Preliminary Results of 2009-2012 Pool Change Analysis
Technical Brief
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NOTE: This is a preliminary draft that has received no review of any sort.

Background

The Trinity River Restoration Program (TRRP) implements the channel rehabilitation and gravel augmentation activities prescribed in the Trinity River Mainstem Fishery Record of Decision issued by the U.S. Department of the Interior (ROD 2000). At present, TRRP has completed about half the mechanical rehabilitation projects called for in the ROD, and has also been adding variable quantities of gravel to the river on a near-annual basis since 2006.

Various public stakeholders have long expressed concerns that gravel additions to the river could result in the filling of some of the deep pools used as holding habitat by adult salmonids. Concern over the potential for pool filling intensified in late 2010 when a perception became widespread among local fishermen that holes and runs were filling with sediment throughout the river. TRRP responded to this public input by eliminating mobile gravel placements from its 2012 channel rehabilitation projects and suspending high-flow gravel augmentations during the 2012 spring flow release.

In addition, TRRP responded to the stakeholder concerns by initiating efforts to investigate the status of pools and holes of interest to the fishing community to evaluate whether widespread changes in pool depths are indeed occurring, where they are occurring, and why. Timely reporting of any findings regarding these issues is critical for TRRP and stakeholders to make informed decisions about upcoming rehabilitation activities. Although these investigations are ongoing and reports have not yet been written, much of the data reduction and analysis is complete. This technical brief summarizes the information and results that are currently available. A more comprehensive report will be prepared later.

Analysis Methods

Changes in pool depths over two different time periods were evaluated using different analysis methods. One analysis provides an historical context by considering pool depth changes over multiple decades using historical data sources, and the other evaluates recent changes in pool depths with an analysis of 3 sets of bathymetric sonar data collected since 2009. Only results connected to changes since 2009 are reported here.

The first of these 3 sonar data sets was collected over about a 3-month period spanning November 2009 through mid-January 2010. These data were collected to be included in a new system-wide terrain model that was being developed with terrestrial and bathymetric LiDAR flown in early April 2009. The bathymetric LiDAR used in that effort was found to be unreliable in water deeper than about 3 feet, so Graham Matthews and Associates

(GMA) was engaged to obtain bathymetric sonar data in as many relatively deep areas of the river as possible prior to the onset of the winter storm season. Collection was performed with a single sonar transducer (with integrated GPS) mounted on a jet boat or raft. This effort resulted in the acquisition of patches of sonar data in more than 160 locations scattered throughout the 40-mile TRRP project area.

A second set of sonar data was collected in the summer of 2010 and in the early winter of 2011, prior to any large winter storm events and before the 2011 flow release. These data were collected specifically to support this pool change analysis, so particular pools were identified for survey. By this time GMA had upgraded their sonar collection methods to include simultaneous collection with 2 transducers, so these surveys resulted in much higher data density than the 2009 surveys. This effort resulted in the acquisition of 59 patches of sonar data.

The final sonar data set was acquired in the summer of 2011 and in the early winter of 2011, prior to any large winter storm events and before the 2012 flow release. GMA was initially asked to survey a large number of deep areas to support this pool change analysis. This survey effort was later expanded to include nearly complete bathymetric coverage to support the development of a new system-wide terrain model that is currently under development. GMA again upgraded their sonar collection methods, and by completion of this larger effort had the capacity to simultaneously collect data with up to 7 transducers. This final data set is therefore extraordinarily dense and covers a large area. A subset of 119 patches of sonar data was extracted from this very large data set for use in this pool change analysis.

The spatial extents of these 3 sets of sonar were intersected by overlaying polygons defining the patches in a GIS. The result was 141 polygons in which data available from different years overlapped completely. These include 93 polygons in which data from 2 of the years can be compared (2009-2010, 2009-2011, or 2010-2011) and 48 polygons in which all 3 years can be compared, for a total of 237 comparisons. Where possible, the locations are assigned commonly-used names or names corresponding to nearby landmarks. Otherwise, they are named according to their river mile location. All but a few of the 141 locations correspond to areas of relatively deep water, and a preliminary classification assigns most of them to one of the following pool types: hole, trough, convergence, backwater, or pool. However, no attempt is made to delineate the boundaries of what is or is not adult holding habitat. Instead, depth characteristics are assessed over whatever portions of the channel that happens to be included in the overlapping data.

The comparisons themselves are achieved by gridding the sonar data for each year in each polygon in a GIS to create sets of co-registered grids with a 3-ft pixel resolution. A nominal baseflow water surface elevation assigned to each polygon area was then used to compute water depth for each grid pixel. The depths were then exported to text format and processed with a Perl script to compute depth histograms and summary statistics such as mean depth, the standard deviation of depths, and depth quantiles.

Preliminary Results

The depth characteristics of the surveyed areas can be effectively displayed with cumulative frequency curves of bed depth. Some examples illustrating how different types of change are reflected in the curves are given below.

Figure 1 shows the fraction of the bed area that exceeded the specified depth in each of the 3 years at Junction City Hole, a location that has seen little change in recent years. The curves shown on Figure 1 can be used to infer depth quantiles indicating a general lack of net change at Junction City Hole. For example, the median depth in 2009 of 8.5 ft decreased to 8.3 ft in 2010 before increasing to a maximum of 8.65 ft in 2011. Similarly, the 75th-percentile depth ranged from 11.9 to 12.7 ft, and the 90th percentile depth ranged from 16.2 to 16.9 ft, with the minimum and maximum values also occurring in 2010 and 2011, respectively. The average depth ranged between 9.15 and 9.46 ft with the net change from 2009 to 2011 totaling just 0.11 ft (deeper).

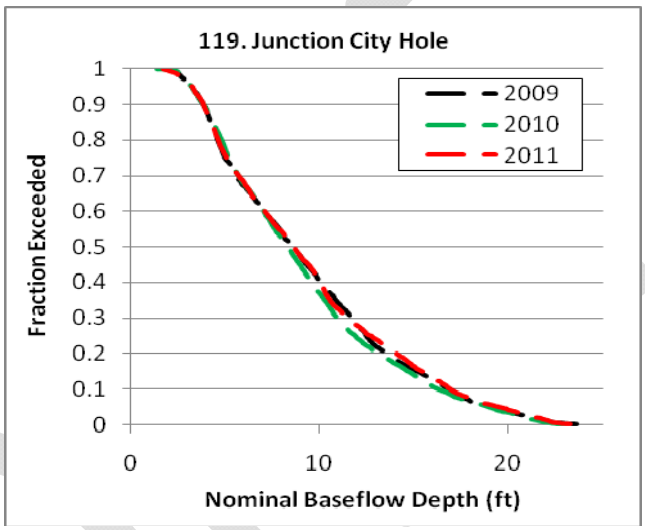

Figure 1: Depth exceedancce curves for the Junction City Hole.

Wellock Pool provides an example of a pool that experienced extreme aggradation (Figure 2). Those curves indicate little change between 2009 and 2010, but clearly show the transformation that occurred during the 2011 flow release. Prior to the release, the median, 75th-percentile, and 90th-percentile depths were 4.3, 5.07, and 5.76 ft, respectively. After the release, they were just 0.8, 1.9, and 4.2 ft.

Changes in the shapes of the curves reflect changes in the shape of the pool itself. For example, it can be seen in Figure 2 that the maximum depth decreased relatively little compared to changes in areas of moderate depth. Prior to the release, Wellock Pool was a topographically simple region of moderate depth, that is, close to 70% of the area was between about 4 and 6 ft in depth (the steep slopes of the 2009 and 2010 exceedance curves are indicative of this kind of simple geometry). In contrast, the 2011 exceedance curve has a much lower and more variable slope. The pool contracted in extent due to the deposition of a bar that emerged above the baseflow water surface along the left bank

(hence the negative depths), but maintained a small area of moderately deep water near the right bank. It is relevant to note here that Wellock Pool was created by mechanical dredging in the late 1980s, and the changes that occurred during the 2011 flow release essentially returned the channel geometry at that location to its pre-dredge configuration.

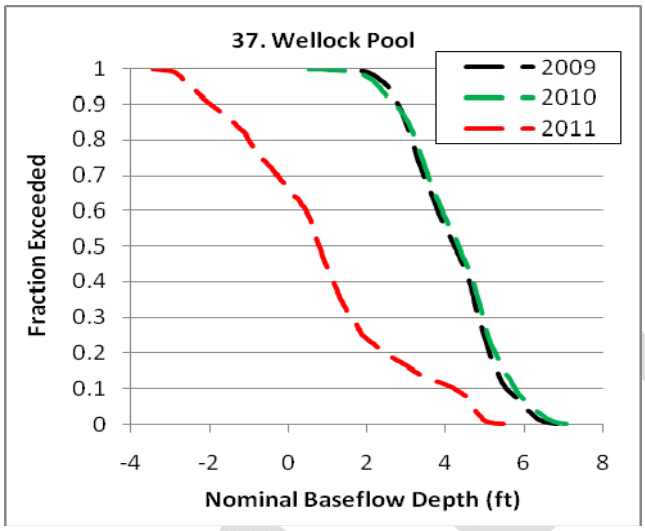

Figure 2: Depth exceedancce curves for Wellock Pool.

A third example (Figure 3) shows Alcatraz, a location where more moderate pool filling occurred. This example demonstrates how the kind of pool filling noted by stakeholders is captured by depth exceedance curves. The curves show that Alcatraz deepened slightly between 2009 and 2010 (median depth increased from 7.1 to 7.7 ft), then aggraded significantly during the 2011 flow release. The median, 75th-, and 90th-percentile depths decreased by 2.9, 2.5, and 1.6 ft, respectively, from 2010 to 2011. Again, aggradation was greater in shallower areas, indicating that the size of the pool decreased more than its maximum depths.

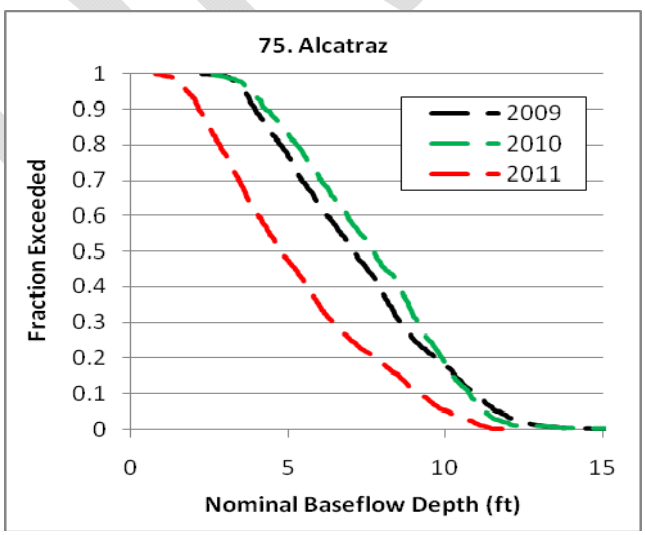

Figure 3: Depth exceedancce curves for Alcatraz.

In a few locations, new pool-like areas formed in places where the pre-existing channel morphology was relatively shallow with simple bed topography. The Lowden floodplain convergence area is an example (Figure 4). This is an area at the downstream end of a funnel-like floodplain that was constructed at the Lowden Ranch site and was designed to cause flow convergence and scour at its downstream end. Implementation of the design resulted in an increase in the median, 75th-, and 90th-percentile depths from 3.7, 4.0, and 4.2 ft in 2010 to 4, 4.7, and 5.1 ft in 2011. While these depths are modest compared to the depths found in true "holes," they are similar to the depths found in areas fishermen often refer to as "steelhead runs."

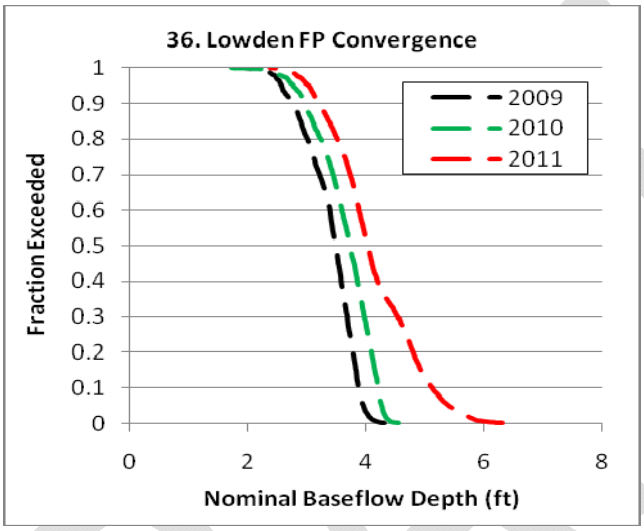

Figure 4: Depth exceedancce curves for the Lowden floodplain convergence area.

Several inter-related results can be inferred from the complete set of changes illustrated by all 141 cumulative depth graphs. First, with a relatively small number of exceptions, depth changes were generally small. For example, the average change in the median depth from 2009 to 2011 across all 141 locations was just 0.08 ft (an increase in depth).

Secondly, the exceptions – places where substantial decreases in depth were observed – are generally special locations where the cause of the aggradation is clear. Wellock Pool and Alcatraz, both of which aggraded substantially during the 2011 flow release (Figure 2 and 3), are cases in point. Aggradation in Wellock Pool is clearly associated with the fact that the 2010 rehabilitation actions at Lowden Ranch and Trinity House Gulch were immediately followed by the largest restoration flow release ever implemented on the river. Construction and gravel augmentation at Lowden Ranch greatly increased the gravel supply to Wellock Pool, while channel modifications at Trinity House Gulch significantly reduced the sediment transport capacity at the downstream end of the pool. As a result, the area encompassing Wellock Pool and the upstream end of the Trinity House Gulch site underwent the largest fluvially-driven channel reconfiguration observed on the Trinity River since the pre-dam era.

Aggradation at Alcatraz also appears to be a direct consequence of nearby channel rehabilitation activities. The Reading Creek project, which was constructed in the fall of 2010, included substantial lowering of the inside of a large channel bend adjacent to Alcatraz. Prior to that surface lowering, the bulk of flood flows followed the channel around the bend where it would impinge on the bedrock wall along the right bank at Alcatraz, creating strong turbulence and bed scour. Lowering of the surface allowed a much larger proportion of flood flow to cut across the bend, thereby reducing the potential for scour at the base of the bedrock wall. This cause of aggradation can be inferred at several other special locations where bed aggradation occurred adjacent to areas of surface lowering, including Sawmill Burner Hole, the Bend at Reading Creek, and the formerly deep runs adjacent to the Salt Flat constructed floodplain.

A third result apparent in these data is a clear spatial pattern in which areas of polygons showing net fill occur clustered in particular reaches, while long sections of channel elsewhere are dominated by net scour. The reaches in which fill predominates are often, but not always, in the vicinity of specific types of channel rehabilitation activities. The overall spatial pattern is shown in Figure 5.

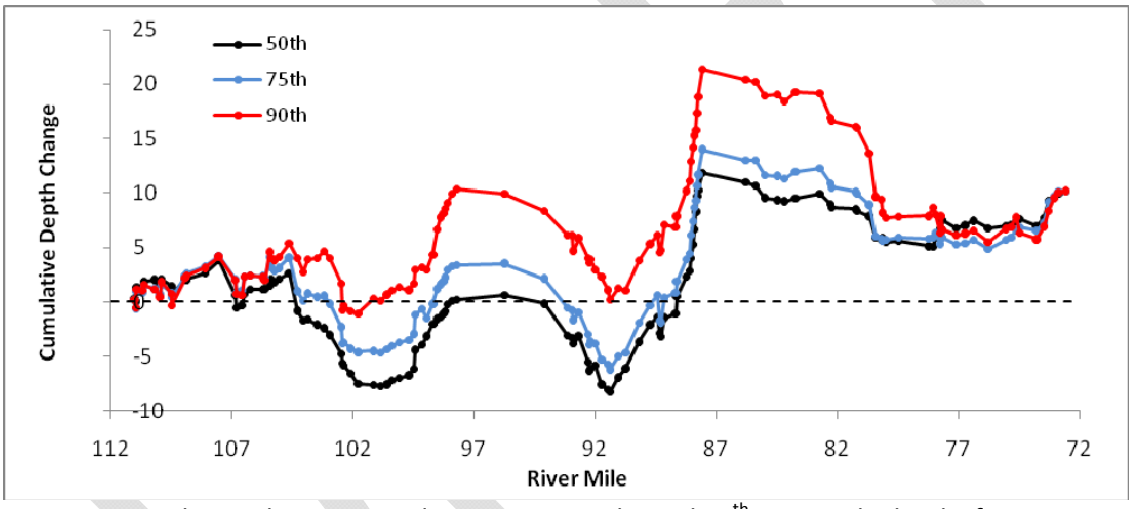

Figure 5: Cumulative change in median, 75-percentile, and 90th-percentile depths from upstream to downstream for all 141 areas analyzed.

The pattern of scour and fill shown in Figure 5 can be considered at several spatial scales. At a relatively large scale, 7 stream segments with different scour/fill characteristics can be identified. The most upstream segment (Segment 1) extends from near Lewiston Dam to River Mile (RM) 104.65 (near the downstream end of the Lowden Ranch rehabilitation site) and corresponds to the Lewiston area. This segment shows an irregular pattern of net scour and fill that, at a finer spatial scale, can be linked to specific rehabilitation actions. Substantial areas of fill in this segment are located in the reach just upstream from Cemetery Hole and adjacent to the constructed Salt Flat floodplain with the Dark Gulch project boundaries. Substantial fill is known to have occurred at the Sawmill Burner Hole, but is not shown on Figure 5 because it occurred prior to 2009. Cemetery Hole itself is also missing from the graph because sonar collected at that location in 2009 was of insufficient quality for this analysis. A rudimentary point-to-point comparison using

the 2009 data suggests moderate fill in that hole between 2009 and 2010, whereas comparison of the higher-quality data from 2010 and 2011 shows that the hole deepened slightly in 2010-2011.

Segment 2 extends from Wellock Pool to RM 101.8, which corresponds to Snell Pool (which is the next pool downstream from Society Pool). This segment shows a consistent tendency for fill, although in most cases the magnitude of the fill is small. The exceptions are at Wellock Pool itself and a formerly-deep run in the center of the Trinity House Gulch rehabilitation site that is referred to here as "Little Tree." Those two spots account for fully half of the total net fill measured for the entire segment.

A switch to consistent pool scour just downstream from Snell Pool defines the beginning of Segment 3, which extends downstream for 6 river miles through the remainder of the Poker Bar canyon to the upstream part of the Indian Creek backwater pool at RM 95.75. This existence of this long stretch of river characterized by pool scour is a strong indication that any local excesses of gravel that may exist in the Lewiston area have not propagated downstream through Poker Bar Canyon.

The 4th segment apparent in Figure 5 is a stretch of river from RM 94.1 (the Hwy 299 bridge at Douglas City) to RM 91.5 ('Skeletor' hole, off Steiner Flat Road) that is characterized by consistent fill. The upstream end of this segment is immediately downstream from Weaver Creek and Indian Creek, both of which contribute significant sediment loads to the river. Sediments delivered from these tributaries that have accumulated over the past 50 years have only recently been activated by increased flows and other changes. However, locations with relatively large amounts of fill include the vicinity of Alcatraz (Figure 3) and a portion of "The Bend" near the mouth of Reading Creek. Both of these locations are adjacent to terrace areas that were lowered as part of the Reading Creek Rehabilitation project in 2010.

Segment 5, which is dominated by net scour, begins at Skeletor and extends through the Junction City canyon to RM 87.6 near Dutch Creek. Net fill was observed at only one location within this nearly 4-mile stretch – just downstream from Goat Hole where bank erosion caused an eddy hole to migrate to a new position.

A tendency for minor net pool filling resumes in Segment 6, which begins at Dutch Creek where the river emerges from the canyon and flows across a wider, more alluvial valley bottom, and ends with the Upper Junction City pools located upstream from the Dutch Creek Bridge. At the time of data collection, TRRP had conducted no restoration activities within this segment or within 5 miles of its upstream boundary.

The final segment, Segment 7, extends from the Junction City Hole, located just downstream from the Dutch Creek Bridge, to the North Fork Trinity River. This segment exhibits no consistent trend toward either scour or fill.

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Preliminary Summary Conclusions

Pools in two relatively long segments of river between Lewiston Dam and the North Fork Trinity River are dominated by scour. Pools in three other river segments show a tendency toward minor fill, while pools in two additional reaches show no consistent tendency either way. Overall, pools appear to have maintained approximately constant depths over the study period with perhaps a small bias toward scour.

Larger amounts of fill were observed at a relatively small number of pools and runs in the Lewiston and Douglas City areas. In nearly all cases, fill at these locations can be directly linked to rehabilitation actions, and in particular to the lowering of terraces adjacent to the pools with or without associated gravel placement. This information has been incorporated into current rehabilitation designs, which explicitly consider the potential effects of terrace lowering and channel widening on pool maintenance.

Minor amounts of fill at various other locations in the study area are probably the result of natural fluvial processes, such as recent activation of sediments delivered from tributaries and increased bank erosion due to ROD flow releases.

Reaches dominated by net scour separate areas where fill is prevalent, suggesting that the effects of any recent local increases in the gravel supply due to gravel augmentation have not propagated far downstream. In particular, the long river segment dominated by scour between Douglas City and Junction City is strong evidence that minor pool filling detected in the Junction City area is unrelated to upstream rehabilitation activities.

References

ROD. 2000. *Record of Decision: Trinity River mainstem fishery restoration final environmental impact statement/environmental impact report*. U.S. Department of the Interior, Washington D.C.

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