Tumalo Creek Restoration Project
Monitoring Report 2008

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Introduction: This report summarizes monitoring conducted on the Tumalo Creek Bridge to Bridge Restoration Project, implemented on the Deschutes National Forest, Bend/Ft. Rock Ranger District between 2004-2007. This report contains monitoring information on fish populations, planted vegetation, and physical stream attributes.

I. Fish Populations: Electrofishing surveys were conducted within all three Phases of the Tumalo Creek Bridge to Bridge Restoration Project to determine the response of fish populations to stream restoration work. Each survey was conducted prior to and two or three years post-restoration. The stream is inhabited by the native redband trout and the non-native eastern brook trout. The three sites were approximately 100 meters in length and were in areas that underwent major reconstruction during the restoration.

Methodology: Multi-pass depletion surveys with block nets and battery-powered Smith-Root backpack electrofishers was the method employed for all pre-project surveys. Post project fish surveys were accomplished with mark-recapture, with the exception of the main channel of Phase I where a depletion survey was used. Caudal fin clips were used to mark fish in the mark-recapture surveys. In all surveys, all fish captured were measured for fork length and released. Some individuals were weighed to develop a Condition Factor.

Table 1. Fish Population Surveys

Phase	Pre-Project Survey Date	Method	Restoration Completion Date	Post-Project Survey Date	Method
I	8/18/2004	Depletion	10/2004	8/31/2006	Depletion/Mark-Recapture
II	8/18/2004	Depletion	9/2005	8/13/2007 8/14/2007	Mark-Recapture
III	7/29/2005	Depletion	8/2006	9/18/2008 9/19/2008	Mark-Recapture

Photograph 1. **Electrofishing Survey**

Table 2. Fish Population Survey Results

Station	Pre or post project	Date	Channel Location	Redband population estimate (95% CI)*	Redband/ 100m	Brook population estimate (95% CI)	Brook/ 100m	Total fish population estimate	Total fish/100 m
Phase I	Pre	8/18/04	main	30 (17-44)	25	60(50-69)	50	90	75
Phase I	Post	8/31/06	main	42 (23-60)	42	73 (67-78)	73	115	115
Phase I	Post	9/07/06	Side channel	65 (29-162)	65	522 (410-663)	522	587	587
Phase I	Post	8/31/06 and 9/07/06	Side and main channels	107	107	595	595	702	702
Phase II	Pre	8/18/04	main	29 (24-34)	35	63 (55-71)	75	92	110
Phase II	Post	8/13 and 8/14/07	main	28 (11-69)**	33	173 (82-398)	204	201	237
Phase III	Pre	8/31/01	main	11(7-16)	21	21 (0-45)	39	32	60
Phase III	Pre	10/10/02	main	16 (10-22)	15	50 (35-64)	46	66	61
Phase III	Pre	7/29/05	Main and side channel	31 (27-35)	28	160 (149-171)	144	191	172
Phase III	Post	9/18 and 9/19/08	Main and side channel	68 (34-148)	59	179 (124-269)	155	247	214

* 95%CI = 95% Confidence Intervals. The population is likely to fall within the range given 95% of the time.
** This population was biased because of the small number of fish recaptured.

Within the Phase I study area, the creation of the side channel and available habitat achieved during restoration increased the numbers of fish post-project. Fish population estimates increased from 75 per 100 meters channel length pre-project to 702 per 100 meters post-project, primarily due to the large numbers of fish inhabiting the newly created side channel. This survey was conducted within a reach that received more extensive restoration than the rest of the Phase I project area, and would be considered atypical of the entire phase. Project work throughout the remainder of this phase was primarily main channel restoration, with a minor component of side channel creation. The increase in fish populations observed within this study area is likely not as pronounced in other areas within Phase I.

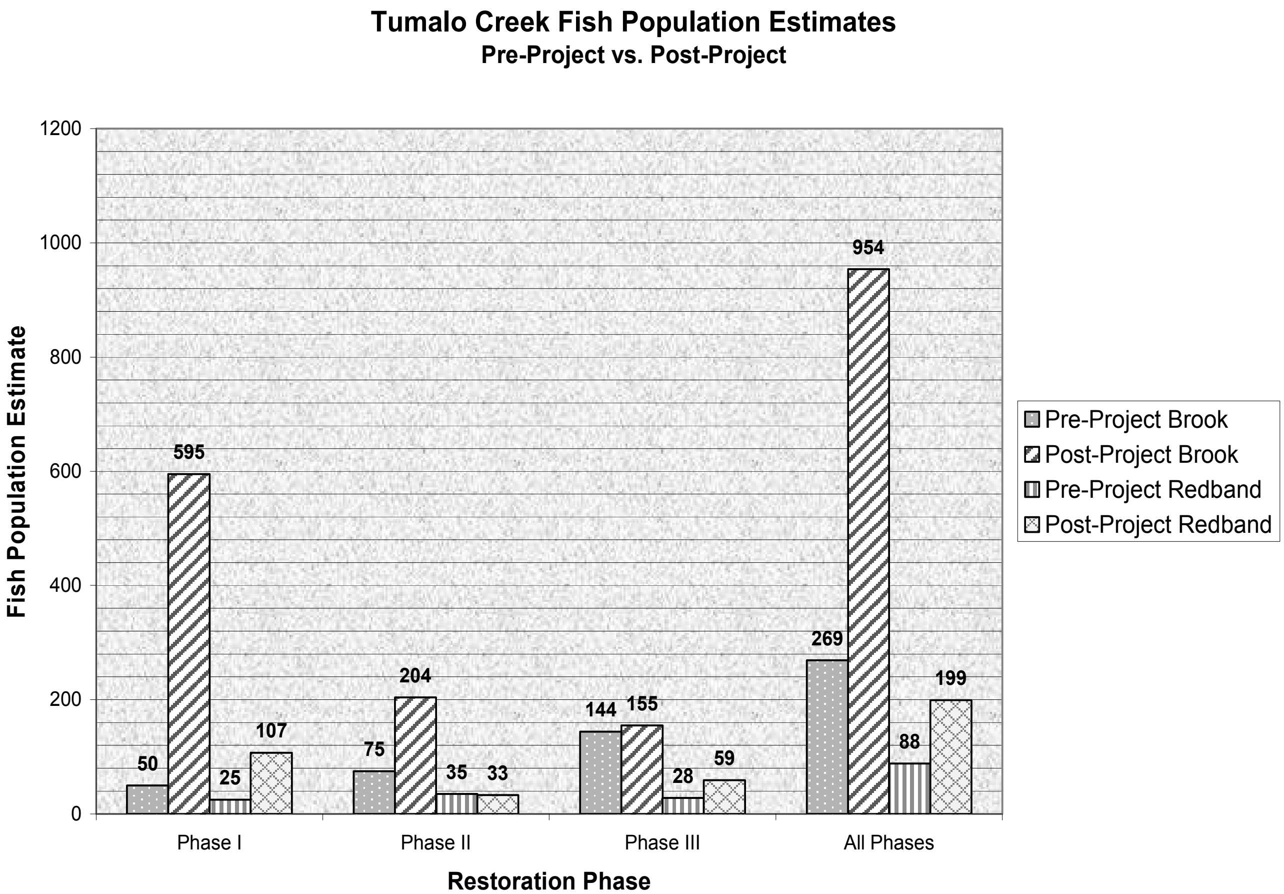
Within the Phase II study area, the fish population estimate increased from 110 fish per 100 meters to 237 fish per 100 meters due to an increase in the brook trout population. This study area did not include side channel creation.

The Phase III study area fish population estimate increased from 172 to 214 fish per 100 meters. The pre-project fish population was higher than the other study areas likely due to accumulations of large wood that had drifted down from above. These accumulations were temporary and unstable, likely to move out at the next high flow event. This area had also been assessed for fish populations prior to some prior restoration work in 2001 that had relocated a portion of the channel and placed boulder structures (8/31/2001 and 10/02/2002 data in table above). The fish population estimates were only 60 and 61 fish per 100 meters at that time. While both fish species exhibited significant increases, the brook trout population had the greatest increase, primarily due to large numbers found within the side channel habitat of the Phase I study area.

No control reach outside of the project area was surveyed. Channel types and habitat conditions upstream and downstream of the nearly 3 mile project area differed from within the project area, making a control area difficult to establish. In addition, due to velocities outside of the project area because of steeper channel gradients, placing block nets as part of the survey protocol was infeasible. However, when comparing pre-project data sets from multiple years, and other survey work done in Tumalo Creek in the recent past, the fish population was fairly consistent at a range of 60 to 75 fish per 100 meters channel length. This range may represent what would have been found within a control reach and that of un-restored areas. The restoration work has significantly increased the fish population above this range.

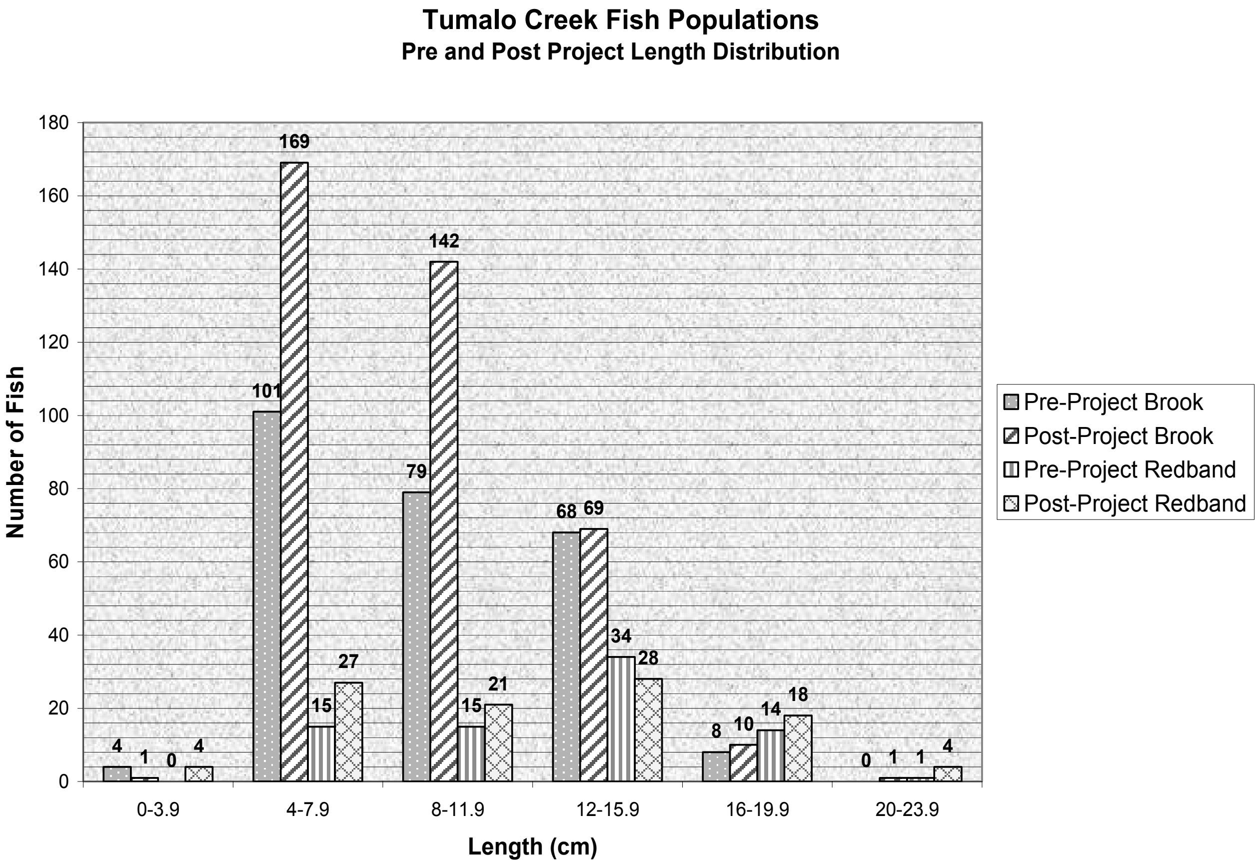
The graph below demonstrates the fish population estimates for both species in all three restoration phases.

Figure 1.



The graph below demonstrates the length frequencies of both fish species pre and post restoration for all phases. Demonstrated is the increase in brook trout, primarily smaller fish associated with side channels which serve as rearing habitat. There was also a slight increase in larger redband trout (>16 cm). The numbers represent what was actually captured and measured rather than the population estimates.

Figure 2.



Several individual fish were weighed when measured for length to derive condition, or well-being of the fish. A Fulton Condition Factor (K) was used to evaluate condition, where K = (W/L^3) x 100,000 (metric units). The higher the number, the heavier the fish is for its length and in better condition. Brook trout pre-project K values ranged from 0.51 to 1.78 with an average of 1.14 (N=79), while post-project K values ranged from .85 to 1.3 with an average of 1.09 (N=43). Redband pre-project K values ranged from .84 to 1.66 with an average of 1.24 and post-project values ranged from 1.06 to 1.38 with an average of 1.17 (N=12). Post-project K values were slightly decreased from pre-project values. The small number of individuals measured post-project may have contributed to the difference.

II. Vegetation Monitoring

Restoration of Tumalo Creek included planting of over 71,000 native riparian shrubs and trees, primarily from rooted stock sourced from on-site or nearby locations. Plots were established within Phase I in the fall of 2004 to monitor plant growth, survival, and effectiveness of browse protection. Numbered metal tags were attached to plants within the plots. Willow and alders were the primary species planted for restoration and were the species monitored in the plots. Plants were measured for height at the time of planting and again 3 years later.

Table 3. Planted Vegetation Results

Plot #	Species	Number of plants measured	Ave. 2004 height (ft)	Ave. 2007 height (ft)	Ave. Increase (ft)	Ave. 2007 crown width (ft)
1 (Reach 12)	W	26	.67	1.36	.69	1.08
2 (Reach 11)	W	58	.91	3.18	2.27	2.84
Weighted Average	**W**		**.84**	**2.61**	**1.77**	**2.29**
1 (Reach 12)	A	23	.22	1.69	1.47	1.28
2 (Reach 11)	A	24	.32	3.08	2.76	1.95
Weighted Average	**A**		**.27**	**2.37**	**2.10**	**1.62**

An objective of the vegetation plots was to monitor plant survival. However, due to substantial loss of tags after high flow events and lateral channel migration, determining survival rates became impractical. Visual observation suggests survival rate was high, perhaps 80% or greater, but losses were experienced where the channel migrated laterally into the plots, washing plants away. Initially in 2004, several hundred plants were provided with vexar plastic browse protection. Monitoring revealed little animal browsing occurring in the first year, therefore browse protection was not used in subsequent years.

The table above includes crown width measurements. This parameter was not collected in previous years making a comparison over time impossible.

The photographs below, taken in October 2008, depict the plants in all three restoration phases. Plants were not measured for height in 2008, but individuals were near 7, 8, and 3 feet height for Phases I, II, and III, respectively. The rod in the photographs is 9.5 feet tall.

Photograph 2. Phase I Plants

Photograph 3. Phase III Plants

Photograph 4. Phase II Plants

III. Physical Stream Attributes

A Forest Service Region 6 Level II stream survey was conducted pre and post-project within the entire 2.8 mile restoration reach to assess some physical stream attributes. Pre-project surveys were conducted in 2004-2006 by phase just prior to restoration each year. A post-project survey was completed within the entire reach during July, 2008. Post-project data for average bankfull depth, average bankfull width, average bankfull width:depth ratios and ranges of width:depth were derived from a Total Station Engineering Survey (completed in late summer of 2007) rather than the stream survey, and was limited to data collected at only 7 cross-sections. The table below compares some of the parameters generated from the surveys.

Pre or Post	Date of Survey	Ave. Bankfull Depth (ft)	Ave. Bankfull Width (ft)	Ave. Bankfull Width: Depth	Range of Width: Depth	# Pools /mile	Ave. Residual pool depth	Pieces of Wood/ mile	% Unstable Stream-banks
Pre	2004-2006	1.92	42.1	23.3	17-181	14.3	2.3	89	12.5
Post	7/2008	1.56	43.7	29.1	19-37.3	20.7	2.2	212	3.3

The stream surveys indicated an increase in the number of pools within the project area, increasing from 14.3 to 20.7 post-restoration. The frequency of large woody material increased from 89 pieces/mile to 212 pieces/mile. Due to survey protocol, not all wood present would end up being counted. For example wood above the bankfull depth and on or buried in the floodplain would not be counted. The restoration project added considerable large woody material to these specific areas that did not result in an increase in the large woody material count. The frequency of unstable streambanks decreased from 12.5% pre-project to 3.3% post-project (i.e., stable banks increased from 87.5% to 96.7% post project). The average residual pool depth remained relatively the same. The average residual pool depth is an indicator of pool volume - the higher the residual pool depth the greater the pool volume.

Determining an accurate bankfull, the key indicator for calculating bankfull width and depth, is difficult on a newly constructed channel, therefore was not collected during the stream survey. Bankfull determinations for the post-project survey were derived from cross-sectional data collected during the Total Station surveys. The average bankfull widths remained relatively constant (slight increase) between the two surveys despite the restoration goal of decreasing bankfull widths. The range of values for bankfull widths was decreased post-project, indicating a narrower, deeper channel was created in areas at the high end of the range. The average bankfull depth decreased, therefore the width:depth ratios decreased. The post-project survey technique for arriving at average bankfull depth differed from that collected during the pre-project stream survey with the former considered to be more detailed and accurate. The limitation of only 7 data collection sites and the differing techniques between surveys makes pre and post – project comparison difficult for the bankfull calculations.