

UTAH SUCCESS STORY: STRAWBERRY RIVER



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RESTORATION EFFORTS DECREASE PHOSPHOROUS
LOADING IN UPPER STRAWBERRY WATERSHED

Restoration efforts in the Upper Strawberry River have led to a 91% decrease in total phosphorous loading protecting Strawberry Reservoir's cold water fishery.

Utah Success Story: Strawberry River

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PROBLEM

The Strawberry River watershed drains approximately 1,155 mi² in northeastern Utah within the Uinta Basin Watershed Management Unit. The Strawberry River begins in the south-western slopes of the Uinta Mountains and flows into Strawberry Reservoir, Starvation Reservoir, Duchesne River and eventually into the Green River. The Forest Service manages 41% of the land in this watershed. Created in 1922 for irrigation water storage, Strawberry Reservoir is one of Utah's premier cold water fisheries sustaining more than 1.5 million angler hours each year. It is also one of the principal water storage features of the Central Utah Project that delivers water to the Wasatch Front through a trans-basin tunnel for municipal and industrial uses.

Historical management of Strawberry Valley caused detrimental impacts on the hydrology of the watershed. Examples include the eradication of woody riparian species through herbicide spraying and removal of beaver dams. Increased erosion from recreational use, hydrologic modifications, grazing, and roads have led to the degradation of water quality in Strawberry Reservoir.

Investigative reports from the 1980's by the Bureau of Reclamation and Mountainland Association of Governments identified the Strawberry River and Co-op Creek as the highest tributary sources of Total Phosphorus (TP) to the reservoir. The Uinta National Forest's Management Plan and Strawberry Watershed Restoration Report of the 2000's further explained that the soils from the gray shale found along Strawberry River and Co-op Creek subwatersheds contain high concentrations of phosphorus. Runoff from this area contains phosphorus rich sediment and contributes loading to the rivers. These reports state that the Strawberry River is the largest source of sediment from bank erosion contributing 9,033 tons of sediment per year to the reservoir (63% of total sediment derived from bank erosion). In addition to an increase in TP loading, excess sediment can impair in-stream and riparian habitat crucial for fish spawning.

High TP and low dissolved oxygen (DO) in Strawberry Reservoir resulted in its being listed as impaired for its cold-water aquatic life beneficial use.

It was listed on Utah's 2004 303(d) List of Impaired Waters and a TMDL was completed and approved by EPA in July 2007.

Since there are no point sources of TP in the watershed, load reductions were allocated solely to nonpoint sources

such as soil erosion and land uses. A reduction of 1,015 lbs/year of TP loading was estimated to be required to protect Strawberry Reservoir's cold water fishery. The Strawberry River was prioritized for restoration as it contributes the highest proportion of TP loading (22%) to the reservoir and has the highest fishery habitat potential of the Strawberry Reservoir's tributaries that is underutilized due to degraded conditions.

PROJECT HIGHLIGHTS

Restoration management plans were implemented in the Strawberry River watershed in the 1980's by the USFS. The primary goals were to reduce TP loading into Strawberry Reservoir and create more favorable habitat conditions for cutthroat trout and kokanee salmon. Initial restoration activities focused on removing direct grazing pressure on the headwaters and planting woody riparian species. In 2001, other partners such as the Utah Division of Wildlife Resources (UDWR), Utah Division of Water Quality (UDWQ), Trout Unlimited (TU), and Friends of Strawberry Valley became integral for expansion of restoration measures returning the Strawberry River back to a healthy state.

Restoration objectives included reducing streambank erosion, narrowing channel width, increasing habitat complexity and lowering of water temperature through several Best Management Practices (BMPs) such as grazing management plans, re-vegetation, stabilization fabric installation, streambank protection structures, and channel realignment.

Strawberry River restoration efforts include stabilizing 13 miles of streambank with approximately 33,630 feet erosion fabric and 452 structures, creating 22 oxbow pond habitats, and improving channel alignment. Meanders were installed in straightened reaches pulling banks back to a 3:1 slope. Invasive woody species were removed and native vegetation (7,900 container stock, 19,000 cuttings, and 250 clumps) was planted connecting the river with the floodplain. Grazing pressure was decreased by installing 3 miles of exclosure fencing to prevent unrestricted cattle access in the headwaters.

Strawberry Reservoir tributary restoration projects will continue in the near future to further reduce TP loading and ultimately preserve DO in the reservoir. Mud Creek and Squaw Creek subwatersheds are targeted in 2015.

FIGURE 1. FIGURE 1. STRAWBERRY RIVER PRIOR TO RESTORATION IN 2001 HAS RAW BANKS AND NO WOODY VEGETATION.



FIGURE 2. FIGURE 2. STRAWBERRY RIVER (SAME REACH) DURING RESTORATION ACTIVITIES IN 2002 INCLUDED INSTALLING STREAMBANK STABILIZING STRUCTURES.



FIGURE 3. STRAWBERRY RIVER (SAME REACH) HAS STABILIZED 11 YEARS (2013) AFTER RESTORATION ACTIVITIES STARTED.



RESULTS

As a result of the watershed scale restoration work that has taken place, TP loading from the Strawberry River has decreased 91% since 2001.

Since 2001, the average TP load is 1,446 lbs/yr which is below the TMDL allocation for the Strawberry River of 3,025 lbs/year. Trend analysis of TP concentration over time shows no significant decrease however concentrations are below the TMDL target of 0.05 mg/L. Stable concentrations point to natural sources of pollution. There is a positive correlation between flow and concentration indicating that erosion and transport of TP during high flows is a dominant process in the watershed.

FIGURE 4. TP LOADING REDUCED BY 91% AFTER STRAWBERRY RIVER RESTORATION.

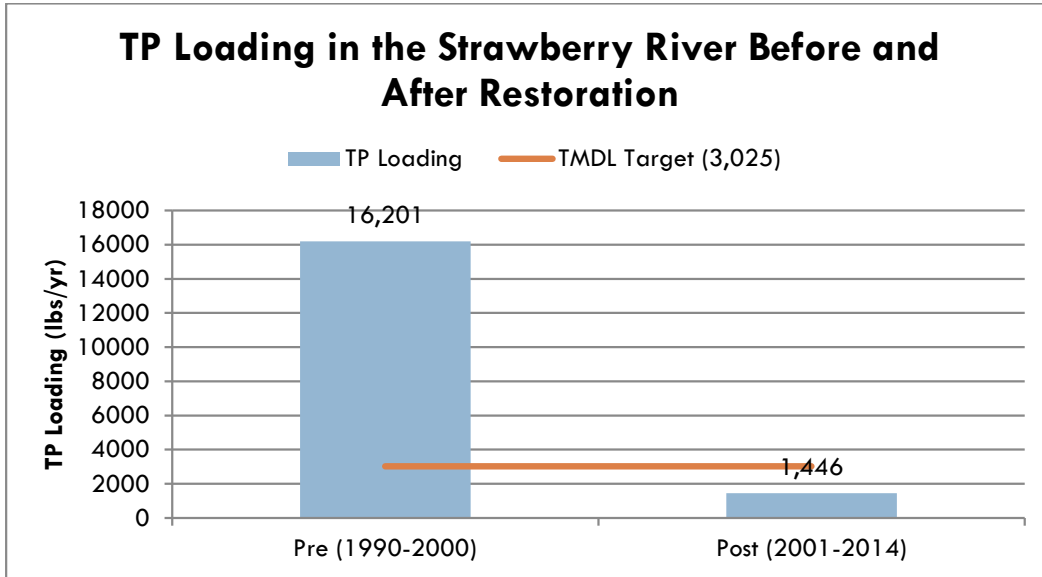
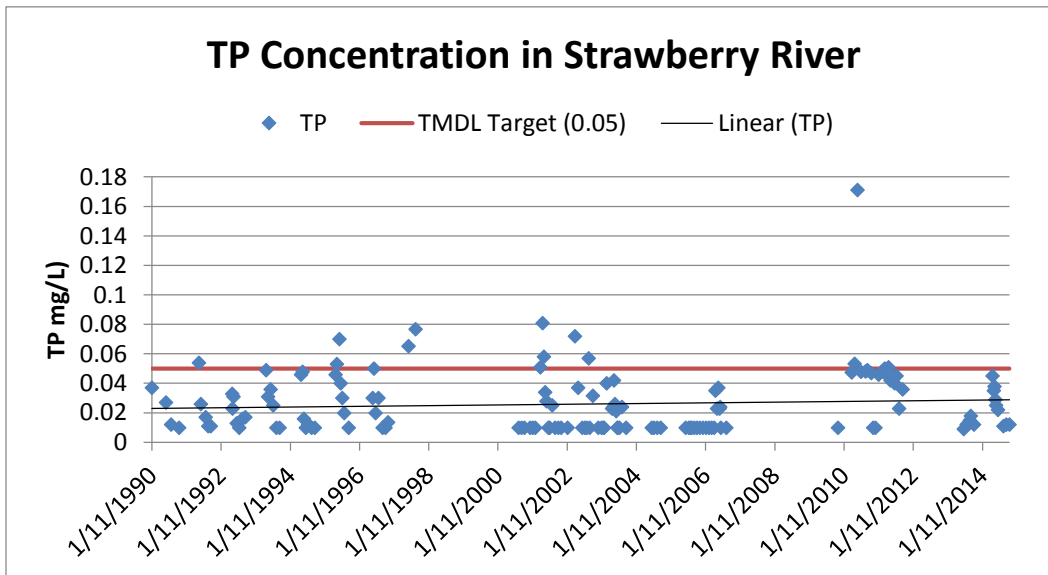
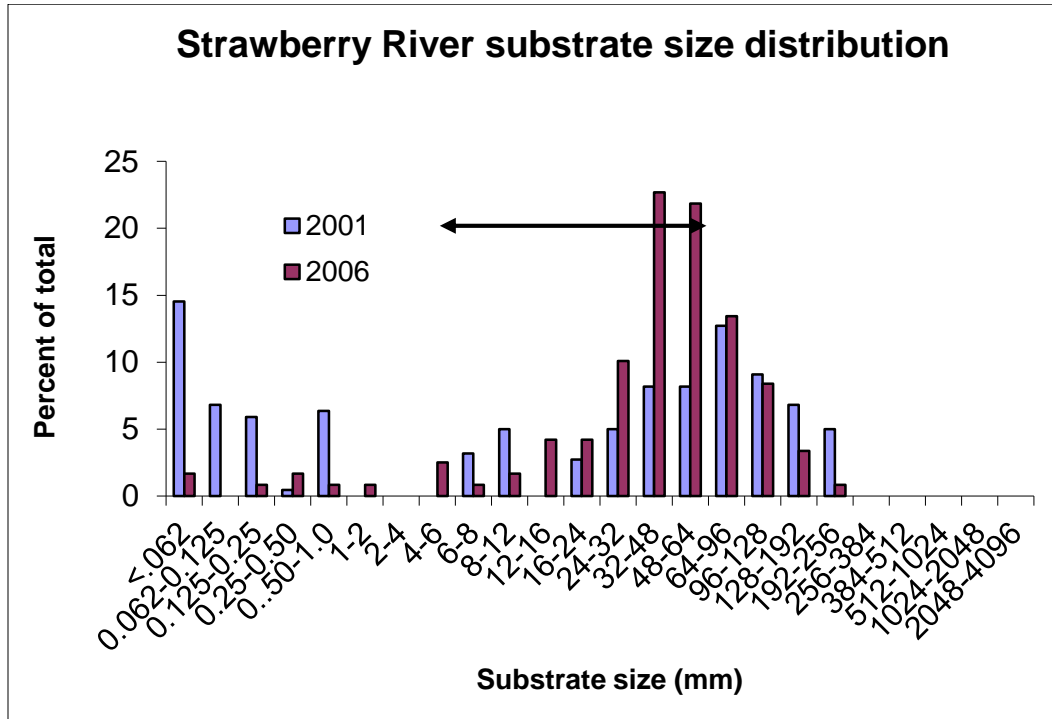


FIGURE 5. TP CONCENTRATION HAS REMAINED STABLE OVER TIME.



UDWR has monitored the physical aspects of the Strawberry River restoration project including streambed composition which influences erosion rates, sediment supply, hydraulics, and spawning habitat. Pebble counts are one way to quantify differences in substrate composition. Riffle pebbles have increased in size after restoration efforts in 2002 indicating banks are stabilizing and fines (< 1 mm) have decreased. Cutthroat Trout (CTBL) prefer spawning gravels to be between 20 – 90 mm with the absence of fines.

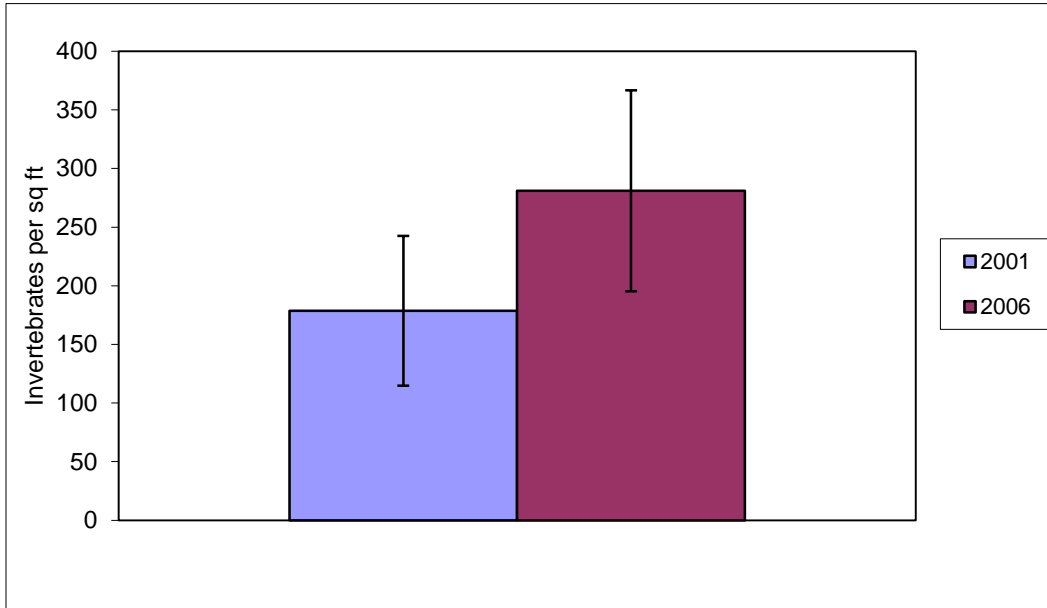
FIGURE 6. RIFFLE PEBBLE SIZE INCREASES AFTER 2003 RESTORATION PHASE. BLACK BAR INDICATES THE OPTIMAL SIZE OF SUBSTRATES FOR CTBL SPAWNING HABITAT.



The benthic macroinvertebrate populations were also measured before and after the earlier restoration phases. Strawberry River restoration enhanced the streambed with more cobble substrate resulting in increased density of invertebrates (Figure 7) though not statistically significantly. Macroinvertebrate communities will be surveyed in the last restoration phases in 2017.

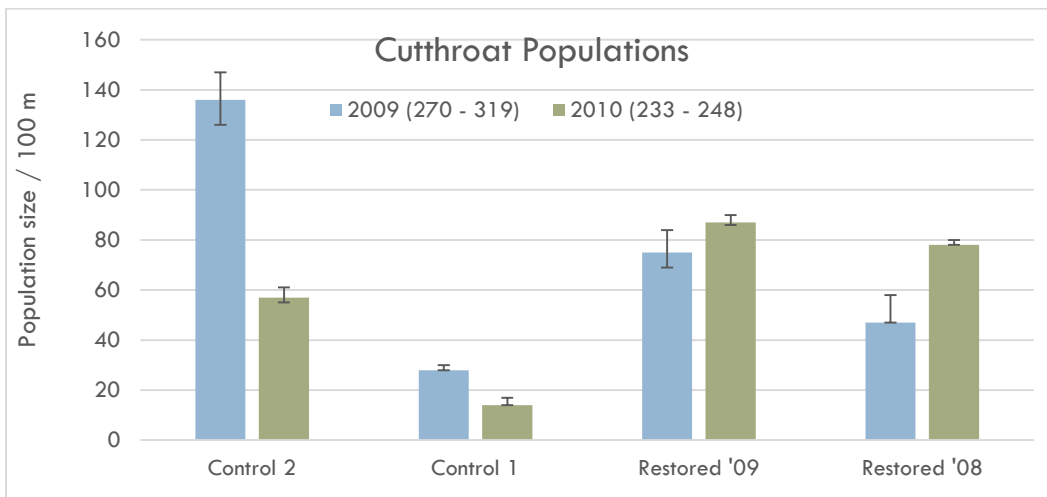
Utah State University surveyed particle size distributions in 5 reaches of the Strawberry River in 2009 and 2010. They found that a smaller percentage of fines in the restored reaches than in the untreated reaches indicating streambanks are stabilizing.

FIGURE 7. INVERTEBRATE POPULATIONS INCREASE AFTER THE 2002 RESTORATION PHASE.



UDWR and USU are continuing to monitor the fishery population in response to restoration efforts. Fishery populations are a valuable tool for assessing the success of the work. Though post restoration data collection has not been completed for this final phase of restoration, data has been analyzed for previous phases which are directly located downstream of the final phase. Figure 6 shows that cutthroat trout (CTBL) are abandoning non-restored reaches and preferentially inhabiting restored sections. CTBL were collected from two untreated reaches (control), 2008 and 2009 restored reaches. Numbers in parenthesis represent the estimated population range for all 4 study reaches in 2009 and 2010 fishery survey. Fishery populations will be surveyed again in fall 2015.

FIGURE 8. CUTTHROAT TROUT POPULATIONS' RESPONSE TO RESTORATION EFFORTS ON STRAWBERRY RIVER.



The Strawberry River restoration project has reduced erosion rates, protecting the reservoir from excess nutrient loading.

Continued implementation of restoration activities are planned for other Strawberry Reservoir tributaries. Monitoring efforts will continue until watershed implementation work has been completed and water quality standards are met. The TMDL stated that Strawberry Reservoir’s water quality conditions are currently adequate to support the fishery though the TMDL implementation plan and USFS Strawberry River Restoration Report suggest that watershed watershed-scale improvement projects will further improve water quality and sustainability of the fisheries.

PARTNERS AND FUNDING

One of the biggest successes of this project was the financial and technical support provided by partner agencies. The overall cost of the Strawberry River Restoration Project was \$1,950,286 (see Table 1 for funding breakdown). Funding sources include US Forest Service (USFS), Environmental Protection Agency (EPA), Utah Division of Wildlife Resources (UDWR), Utah Division of Water Quality (UDWQ), Watershed Restoration Initiative (WRI), Habitat Council (HC), and Blue Ribbon Fisheries Advisories Council (BRFAC). Other project partners include Utah State University, Friends of Strawberry Valley (FOSV), Trout Unlimited (TU), and Spring Creek Natives Nursery.

TABLE 1. FUNDING SOURCES OF STRAWBERRY RIVER RESTORATION.

Year	BRFAC	HC	EPA 319	ARRA	WRI	Utah NPS	USFS (NEPA)	In-kind	Yearly Total	Miles (river) completed
2002		\$94,000					\$20,000	\$23,258	\$137,258	0.87
2005	\$39,952	\$29,210					\$20,000	\$2,750	\$91,912	0.92
2008	\$50,583	\$50,583	\$61,231		\$40,000		\$20,000	\$148,205	\$370,602	1.05
2009	\$38,500						\$30,000	\$7,100	\$75,600	0.4
2010				\$539,787				\$5,600	\$545,387	4.7
2012		\$30,500				\$20,927		\$1,200	\$52,627	Repairs
2013	\$40,000	\$40,000	\$115,000		\$40,000		\$30,000	\$7,400	\$272,400	
2014	\$60,000	\$60,000			\$60,000			\$4,200	\$184,200	
2015	\$20,000	\$20,000	\$156,000		\$20,000			\$4,300	\$220,300	5.2
Totals	\$249,035	\$324,293	\$332,231	\$539,787	\$160,000	\$20,927	\$120,000	\$204,013		13.14
Grand Total									\$1,950,286	