Evaluation of Mill Creek Flushing Flow August 19-22, 2006

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Introduction
Montana Fish, Wildlife and Parks (FWP) contracted with the Mill Creek Water District to cease diversions from Mill Creek for approximately a 60-hour period in order to move or flush Yellowstone Cutthroat and Rainbow Trout fry and young fish into the Yellowstone River. The Water District agreed to cease diversion no later than 10 PM, August 19, 2006 with partial resumption of diversion beginning approximately 6 A.M., August 22, 2006 and full diversion resuming no sooner than 10 A.M. than same day.

Monitoring
Hydrologic and biologic results of the flush were monitored from August 19 through August 22.

We installed two TruTrack® stage (water level) recording devices. The upstream stage recorder was installed in Mill Creek at the bridge near the mouth of Mill Creek Canyon at approximately stream mile 5.4 while the downstream stage recorder was installed in Mill Creek at the bridge on the East River Road about 0.4 stream miles upstream from the confluence with the Yellowstone River (Figure 1). The map in Appendix A depicts these locations.

Figure 1. Mill Creek, August 19, 2006, prior to flush at East River RD Bridge. Stage recording device is being attached to bridge abutment.

For the upstream recording station, we developed a stage-discharge relationship based on flow measurements at different stages and a survey of the channel to determine the stage at which water would no longer flow. The stage recorders collected water height data every 5 minutes. This stage data could then be converted to flow data using the stage-discharge relationship. For the downstream recording station, we measured flow to verify that an existing stage-discharge relationship developed by the U.S.

Geological Survey in November 2005 was valid. As with the upstream location, this allowed the recorded stage data to be converted to flow data.

The flow data is represented in Figure 2. The flow data used in this chart are the hourly averages for the respective stations. The flow is measured in cubic feet per second (cfs) where one cfs equals 40 miner's inches. The time scale is in hours with hour 1 being equivalent to the average flow from 6 pm to 7 pm on August 19. Similarly hour 6 would correspond to the average flow from 11 pm to 12 am on August 19.

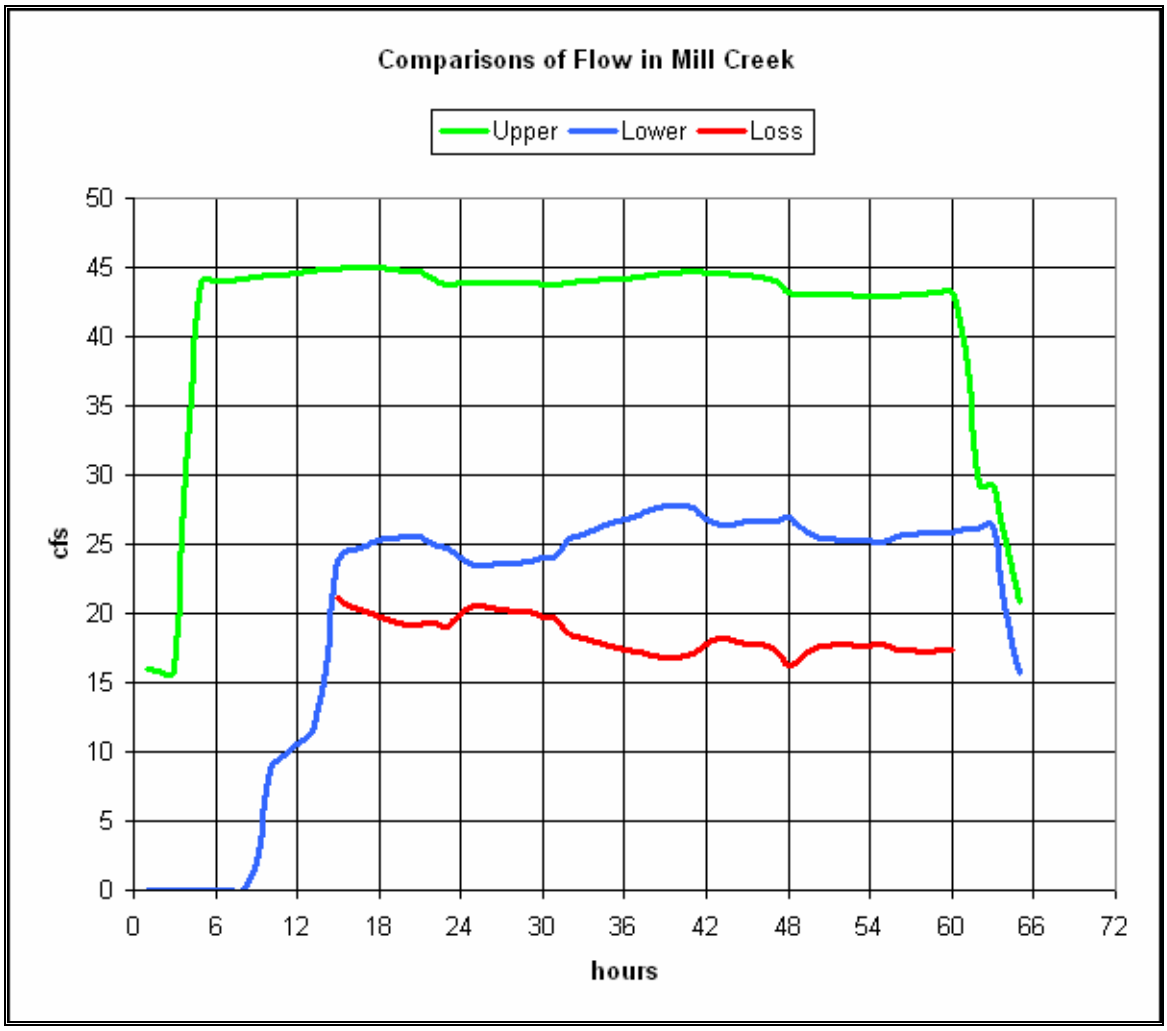


Figure 2. Flow data collected in Mill Creek from August 19 through August 22, 2006. Flow, in cfs, is shown as an hourly average. The green line is flow at the upper gauge, the blue line is flow at the lower gauge, and the red line is the estimate of flow loss between the two gauging stations.

The water users on the Allen-Sexton Ditch located about 0.7 miles upstream of the lower station at the East River Road bridge voluntarily shut off their ditch at 7:30 A.M. August 20 in order to prevent entrainment of fish and to provide additional water to move fish to the Yellowstone River. The measuring device on the ditch indicated a diversion of 7.7 cfs from Mill Creek just prior to the ditch being shut off. The second significant increase in flow at the lower station, occurring at about hour 14, reflects the closing of the Allen-Sexton Ditch. It should be noted that at this time flows were still increasing due to the closing of the Water District pipeline.

A closer review of the stage data indicates that from the time flows began to increase at the upper station it took about 4¾ hours for water to arrive at the lower station, 5 miles downstream. Prior to the flush, Mill Creek was essentially dry below the Allen-Sexton Ditch diversion. It took approximately ½ hour for the increased flow created by the closing of the Allen-Sexton head gate to travel the 0.7 miles to the lower station. At the end of the flush, flows at the lower station began to decline about 2½ hours after they began to decline at the upper station.

During the flush, the Melin-Allen Ditch continued to divert water and is the only known diversion during the period. While the flow being diverted in the Melin-Allen Ditch was not measured, visual inspection yielded an estimated diversion of 4 to 5 cfs. For the purposes of estimating the loss between the upper and lower stations it was assumed that this ditch was diverting 4.5 cfs continuously. The red line reflects the difference in flow between the stations minus 4.5 cfs to account for the Melin-Allen Ditch flow (Figure 2).

Once Mill Creek flow stabilized at the lower station, flows tended to decline during the P.M. hours and increase during the A.M. hours. Diurnal changes in evaporation and water use by trees and plants near the stream likely caused this effect. There was a lag to this effect as flows were still increasing during the morning as temperatures warmed and plants were again using water. The opposite was true in the evening.

During at least the first 32 hours, losses were likely higher due to the charging or filling of the alluvial gravels through which Mill Creek flows. By hour 32 or 1-2 A.M. on August 21 the losses steadied to some degree. After this point the estimated loss remained near 30% (Figure 3). This percent loss is representative of the loss for the time of year and the flow rates observed. Quite warm and dry weather conditions persisted during the flush. The average high air temperature for August 19-22, at a weather station located 12 miles south of Livingston, is 80-81 degrees Fahrenheit. While we did not record air temperatures, they were likely above these average highs. The percent loss of stream flow in Mill Creek might not be the same for either higher or lower flow rates than those observed and may vary throughout the summer as the length of day changes even during periods with similar air temperatures.

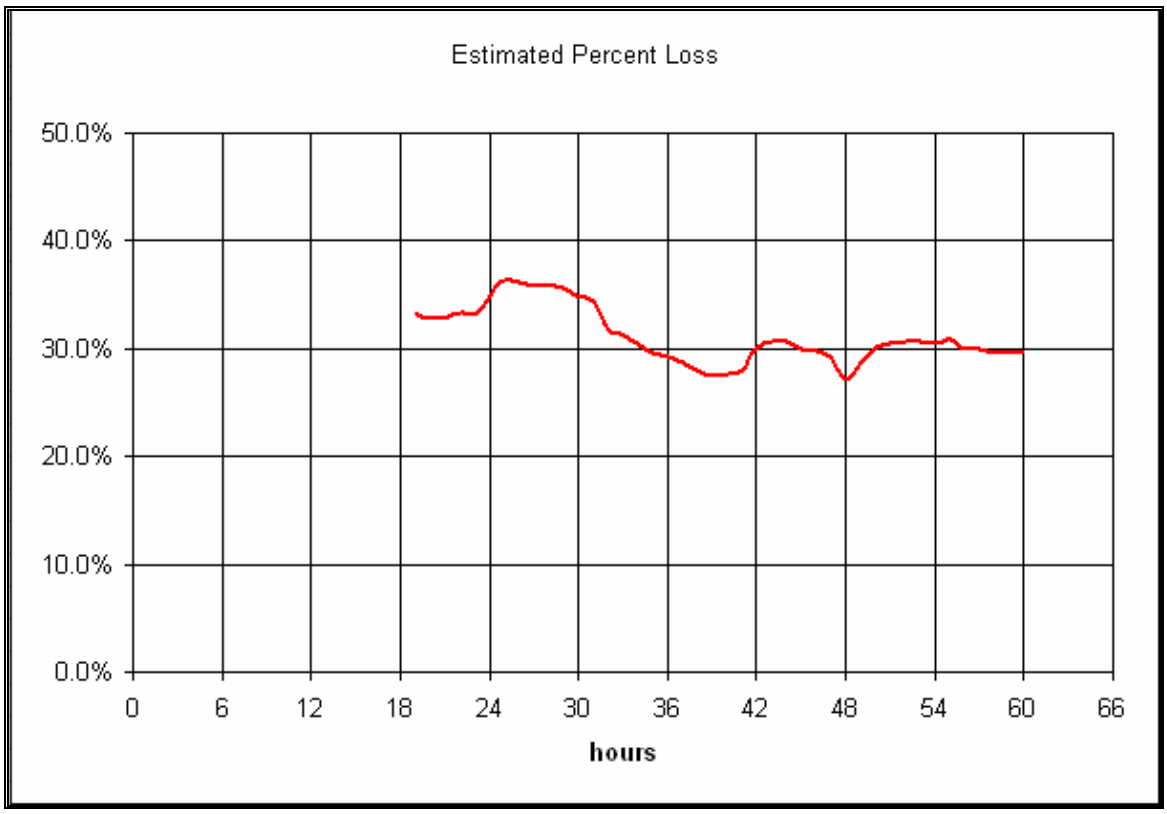


Figure 3. The following chart shows the estimated percent loss between the upper and lower recording stations.

The cessation of diversion by the Water District provided an increase in flow of about 30 cfs at the upper recording station and an increase of about 17 cfs at the lower station, attributing 7.7 cfs to the cessation of diversion from the Allen-Sexton Ditch. These numbers would indicate greater than 30% loss. However, the overall hydrologic setting in Mill Creek must be considered. Prior to the flush approximately 4 cfs of the 16.2 cfs observed at the upper station prior to the flush was lost from the stream with diversion accounting for 12.2 cfs; 4.5 cfs going to the Melin-Allen Ditch and 7.7 cfs into the Allen-Sexton Ditch. In other words, this 4 cfs loss was already occurring. When subtracted from the total 13 cfs observed loss during the flush a net loss of 9 cfs results or 30% of the 30 cfs increase observed at the upper gauge.

In order to assess downstream movement of fry during the flush we installed fry traps in two locations. These locations are displayed in Appendix A. The first location was immediately below the Allen-Sexton Ditch diversion. The trap was set in the evening of August 19 and water was barely flowing past the trap. This trap was moved upstream slightly to reduce potential negative impacts to fry, such as strong currents, on August 20. The trap was run continuously until 7:58 A.M. on August 21 when the trap was removed to reduce negative impacts and mortality on migrating fry. We located the second fry trap on the McCrum property where Mill Creek forks, just upstream of the confluence with the Yellowstone River. This trap was set in the evening of August 19 as well and no water was flowing in this portion of Mill Creek. This trap was run continuously until 10:55 A.M. on August 22. The upstream trap was used to determine if fry from the portion of Mill Creek that had not been dewatered were moving during the flush and the trap above the confluence to determine if fry would be able to reach the confluence given the significant portion of the streambed that had been dewatered in previous weeks.

Trout fry were captured in the trap below the Allen-Sexton ditch on August 20 and 21 (Table 1). The first capture in the upstream trap was a single 25-millimeter trout on August 20 (Figure 4). A total of three

trout fry and one sculpin fry were captured on August 20. Thirty-one trout fry and one sculpin fry were captured on August 21 and ranged from 26 to 73 millimeters in total length.

Date	**8/20/06**	**8/20/06**	**8/20/06**	**8/21/06**
Time	**8:34 am**	**3:38 pm**	**7:16 pm**	**7:58 am**
Trout Fry	1	2	0	31
Sculpin Fry	0	1	0	1

Table 1. Fry capture results by date and time for the fry trap located below the Allen-Sexton Ditch.

Figure 4. Trout fry trapped in Mill Creek below the Allen-Sexton head gate.

Trout fry were not captured in the trap above the confluence with the Yellowstone River until August 21 (Table 2 and Figure 5). Only one trout fry was captured that day. Four more were captured in this trap on August 22. Fry at this trap ranged in length from 25 to 64 millimeters in total length.

Date	**8/20/06**	**8/20/06**	**8/20/06**	**8/21/06**	**8/21/06**	**8/22/06**	**8/22/06**
Time	9:08 am	3:18 pm	7:40 pm	7:28 am	7:48 pm	7:30 am	10:55pm
Trout	0	0	0	1	0	4	0

Table 2. Fry capture results by date and time for the fry trap located upstream of the confluence with the Yellowstone River.

Figure 5. Fry trap being set in Mill Creek just upstream of confluence with Yellowstone River 1.

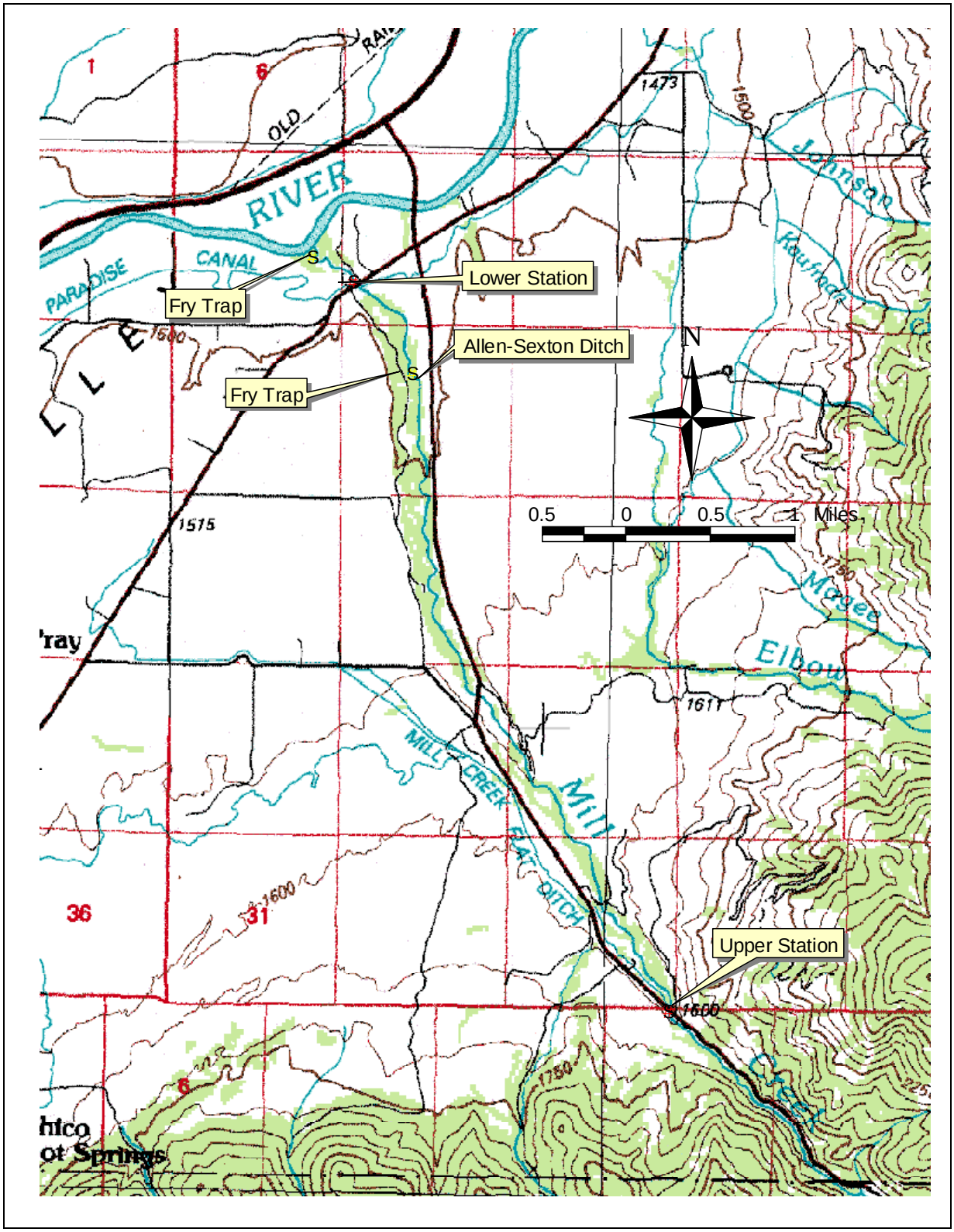
Some of the larger trout captured in the fry traps were likely fingerlings from the 2005 year class that had remained in Mill Creek.

Conclusions

Mill Creek responded quickly to changes in flow taking only 4¾ hours for the increased flow to travel the 5 miles between the recording stations despite the last 0.7 miles of stream being dry. The decrease in flow took only 2½ hours to move between the stations. The estimated net loss of 30% between the recording stations is somewhat lower than expected, but should not be used as a standard applicable to different times of the year and different flow regimes without further study. Even with the last 1.1 miles of the stream being dry, the closing of the Water District Pipeline alone would have been sufficient to generate a flow that would have reached the Yellowstone River. The closing of the Allen-Sexton diversion provided an additional benefit by ensuring sufficient flow was present and more importantly preventing entrainment of migrating fry.

The fry trapping data suggests that a few fry were likely able to reach the Yellowstone River. The large amount of streambed and the number of redds that were dewatered before the fry could hatch certainly reduced the number of fry that could be moved to the Yellowstone River with this flush. If a base flow that will keep redds wet and allow fry to hatch can be maintained, a flushing flow has the potential to move a large number of fry to the Yellowstone River and help maintain healthy, viable year classes of trout that can return to Mill Creek to spawn when they mature.

Appendix A



Lower Mill Creek – 2006 Flush