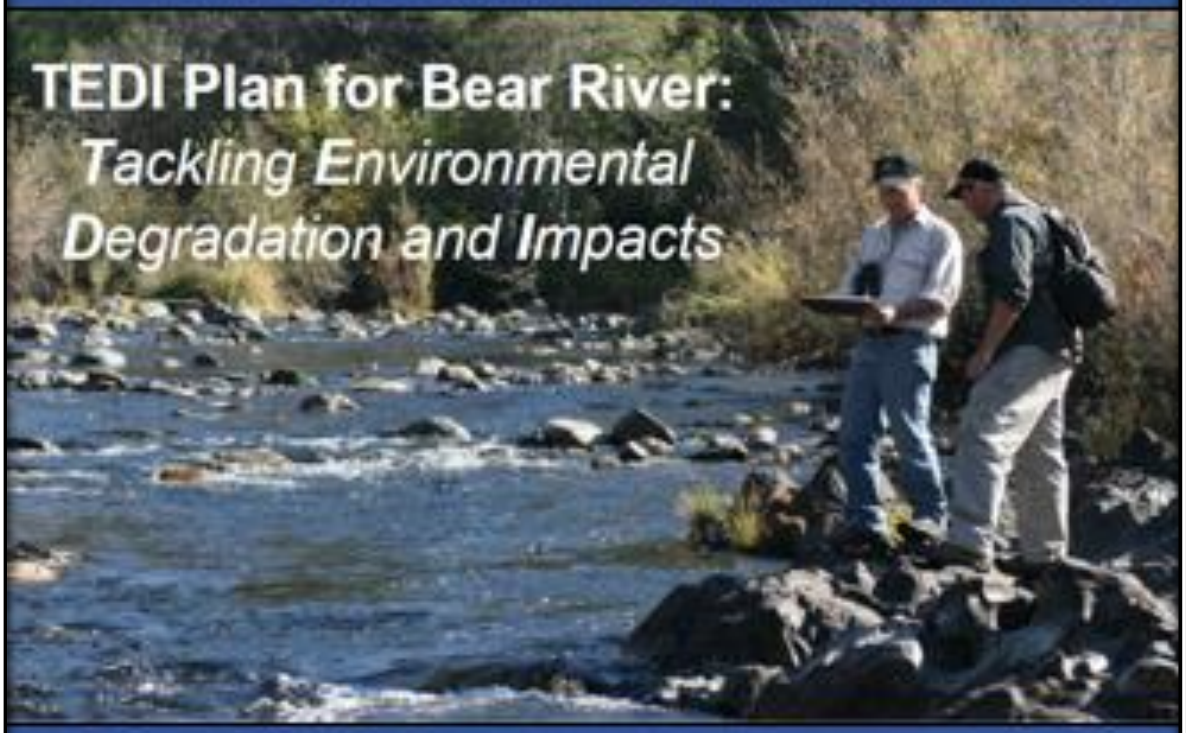
The Bear River Watershed



Regional Watershed Management

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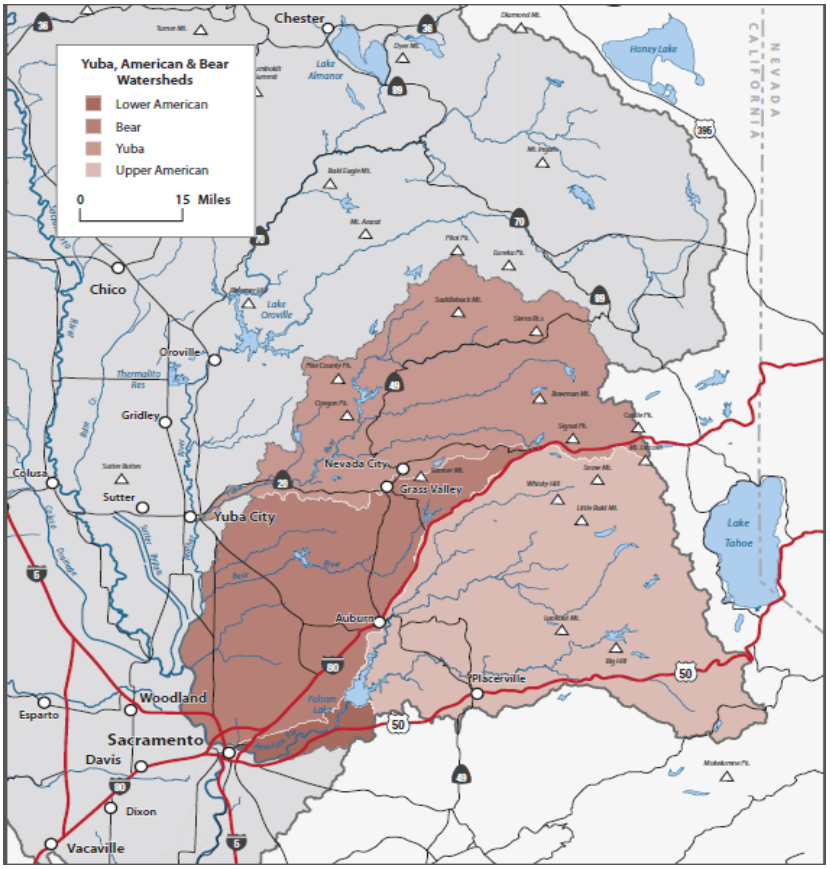
Mission Statement

The Bear River Watershed, located northeast of Sacramento, California, represents one of California's most heavily managed watersheds due to its importance in regards to water conveyance for agricultural water supply and hydropower development. Both former and current developments within the watershed have degraded the quality of the watershed, in terms of hydraulic flow as well as ecosystem health. It is intended that the T.E.D.I. (Tackling Environmental Degradation and Impacts) Plan for Bear River will restore fishable and swimmable water quality in the Bear River Watershed by 2045.

Watershed Background Information

Watershed Characteristics

The Bear River Watershed is one of four watersheds comprising the American River Subregion of the Sacramento River Watershed in California. Portions of four counties, the Nevada, Placer, Sutter, and Yuba can be found within the Bear River Watershed. Originating in the Sierra Nevada mountain range at an elevation of over 5,000 feet, the watershed ends at its discharge point to the Feather River at an elevation less than 100 feet above mean sea level. The watershed encases the 75-mile long Bear River and covers an area of roughly 220,000 acres. Over 990 miles of streams, creeks, and rivers reside within the watershed. Unfortunately, approximately 45% of these streams are within 100 meters of a public road, owed largely to the fact that nearly 2,000 miles of road can be found within the watershed as well. .



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History

Around 3,000 BC Native Americans known as the Nisenan began settling villages within the Bear River Watershed. They lived relatively undisturbed lives in harmony with the ecosystem until the 1800s when European settlers discovered them. Those who survived early contact with the settlers were ultimately killed or displaced as a result of the impending California Gold Rush. The Bear River Watershed found its first significant settlement in the mid-19th century as a result of this gold rush. During this period, massive gold mines were constructed to allow for greater gold recovery from the ores found in the region. These large earth-moving projects lead to substantial sediment runoff into the Bear River adversely affecting the aesthetics and ecosystem health of the river. Even more importantly though, the gold extraction process led to the release mercury into the environment as mercury was used to enhance gold recovery. The United States Geological Survey estimates that nearly one-third of the 26 million pounds of mercury used in the Sierra Nevada Mountain Range, where Bear River originates, was released to the environment. This mercury is still present today, especially in the form of methylmercury, known for its tendency to bioaccumulate within the tissues of living organisms posing a threat to both wildlife and humans. As the gold rush waned, settlers in the region turned to other means of living, including agriculture. The growth of farms in the 19th and 20th centuries led to the need for irrigation and the Bear River was dammed to provide sufficient water for the expansion of agriculture in the region. It was quickly realized that this water could also be utilized to provide hydroelectric power for the region. In the late 1800s and early 1900s, numerous hydroelectric plants were constructed along the river, several of which survive today. As for today, the future of Bear River is unclear. As recently as 2011, the Nevada Irrigation District proposed the construction of another dam to provide sufficient water resources to nearby cities. While this proposal was eventually retracted due to heavy opposition, a newer dam proposition was just put forth in 2014. The status of this request is currently pending.

Figure 2: Combie Reservoir Dam

Land and Water Use

The Bear River Watershed is comprised primarily of woodland to the north and east in the Sierra Nevada where mining operations originally dominated. To the west, agriculture mainly dominates the region. Urbanization is predominantly located to the southern region of the watershed. Some of the unique features found within the watershed include the Empire Mine, one of California's largest gold mines and the Beale Air Force Base, home of the 9th Reconnaissance Wing. Water use in the region is primarily utilized for domestic and agricultural purposes. On the Bear River, hydroelectric dams often employ the river water for electricity generation.

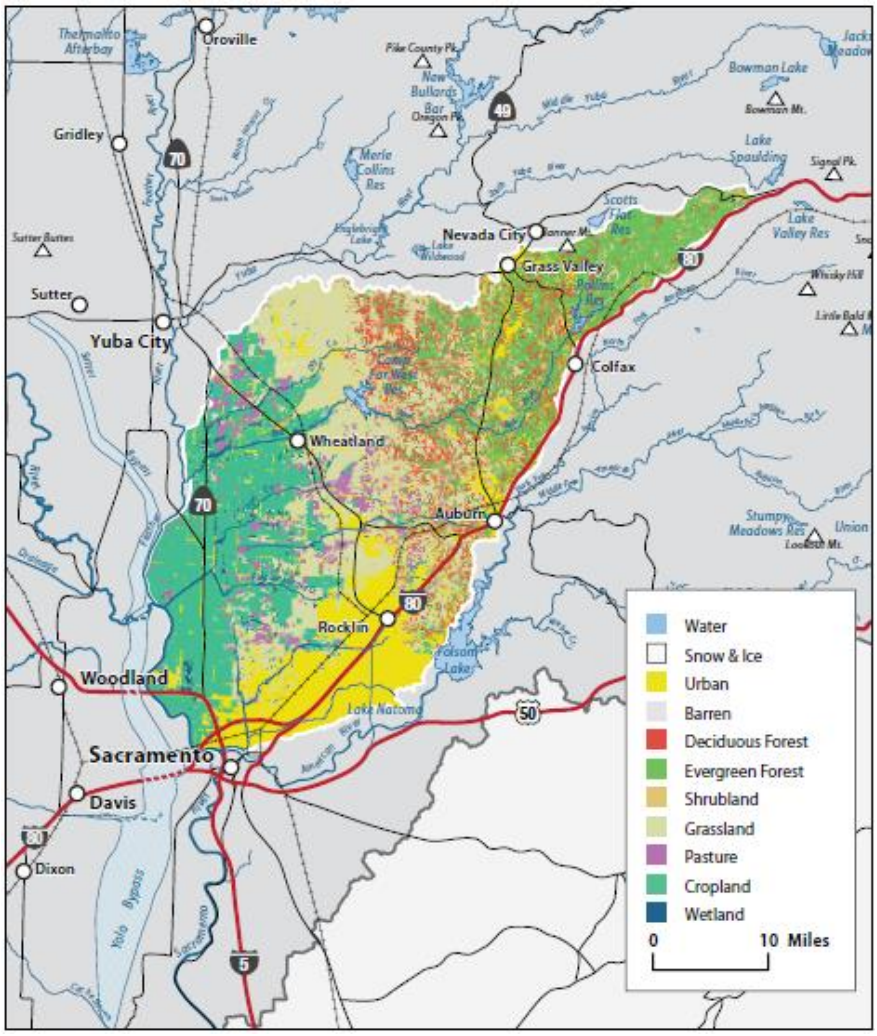

Figure 3: Bear River Watershed Land Use

Existing Organizations

Numerous organizations exist to help protect and repair this watershed. These organizations can be found highlighted below, along with a brief description of each.

CABY - CABY stands for Cosumnes, American, Bear and Yuba Rivers. This is a collaborative planning effort that is itself composed for more than thirty different organizations and stakeholders. These organizations consist of recreation, agriculture, conservation, and community groups. This organization was established in 2006 and is currently pursuing a grant to continue its watershed work.

SRWP - SRWP stands for the Sacramento River Watershed Program. This program consists of thousands of people and covers most of northern California. This organization is certified as a not-for-profit corporation and strives to ensure that the "current and potential uses of the watershed's resources are sustained, restored, and where possible, enhanced, while promoting the long-term social and economic vitality of the region."

Sierra Watch - This organization was founded in 2000 by a small group of residents when they learned of plans to develop Tahoe's Martis Valley. The program has since expanded throughout the Sierra to become an advocate for lasting conservation and defender again irresponsible development and has commissioned biologists, lawyers, and planners.

Sierra Water Workgroup - This organization strives to "increase inter-regional cooperation and assist regional efforts in protecting and enhancing water quality, water supply, and watershed health." In addition, it works to protects lands, water and wildlife in rural communities and collaborates with other conservation groups.

Placer Land Trust - The Placer Land Trust works with landowners and conservation partners "to permanently protect natural and agricultural lands in Placer County for future generations." This organization advocates for the protection of natural landscapes and promotes sustainable stewardship of land and water resources.

Bear Yuba Land Trust - The Bear Yuba Land Trust exists to "create a balance between nature" and the people that call the Sierra their home. It is a private non-profit organization that promotes voluntary conservation of natural and historical resources.

Environmental Problems and Rectifying Goals

P.1: Fishery Destruction

At one point, Bear River supported thriving populations of salmon and steelhead. However, no self-sustaining salmon runs presently exist, and the current status of steelhead is unknown. The deteriorated state of Bear River can be held partially responsible for this issue. Viable populations of fish within the river could provide a food source not only for humans that reside in the Bear River Watershed, but also for predators who were displaced as a result of the fishery loss. Potentially, self-sustaining bear and predatory bird populations, such as the bald eagle, could thrive in the Bear River Watershed if a sufficient source of prey such as salmon was also present. Furthermore, the resurgence of the fisheries could provide an economic boost to the region. Revenue generated from this industry could directly feed back into watershed

management, preserving and improving the state of the fisheries. If fishery restoration and the rebirth of fishable waters is to become a reality though, several goals must be accomplished before this dream can come to fruition.

G1.1: Mitigate Effects of Damming

The construction of numerous dams has impacted the potential for fish to thrive in the Bear River. These dams limit the range of fish to travel upstream and impede spawning. Furthermore, the dams limit hydraulic flow downstream of these engineering projects. Reductions in water flow can adversely water quality in terms of water temperature and dissolved oxygen, further eliminating potential habitats for fish in the Bear River. While the removal of presently established dams is relatively impractical, their effects upon fish spawning can be reduced. The implementation of fishways can permit fish to travel farther upstream and promote their spawning range. In scenarios where relatively short dams have been constructed, fish ladders can provide stepping stones for fish to reach upstream regions previously blocked off by dams. Alternately, fish elevators can be employed to allow fish to overcome taller, more obstructive dams. While these amendments can reduce the negative impacts of previously constructed dams on the Bear River, it is also necessary to ensure that the construction of future dams do not impede fish spawning routes. Ideally further dam construction upon the river will be halted, however a request for the addition of another dam to the river has already been pending since 2014. If additional dams are built along the Bear River in the future, they should include designs to allow for fish movement along the river. It is believed that the adoption of these proposals will allow for additional fish spawning upstream and aid in the restoration of the fisheries.

G1.2: Minimize Methylmercury Contamination

Methylmercury is just one of the many organic forms of mercury that can be found in fish. However, methylmercury represents the most readily incorporated form into biological tissues and poses the greatest toxic threat to humans, especially due to its tendency to biomagnify through the food chain. Methylmercury is derived from a two-step biogeochemical process including an oxidation step and eventual methylation. Mercury methylation is predominantly controlled by sulfate-reducing bacteria and other microbes that thrive in low dissolved oxygen conditions, such as in algal mats. Limiting these conditions should likewise limit the conversion of elemental or ionic mercury ultimately to methylmercury. One manner of reducing the occurrence of anoxic environments can stem from eutrophication control, which is tied to responsible fertilizer use. Educating the regional public about the importance of responsibly applying fertilizer to minimize nutrient runoff and eventual eutrophication should reduce the likelihood of algal mat development and anoxic environments where mercury methylation can occur. While this outreach will ideally reduce future methylmercury contamination of fish in the

Bear River, current monitoring of methylmercury contamination must also be put into place. This contemporary monitoring can notify residents when methylmercury concentrations within fish reach levels hazardous to human consumption, protecting the fishery industry and human life. With these precautions in place, the fisheries within Bear River should be able provide safe-to-eat seafood for the region.

P.2: Water Quality Contamination

The improvement of the water quality of Bear River is one of the most vital points that the T.E.D.I. Plan intends to address. Water quality is the overarching characteristic that dictates if water is swimmable and fishable. If the T.E.D.I. Plan is to succeed, sufficient water quality must be reached to allow for safe swimming and fishing. With cleaner water flowing in Bear River, a greater variety and quantity of species will be found within the watershed. Furthermore, recreational activities within the region will spur on tourism increasing revenue for the area. This increased income can once more be utilized to further improve the quality of the watershed, protecting it for future generations. However, in order for the tourism industry to thrive and for the replenishment of the watershed to its original, pristine condition several goals must be realized to improve the water quality of Bear River. Of particular interest, the State of California is currently re-evaluating its TMDLs for mercury, so in its absence the EPA water quality criteria for dissolved mercury for protection of aquatic organisms have been provided. The maximum allowable concentration is 1.4 µg/L while the allowable continuous concentration is 0.77 µg.

G2.1: Mercury Remediation

From the initial days of the California Gold Rush, miners utilized mercury to promote gold extraction and recovery. However, a large quantity of this industrial mercury was released to the environment, contaminating the local soil and water resources. Much of the water-based mercury settled into the soils beneath the surface water though where it has remained relatively undisturbed. However, this inorganic mercury is often brought back to the surface when the riverbed is disturbed. This can occur naturally from heavy storms, or through anthropogenic actions including dredging. Additionally, land development in this region can occasionally unearth previously entombed mercury stores, reintroducing them to the environment once more. To reduce the release of mercury back to the environment, soil treatment during dredging operations and earthwork can help remove the heavy metal from the soil. Thermal desorption could treat the contaminated soil with heat to volatilize the mercury from the soil. Off-gas treatment of these emissions could also reduce the potential for air pollution and concentrate the mercury for disposal as hazardous waste. The soil could then be used as clean backfill. As this treatment method could be rather costly though, the employment of chemical phytorextraction could prove a cheaper yet effective mean of treating mercury contamination. The addition of a

chemical such as potassium iodide coupled with planting flora such as the bush bean can make the mercury more bioavailable and allow the plants to uptake it. These plants can then be harvested and disposed of as hazardous waste. However, some drawbacks of this may include the potential to alter the pH of Bear River due to the potassium iodide addition or the chance of bioaccumulation through animals feeding upon the flora. Despite the disadvantages, these treatment options, or similar ideas, have the potential to remediate the mercury contamination and improve the water quality to allow for a healthier ecosystem in the Bear River Watershed.

G2.2: Maintain Healthy Floral Growth

Watershed vegetation plays a vital role in protecting the water quality of global waterways. Flora anchors soil and sediment in place, preventing its runoff to regional waters. High sediment concentrations can increase turbidity, negatively affecting aesthetics of the water and limiting sunlight to subsurface water plants. Furthermore, land plants can trap bacteria from animal wastes from infiltrating to surface waters, where these microbes can sicken life within the water bodies. To reduce the risk of contaminating the water, the establishment of healthy riparian buffers can minimize the chances of fecal coliforms finding their way into the river prior to becoming entrapped by flora. One hurdle to this solution however is the prevalence of roads near creeks within the watershed. About 68% of the stream system is located within 200 meters of a road. If fewer roads were constructed close to the riverways, healthier riparian buffers could be maintained. Another manner of ensuring that the watershed maintains a healthy floral ecosystem is to enact controlled burns. Current growth of the watershed is unhindered and has led to the establishment of a dense under canopy. This unkempt growth places the watershed at risk as a wild conflagration could consume nearly all floral growth in a region. This would eliminate any defenses to keep sediment and bacteria out of the waterways, adversely affecting the water quality for months. If these notions were enacted however, the Bear River could be restored to a healthy habitat suitable to water flora and recreational swimming for humans.

P.3: Reduced Water Flow

As a greater population has settled near Bear River, water demand of the local communities has grown. This increased demand has stressed the Bear River and led to the construction of several dams to requisition water for domestic and agricultural use. The greater diversion rate has limited downstream flows, limiting available water for downstream communities and reducing habitats for local fauna. The continued construction of dams and additional use of the Bear River as a water resource for the region has the potential to dry up the river in the coming decades. If future generations are to enjoy the Bear River as well, certain changes must be made to ensure that the river flow for centuries to come.

G3.1: Reduce Water Consumption

One simple manner of reducing the quantity of diverted water from Bear River is to lower the demand for it. With consumers utilizing less water in their homes and industries, a greater amount can remain in the river to maintain and improve its flow rate. One way to accomplish this goal is through public education. Informing the public of the importance of conserving water through such actions as taking quicker showers and turning off the water when brushing their teeth can go a long way towards reducing overall water demand of a community. In the event that these relatively easy adjustments do not work, cities and counties can take the initiative and set ordinances in place that limit water use. Actions such as watering one's lawn or washing one's car can be banned in times of water stress and additional charges for using more than a predetermined quantity of water in a set timeframe can economically convince the public to use water more responsibly. The adoption of proposals such as these can ensure adequate flow and supply sufficient water to downstream communities and wildlife.

G3.2: Increase Groundwater Storage

Groundwater represents one of the vital sources of water to the Bear River year-round. Without groundwater percolation into the river, it would surely dry up in times of low rainfall. To this effect, it is imperative to maximize groundwater recharge throughout all seasons. One way of achieving this goal is through the minimization of impervious cover throughout the watershed. With less impervious cover, rainfall has a greater opportunity to percolate into the soil where it can be slowly released into Bear River over time. If impervious cover cannot be outright eliminated in some scenarios, it would be best to disconnect it as unconnected impervious area can allow for greater infiltration than connected. A more effective method of maximizing groundwater recharge however may involve the use of injection wells to improve aquifer storage during the wet season to save additional quantities for the dry season. This manner could reduce the need to draw from Bear River in times of drought, ensuring that ample flows find their way downstream. Employing such techniques previously mentioned should allow for the Bear River to flow sufficiently for future generations to enjoy.

Recommendations

It is believed that the T.E.D.I. Plan for Bear River Watershed can succeed in achieving fishable and swimmable water quality in the Bear River by 2045 through the support and willingness of the public. For this plan to come to fruition, the establishment of a governing and overseeing committee is required. This committee will include strong leaders and community representatives and will be responsible for ensuring that the tenets of the plan are successfully

fulfilled. With the support of the public and a desire to protect our local environment, the T.E.D.I. Plan will certainly lead to a better tomorrow for Bear River.

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