed for specific elements of the permitting process, such as design standards for irrigation infrastructure for improved water delivery and fish passage and


Fig 5.3: Volunteers collecting fisheries data on East Canyon Creek

screening.

Policy Objective 1.2- Develop a stream project design guidebook: Develop a locally relevant document that describes Best Management Practices, along with relevant information about aquatic habitat restoration, protection and damage minimization. This information will be summarized from established literature (hard copy and web-based) by 2015.

Policy Task 1.2- Workshops: Design, host and participate in relevant project tours and design workshops.

Policy Objective 2- Participate in State-level Efforts to Comprehensively Review Current Water Law: Representative watershed leaders will become engaged in the State of Utah's newly announced efforts, known as Utah's Water Future, to critically evaluate and provide relevant feedback on issues related to current water law, supply, delivery and recreation.

Policy Objective 3- Implement Protective Angling Regulations: Through consideration and analysis of biological, ecological and social data, continue to develop and implement angling regulations that are designed to eliminate legal harvest of "at risk" native fish species and where necessary, to minimize incidental mortality from recreational angling.

Policy Task 3.1- Protective regulations: Implement regulations designed to eliminate legal harvest of Bonneville cutthroat trout and where necessary bluehead sucker by 2014.

Strategy 3-Land and Water Use

Assumptions that led to the Development of this Strategy: This strategy assumes that, although historical and contemporary emphasis has been placed on physical habitat restoration within the watershed, other actions, although possibly more complex and expensive may provide equal or greater benefit to the watershed. It is also assumed that the current level of financial support for past and ongoing habitat restoration approaches is flexible enough to be applied to this strategy. This strategy also assumes that landowners, water users and water managers are willing to participate in actions related to this strategy.

Risks Associated with the Implementation of this Strategy: Application of this strategy may require a redirection of actions by some project partners, which may result in current projects and actions being postponed or declined in favor of more relevant and effective projects and actions. This strategy involves additional attention to issues previously considered intractable or lower priority by some stakeholders. It is possible that this different approach will be seen as ineffective, or there may be significant time lag before the ultimate outcomes (i.e., large-scale change in management that leads to large-scale benefits to the watershed) are achieved. It is also possible that landowners, water users and water managers may not be supportive of some restoration actions, which could threaten the credibility of restoration practitioners and conservationists with some landowners, managers and resource users.

Fig 5.4: Fish Passage and screening structure at Weber Canyon

Land and Water Use Strategy 1- In-stream Flow Enhancement: Where possible establish flow patterns that promote conservation of at-risk species and enhances other watershed values.

Land and Water Use Task 1.1- Environmental flows: Ensure that existing environmental flows have been provided historically and monitor real-time flows to ensure they are being provided for currently.

Land and Water Use Task 1.2- Define flow regimes Where existing environmental flows are lacking, define flow regimes that would benefit conservation values and work with water managers to integrate those flows into existing management practices.

Land and Water Use Task 1.3- Flow leases Implement in-stream flow leases in critical portions of the watershed by 2015.

Land and Water Use Task 1.4- Support water conservation initiatives: All stakeholders will support and where necessary, augment the ongoing efforts to promote water conservation practices throughout the watershed.

Land and Water Use Strategy 2: Improve Fish Passage. Improve fish passage for migrating native species to allow full expression of life-history strategies.

Land and Water Use Task 2.1- Water conveyance assessment: Complete a comprehensive assessment of existing water conveyance systems and prioritize actions to enhance fish passage and reduce fish entrainment.

Land and Water Use Task 2.2- Passage design improvement: Create a toolkit of fish friendly diversion and road crossing Passage Options tailored to the Weber River watershed. Develop a manual summarizing established literature that contains alternative designs for in-stream diversion structures and road crossings that meet environmentaly and fish friendly criteria.

Land and Water Use Task 2.3- Barrier and passage projects: Design and implement fish passage projects at existing and highest priority barriers.

Land and Water Use Strategy 3- Support smart growth initiatives: Work with appropriate jurisdictions to designate and protect key riparian habitats to protect communities from flooding, retain ecological function, and sustain responsible agricultural practices and legacies.

Land and Water Use Strategy 4- Work with NGOs and private landowners to support farmland preservation. Work with land trust partners and private landowners to make the link between agricultural protection and conservation protection clear, and seek balanced solutions that are a win-win for everyone involved.

Land and Water Use Strategy 5- Improve stormwater management: Identify approaches to reduce water quality impacts related to stormwater runoff

Strategy 4-Habitat Restoration

Assumptions that led to the Development of this Strategy: Habitat restoration has historically been the primary strategy applied in the Weber River by many stakeholders. Most of the projects have addressed relatively small-scale challenges to aquatic resources and terrestrial wildlife species. In fact, many of the funding sources have been built around the development and quick implementation of these small projects, which were easily fundable because of modest project costs and tractable design requirements. However, many of the historical efforts behind restoration in the past were driven by opportunity more than strategy. This past strategy of restoration encouraged smaller projects with small-scale, but visually conspicuous results. However, this past strategy also resulted in a non-cohesive approach to restoration and an attempt to undertake an abundance of projects. The current strategy relies

Fig 5.5: Volunteer restoration efforts along the Weber River

upon the assumption that larger-scale actions, more expensive projects and unconventional approaches will be acceptable to landowners and land managers, and that funding sources are flexible enough to support a new diversity of projects, including broadened restoration priorities to address the needs of terrestrial wildlife species, as well as aquatic resources. This strategy also relies upon the assumption that the project partners have the current capacity to implement larger-scale and more complex projects.

Risks Associated with the Implementation of this Strategy: One of the driving factors behind the development of this strategic plan was the consideration that the *status quo* (e.g. relying heavily on physical restoration actions in a piecemeal fashion) was not addressing the root causes of degradation within the watershed. Changing the restoration approach by broadening the diversity, breadth and scope of restoration actions represents a great risk to the stakeholders within the watershed implementing these actions. Breaking through traditional methods and actions comes with potentially high upfront costs to credibility and financial resources. Future restoration actions that are possibly more complex and challenging, and which span multiple years and approaches with less conspicuous results may not receive immediate acceptance by funding sources, members of agency leadership and landowners. Proposed actions, such as riparian exclusion fences may be perceived by the agricultural community as being oppositional to grazing.

Habitat Restoration Strategy 1- Riparian Management: Fence riparian areas to protect aquatic resource and terrestrial wildlife values from intense grazing practices.

Habitat Restoration Task 1.1- Riparian exclusions or pastures : Identify and prioritize appropriate locations or opportunities to install grazing exclusions or riparian pasture areas.

Habitat Restoration Strategy 2- Partnerships: Develop and leverage diverse and non-traditional partnerships to consolodate small scale actions into larger scale multi-benefit projects.

Habitat Restoration Strategy 3- Monitoring: Develop a comprehensive, adaptive and quanitative monitoring plan that tracks the health of the watershed and the effectiveness of restoration actions by assessing the health of the conservation targets identified in this plan.

Future Research

Knowledge gaps were not identified as a specific threat to the health of our watershed, but the watershed group does recognize our improving, yet inherently and continually limited understanding of our watershed. It became apparent throughout this process that in some critical cases, we lack the fundamental knowledge that is required to effectively and adaptively manage and conserve the social values and conservation targets throughout this watershed. However, rather than listing all of our knowledge gaps as threats, for which there are many, the group decided to identify critical research findings that are needed in the future, then as research funding and opportunities become available, the committee can draw from this listing to direct research priorities. By developing, using and improving upon this list of priority research needs we will ensure that the growth of our knowledge will keep pace with our efforts to restore our watershed.

Identified *Data Gaps*

- Methods to quantify qualitative features of the river and watershed (aesthetics, quality of life, human well-being)
- What are the effects on aquatic species from dewatering and alteration of the hydrograph on main stem and tributary systems.
- Evaluate and monitor the trade-offs of isolation versus reconnection actions with an emphasis on non-native species invasion and the spread of disease.
- Develop a better understanding of optimal hydrology and its ecosystem impacts.
- Inventory of all main stem and tributary diversions and barriers to fish migration.
- Assessment of watershed scale geomorphic function and condition
- Assessment of irrigation related entrainment risk
- Assessment of public beliefs, values and perceptions regarding water quality, water use, and watershed health
- Specifically, determining the life history requirements of Bluehead Suckers and other non-game aquatic species and riparian birds with an emphasis on determining the most effective measures for targeted conservation.
- Potential water conservation approaches

Fig 5.7: Electrofishing survey in the Weber River to assess fish health.

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Appendix A

Acronyms commonly used in this document

AGRC - Automatic Geographic Reference Center
BLM - (United States) Bureau of Land Management
BOR - (United States) Bureau of Reclamation
CAP - Conservation Action Plan
cfs - Cubic feet per second
CWA - Clean Water Act
DEQ - (Utah) Department of Environmental Quality
DO - dissolved oxygen
DWQ - (Utah) Division of Water Quality
EPA - (United States) Environmental Protection Agency
FWS - (United States) Fish and Wildlife Service
kg - kilogram
NRCS (United States) - Natural Resources Conservation Service
SBWRD - Synderville Basin Water Reclamation District
TAC - Technical Advisory Committee
TDS - Total Dissolved Solids
TMDL - Total Maximum Daily Load
UDEQ - Utah Department of Environmental Quality
UDNR - Utah Department of Natural Resources
UDWaR - Utah Division of Water Resources
UDWR - Utah Division of Wildlife Resources
UDWQ - Utah Division of Water Quality
UDWRi - Utah Division of Water Rights
UGS - Utah Geological Survey
USDA - United States Department of Agriculture
USFWS - United States Fish and Wildlife Service
USGS - United States Geological Survey
USU - Utah State University
WBWCD - Weber Basin Water Conservancy District
WRAS - Watershed Restoration Action Strategy
WRWC - Weber River Watershed Coalition

General

BMP - best management practice
I&E - information and Education
NPS - non-point source
POTW - publicly owned treatment works
WWTP - wastewater treatment plant

Legislation

§303(d) - a list of impaired waterbodies required by Section 303, subsection (d) of the Clean Water Act

ARRA - American Recovery and Reinvestment Act
CWA - Clean Water Act
ESA - Endangered Species Act
NEPA - National Environmental Policy Act

Technical

ac - acre
BMP - best management practice
cfs - cubic feet per second
cm - centimeters
DO - dissolved oxygen
GIS - Geographic Information System
HUC - Hydrologic Unit Code
kg - kilogram
km - kilometer
km^2 - square kilometer
L - liter
LA -load allocation (for non-point source discharges)
m - meter
m^3 - cubic meter
mg - milligram
mg/L - milligrams per liter
MGD - million gallons per day
mL - milliliter
mm - millimeter
NPDES - National Pollutant Discharge Elimination System
NPS - non-point source
oC - degrees Celsius
oF - degrees Fahrenheit
P - phosphorus
pH - a measure of acidity (pH 1–6 = acidic, pH 7 = neutral, pH 8–14 = basic)
ppm - part(s) per million
SNOTEL - snow telemetry
STORET - EPA water quality database
T&E - threatened and/or endangered species
t/y - tons per year
TMDL - total maximum daily load
TP - total phosphorus
TSI - trophic state index
TSS - total suspended solids
UPDES - Utah Pollutant Discharge Elimination System
WLA - wasteload allocation (for point source dischargers)
WQS - water quality standard

Appendix B

Selected Definitions:

303(d) List: A list of impaired and threatened waters (stream/river segments, lakes) that the Clean Water Act requires all states to submit for EPA approval every two years on even-numbered years. The states identify all waters where required pollution controls are not sufficient to attain or maintain applicable water quality standards. When a water is placed on the 303(d) list, the state is required to develop a Total Maximum Daily Load (TMDL) for that water within 8-13 years of the listing.

Allele: One of a number of alternative forms of the same gene or groups of genes. These alternative forms of genes produce different effects, some are observable, however many genetic variations are not. Specific alleles can form for different fish populations, subspecies, and species, allowing scientists to analyze groups of genes within individuals of a population to determine the amount of mixing or cross-breeding that has occurred.

Benthic: The ecological zone of a body of water that is at the lowest level including the sediment surface and subsurface layers. Animals that live in this zone are called benthic organisms or benthos.

Blue Ribbon Fishery: In Utah, Blue Ribbon fisheries are waters specifically identified by the Utah Division of Wildlife Resources and the Blue Ribbon Fisheries Advisory Council that provide highly-satisfying fishing and outdoor experiences for diverse groups of anglers and enthusiasts.

Conservation Action Planning (CAP): Conservation Action Planning (CAP) is a relatively simple, straightforward and proven approach for planning, implementing and measuring success for conservation projects. CAP was developed by The Nature Conservancy and is based on the Open Standards for the Practice of Conservation.

Ecological System: A geographical division of the Weber River Watershed based on groups of 12-digit Hydrologic Unit Boundaries, developed by the United States Geological Survey, that contain similar biological, geological and climatic features, that are hydrologically connected, and are consistent with ongoing watershed assessment activities.

Extant: A population, subspecies or species that is still in existence, as opposed to extinct.

Fish Strain: A group of fish from the same species, either from wild origin or domestication that shares unique characteristics, both genetically and physically.

Fluvial Life History: A life history strategy exhibited by fish in which an individual fish uses mainstem river and tributary habitats at different times to fulfill its life cycle. For example some Bonneville cutthroat trout in the Weber River live in the mainstem as adults, but migrate into headwater tributaries to spawn. The resultant juvenile fish in the tributaries move downstream into the Weber River as they get older and become adults. This cycle repeats in subsequent generations.

Genetic Introgression: The movement of genes from one species or subspecies to another by repeated reproduction of hybrids through a process called backcrossing. For example rainbow trout and cutthroat trout cross-breed or hybridize. Over time the original hybrids breed with genetically pure cutthroat trout or other hybrids in the subsequent generation to further increase the mixing of genes between the different species.

Habitat Fragmentation: The process of creating discontinuities in an organism's habitat, breaking populations into smaller pieces. In stream environments, fragmentation can be caused by natural processes, such as the formation of waterfalls, but it can also be caused by human actions, such as the construction of culverts, dams and diversions that block flow or create vertical discontinuities in water flow. Habitat fragmentation breaks populations up into smaller segments increasing the risk of extinction to those populations.

Hybridization: Reproductive crosses or interbreeding between populations, strains, subspecies or species of animals or plants. For example, rainbow trout and cutthroat trout are two different species, which can interbreed. When this happens, "cutbows" are the resultant hybrids.

Hydrograph: A graph showing the rate of flow (discharge) versus time at a specific point on a river. Most natural and unregulated streams have a relatively consistent hydrograph from year to year with some annual variation.

Hydrograph Alteration/Hydromodification: Modifications to the natural hydrograph caused by human actions, such as the construction of dams or diversion of water.

Life History: Also known as a life cycle, it is a period of time and required steps for a generation of a species to self-perpetuate from birth through reproduction.

Macroinvertebrate: An invertebrate that is large enough to be seen without the use of a microscope. Macroinvertebrates that live in the water for a portion of their lives are called aquatic macroinvertebrates. Some aquatic macroinvertebrates are very sensitive to water pollution and their presence/absence can be used to assess the status of a water body.

Metapopulation: A metapopulation consists of a group of spatially separated and distinct populations of the same species which interact at some level, and includes areas of suitable habitat that are currently unoccupied. In classic metapopulation theory, each distinct population eventually goes extinct as a consequence of random events. The smaller the population, the more prone it is to extinction. Although the individual populations have a finite life, the metapopulation is more stable over time through connectivity of the individual populations. Fragmentation impacts metapopulation dynamics by severing the connection between the individual populations. The isolated populations are at higher risk of extinction and the lack of connectivity to the metapopulation suggests that natural recolonization would not occur. Over time the gradual loss of individual populations without natural recolonization can put an entire species or subspecies at a higher risk of extinction.

Putative: Commonly accepted or identified. For example, Eight putative subspecies of cutthroat trout across the western United States have been identified, primarily by geographic isolation and physical characteristics exhibited by the fish in those geographic areas. So it is generally accepted that Bonneville cutthroat trout look different than Yellowstone cutthroat trout. This is further supported by genetic research.

Total Maximum Daily Load (TMDL): Waters placed on the 303(d) list by the states require completion of watershed-scale studies that identify the causes of impairment, pollutants of concern, quantify pollutant loading from respective sources, and establish timelines and strategies to reduce pollution and achieve water quality endpoints. These studies are called Total Maximum Daily Loads, or TMDLs.