Fisheries Investigation
South Fork West Fork Gallatin River
Update – December 16, 2016

During the first week of March, 2016, approximately 33-million-gallons of treated effluent was released into Second Yellow Mule Creek from a holding pond on Yellowstone Club properties. This release resulted in avulsion of soils which travelled to and through Second Yellow Mule Creek, the South Fork West Fork of the Gallatin (SFWF), and the Gallatin River. Three sections of the South Fork West Fork Gallatin were sampled on March 10, 2016 to assess immediate effects on fish populations (Report dated March 23, 2016). Fish populations were again visited on August 16 of 2016 to ascertain population changes in the South Fork West Fork Gallatin River. Multiple pass depletion sections/reaches included, 1) a site just upstream of the confluence of Second Yellow Mule Creek (110 m), 2) just downstream of Second Yellow Mule Creek (175 m) and, 3) approximately ¼ mile downstream of the confluence of Second Yellow Mule Creek and SFWF (105 m; Figure 1). Because Ousel Falls is a barrier to upstream movement of fishes, only two species of fish occupy habitat in the reaches sampled – Westslope Cutthroat Trout hybrids *(Oncorhynchus clarkii lewisi x Oncorhynchus mykiss)* and Rocky Mountain Sculpin *(Cottus bondi)*. All work was completed by Montana Fish, Wildlife & Parks, Confluence Consulting, United States Forest Service, and Gallatin Task Force volunteers.

Site characteristics:

<u>Section 1</u> - Upstream of Second Yellow Mule Creek:

This 110-meter section was unimpacted by sediment and effluent. The stream bottom in this section was less than 20% imbedded, and characterized by boulder/cobble with little influence of fines.

<u>Section 2</u> - Downstream of Second Yellow Mule Creek

In March, this 175-meter section was fully embedded and flattened, with high levels of fine silt and sand/silt 1 to 2 feet in depth on stream margins and in thalweg. Visual observation indicated 90 to 100% embeddedness in this section downstream 1/8 to 1/4 mile. A second report by Confluence Consulting investigates these fluctuations in sediment (Confluence Consulting Inc. 2016).

In August, post run-off, this section was far less embedded. Habitat was still monotypic but had improved (Confluence Consulting Inc. 2016).

Section 3 - *¼ mile downstream of Second Yellow Mule Creek*

In March, this 105-meter section appeared far less embedded than the upper section downstream of Second Yellow Mule Creek. However, there was still a significant amount of very fine sediment in this reach. Turbidity was moderate but low enough to allow depletion estimates.

In August, post-runoff, levels of fine sediment were much reduced. Habitat was greatly improved and turbidity was negligible.

Methods:

Sampling was conducted on March 10 and August 16, 2016. The upper three sections were blocked at the bottom end with nets and electrofished with either a Smith-Root 12B or LR24 backpack electrofisher. Two to three passes were needed for depletion estimates. Fish were netted and held in live cars between electrofishing passes. All captured fish - Westslope Cutthroat Trout hybrids and Rocky Mountain Sculpin were measured to the nearest mm (all sites). MicroFish© (VanDeventer and Platts 1985) was used to calculate estimates with 95% confidence intervals.

Results:

Section 1 - Upstream of Second Yellow Mule Creek:

In March, this section held 72 WCT per 100 meters. The 95% confidence intervals for this three-pass section were 64 to 82 WCT (Figure 2). WCT captured in this reach ranged from 78 to 290 mm (average 174). At least four year classes were captured in this section - age one, two, three, and 4+ (Figure 3). Size of captured sculpin were similar in both March and August. Approximately 200 Rocky Mountain Sculpin were estimated to inhabit this section including capture of one year old fish (approximately 40 mm: Figure 4). Rocky Mountain Sculpin estimates were difficult to obtain because of capture and netting efficiencies.

In August, this section held 88 WCT per 100 meters. The 95% confidence intervals for this three-pass section were 84 to 92 WCT (Figure 2). WCT captured in this location ranged from 88 to 280 mm (average 165). At least four year classes were captured in this section - age one, two, three, and 4+ (Figure 3). Rocky Mountain Sculpin estimates were difficult to obtain because of capture and netting efficiencies. However, the presence of similar size classes was evident in both March and August samples (Figure 4).

<u>Section 2</u> - Downstream of Second Yellow Mule Creek

In March, this section held 21 WCT per 100 meters. The 95% confidence intervals for this three-pass section were 18 to 24 WCT (Figure 2). WCT captured in this location ranged from 95 to 305 mm (average 175). At least four year classes were captured in this section - age one, two, three, and 4+ (Figure 3). Approximately 142 Rocky Mountain Sculpin were estimated in this section including capture of one year old fish (approximately 40 mm: Figure 4). Rocky Mountain Sculpin estimates were difficult to obtain because of capture and netting efficiencies. Approximately 60% of Rocky Mountain Sculpin in this section showed evidence of fin erosion, particularly caudal and dorsal fins (Figure 5). We hypothesize that fin erosion was caused by rapid deposition of sediment into interstitial spaces as well as extremely high levels of suspended sediment. Five WCT mortalities were observed in this section ranging in size from 146 to 231 mm.

In August, this section held 49 WCT per 100 meters. The 95% confidence intervals for this section were 44 to 54 WCT (Figure 2). WCT captured in this location ranged from 82 to 270 mm (average 176). At least four year classes were captured in this section - age one, two, three, and several 4+ (Figure 3). We observed far more age 1+ WCT in this section in August (Figure 3). This increase corresponded in scope to a decrease in numbers of 1+ fish in the section ¼ mile downstream of Second Yellow Mule Creek. Rocky Mountain Sculpin collected in this reach were similar in size to those collected during March sampling (Figure 4). This section still had fewer smaller (age 1+) Rocky Mountain Sculpin than the upstream (control) section and the section 1/4 mile downstream from the confluence. It appears juvenile Rocky Mountain Sculpin in this section may still be impacted by lingering amounts of fines and reduced heterogeneity of the streambed. Low numbers of sculpin, especially smaller age classes may an artifact of pre-existing habitat limitations in the section, degraded habitat, or a combination of the two. An added complication is the small home range of sculpin (Breen et al. 2009; Schmetterling and Adams 2004). Recolonization of this reach may take more time than for the more mobile WCT. Rocky Mountain Sculpin captured in August showed little sign of fin erosion. The apparent lack of fin erosion in August could be the result of fin regeneration, mortality of Rocky Mountain Sculpin that exhibited fin erosion, or capture of individuals that had migrated from upstream areas.

<u>Section 3</u> - ¼ mile downstream of Second Yellow Mule Creek

In March, this section held 104 WCT per 100 meters. The 95% confidence intervals for this three-pass section were 85 to 161 WCT (Figure 2). A third pass was not completed on this site due to lack of daylight. WCT captured in this location ranged from 51 to 340 mm (average 168). At least five year classes were captured in this section - age 0+, one, two, three, and several 4+ and at least one fish assumed to be greater than 5 years in age (Figure 3). We observed far less age 1+ WCT in this section in August (Figure 3). This increase corresponded in scope to a decrease in numbers of 1+ fish in the section immediately downstream of Second Yellow Mule Creek. Approximately 573 Rocky Mountain Sculpins were estimated in this section including capture of numerous one year old fish (approximately 40 mm; Figure 4). Rocky Mountain Sculpin estimates were difficult to obtain because of capture and netting efficiencies.

In August, this section held 118 WCT per 100 meters. The 95% confidence intervals for this three-pass section were 105 to 131 WCT. WCT captured in this location ranged from 65 to 320 mm (average 181). At least four year classes were captured in this section - age one, two, three, and several 4+ (Figure 3). No estimate was obtained for Rocky Mountain Sculpin in this section. Rocky Mountain Sculpin were generally very abundant in this reach.

Discussion:

Weights of WCT and Rocky Mountain Sculpin were not collected because of personnel and time constraints. In August sampling, in all sections, WCT and Rocky Mountain Sculpin appeared to be in excellent condition, plump, with no signs of fin erosion. This differs from spring sampling wherein approximately 60% of sculpin sampled showed obvious signs of caudal and dorsal fin erosion downstream of Second Yellow Mule Creek (Sections 2 and 3). There were far more sculpins in the 40 to 55 mm range in the control section upstream of Second Yellow Mule Creek. It is unknown whether these fish immigrated from upstream or downstream reaches. Although WCT numbers in Section 2 had increased from the March sampling (133% increase), results indicate that population levels of WCT are still depressed immediately downstream of Second Yellow Mule Creek. It appears that much of the increase in numbers of WCT in Section 2 can be attributed to upstream movements of 1+ WCT (Figures 2 and 3). This could be attributed to seasonal movement or improvement in habitat conditions in Section 2. The literature suggests that if standard errors are similar and there is no overlap, 95% confidence intervals are very conservative and significance can be implied (Payton et al. 2003). Clearly there has been a significant increase in numbers of WCT in the section sampled immediately downstream of Second Yellow Mule Creek. Embeddedness in this section was much decreased in August – likely because of flushing flows during spring run-off. This 175-m section still suffers from sediment deposition and habitat homogeneity. Some of this homogenized habitat may have existed prior to the effluent spill; however, given the improvement in WCT numbers compared to upstream (control) and downstream 1/4 mile – habitat has clearly improved enough to allow immigration from upstream and downstream. In Section 3, 1/4 mile downstream of Second Yellow Mule Creek, Numbers of WCT were higher in the spring; however, the 95% confidence intervals overlapped suggesting that the differences were not statistically significant (Payton et al. 2003). Total WCT numbers were slightly higher in March vs. August in the upstream control section, 84 and 73 WCT per 100 m, respectively. This difference is likely statistically significant, but uninformative because of natural variability, both seasonally and demographically. Moreover, the observed difference is much greater than that of WCT in in the control section.

Impacts of suspended sediment and spring movement of bedload sediment on primary (periphyton), secondary (macroinvertebrates), and tertiary organisms (fish) are very well documented (Wood and Armitage 1997). Sediment is naturally produced in pristine rivers with levels being highly variable and dependent on geology and the streams hydrograph. The volume of sediment produced during the Yellowstone Club spill far exceeded natural levels. Further details on levels of sediment, channel cross sections, and macroinvertebrates can be found in a report prepared by Confluence Consulting (Confluence Consulting Inc. 2016). The South Fork West Fork Gallatin is a high-energy spring snowmelt system. Because of this; spring flushing flows in 2016 improved levels of fine sediment, and numbers of pools post run-off. Macroinvertebrates typically rapidly colonize areas that have been physically disturbed (Yount and Niemi 1990), regeneration of periphyton, re-colonization by macroinvertebrates, and regeneration of pools should aid in full recovery of WCT and Rocky Mountain Sculpin populations in Second Yellow Mule Creek and the SFWF in 2 to 5 years.

Data Needs:

- **The three sites referenced in this study should be sampled again in summer/fall of 2017– 2018. If personnel time allows, sampling should include collection of weight to determine condition of fish.**

Literature Cited:

Breen, M. J., Ruetz, C. R., Thompson, K. J., & Kohler, S. L. (2009). Movements of mottled sculpins *(Cottus bairdii)* in a Michigan stream: how restricted are they? *Canadian Journal of Fisheries and Aquatic Sciences*, *66*(1), 31-41.

Confluence Consulting Incorporated (2016). Monitoring Report, Confluence Consulting, Bozeman, MT 59771.

Payton, M. E., Greenstone, M. H., & Schenker, N. (2003). Overlapping confidence intervals or standard error intervals: what do they mean in terms of statistical significance?. Journal of Insect Science, 3(1), 34.

Schmetterling, D. A., & Adams, S. B. (2004). Summer movements within the fish community of a small montane stream. *North American Journal of Fisheries Management*, *24*(4), 1163-1172.

Van Deventer, J. S., & Platts, W. S. (1985). A computer software system for entering, managing, and analyzing fish capture data from streams (Vol. 352). US Dept. of Agriculture, Forest Service, Intermountain Research Station.

Wood, P. J., & Armitage, P. D. (1997). Biological effects of fine sediment in the lotic environment. *Environmental management*, *21*(2), 203-217.

Yount, J. D., & Niemi, G. J. (1990). Recovery of lotic communities and ecosystems from disturbance—a narrative review of case studies. Environmental Management, 14(5), 547-569.

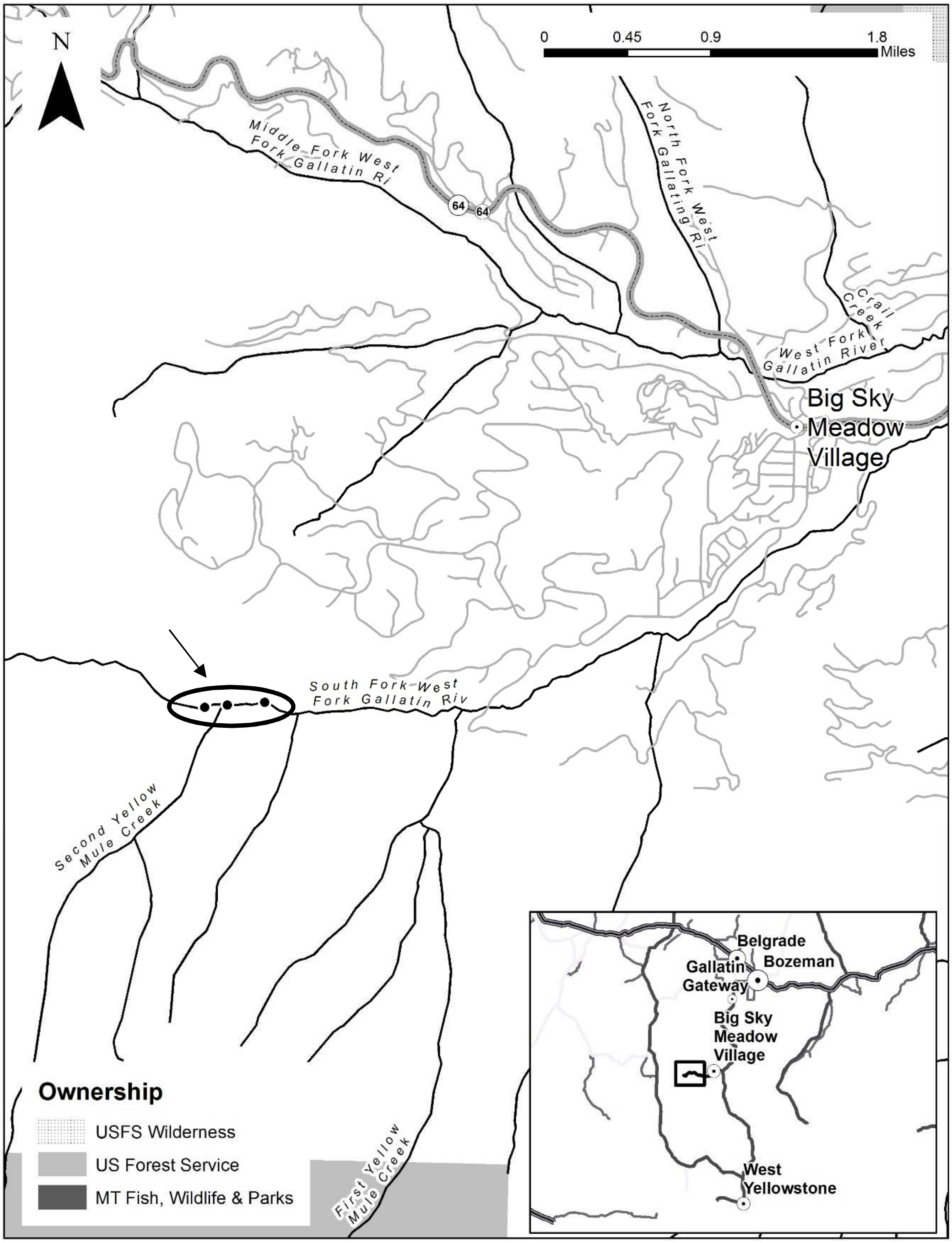


Figure 1. Sampling locations and general area of SFWF Gallatin, Second Yellow Mule Creek, and the Gallatin River. Black dots represent sampled reachs/sections and are approximate.

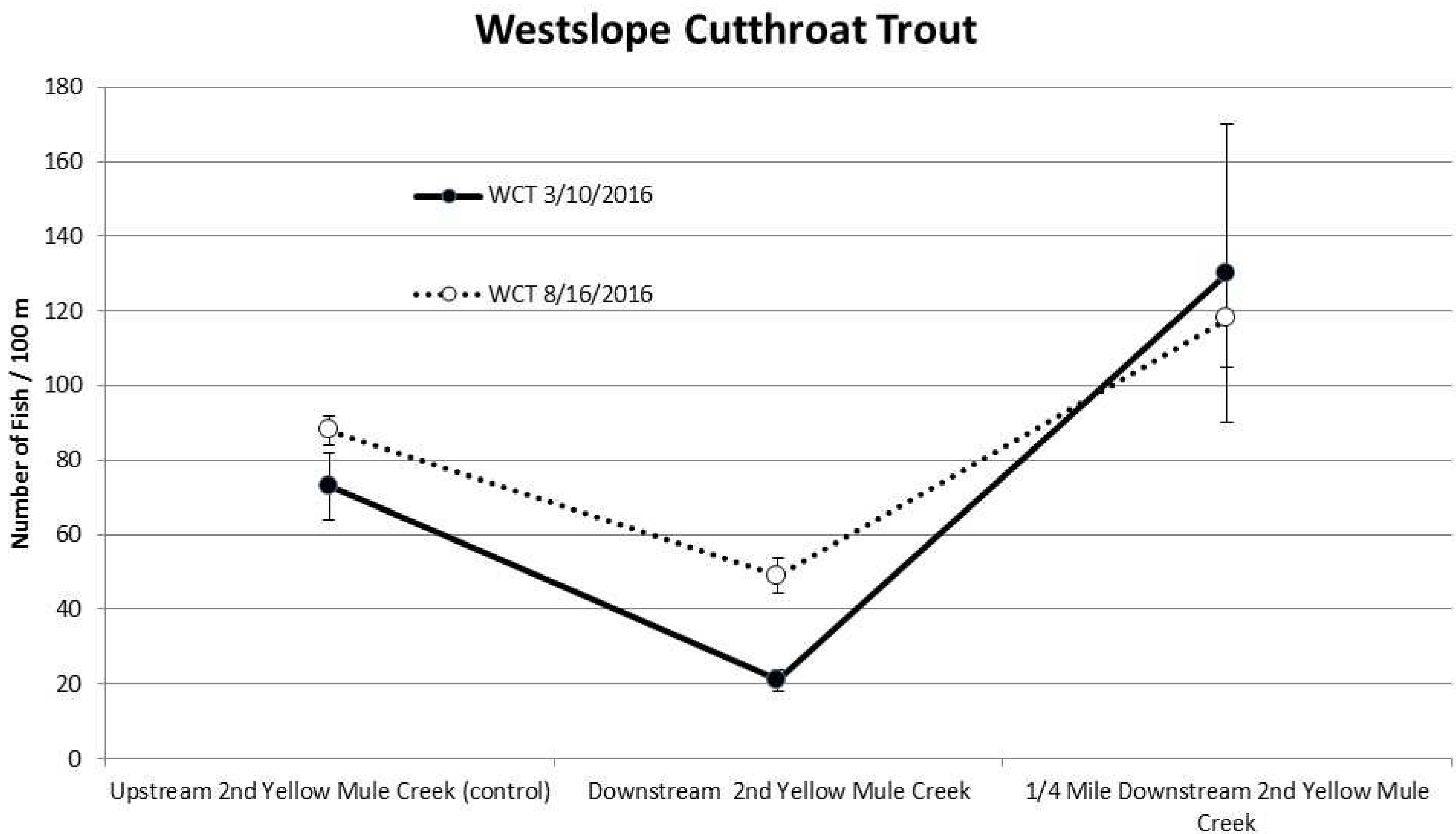


Figure 2. Population estimates at the SFWF Gallatin. Estimates are standardized to number of fish per 100 m. Error bars represent 95% confidence intervals.

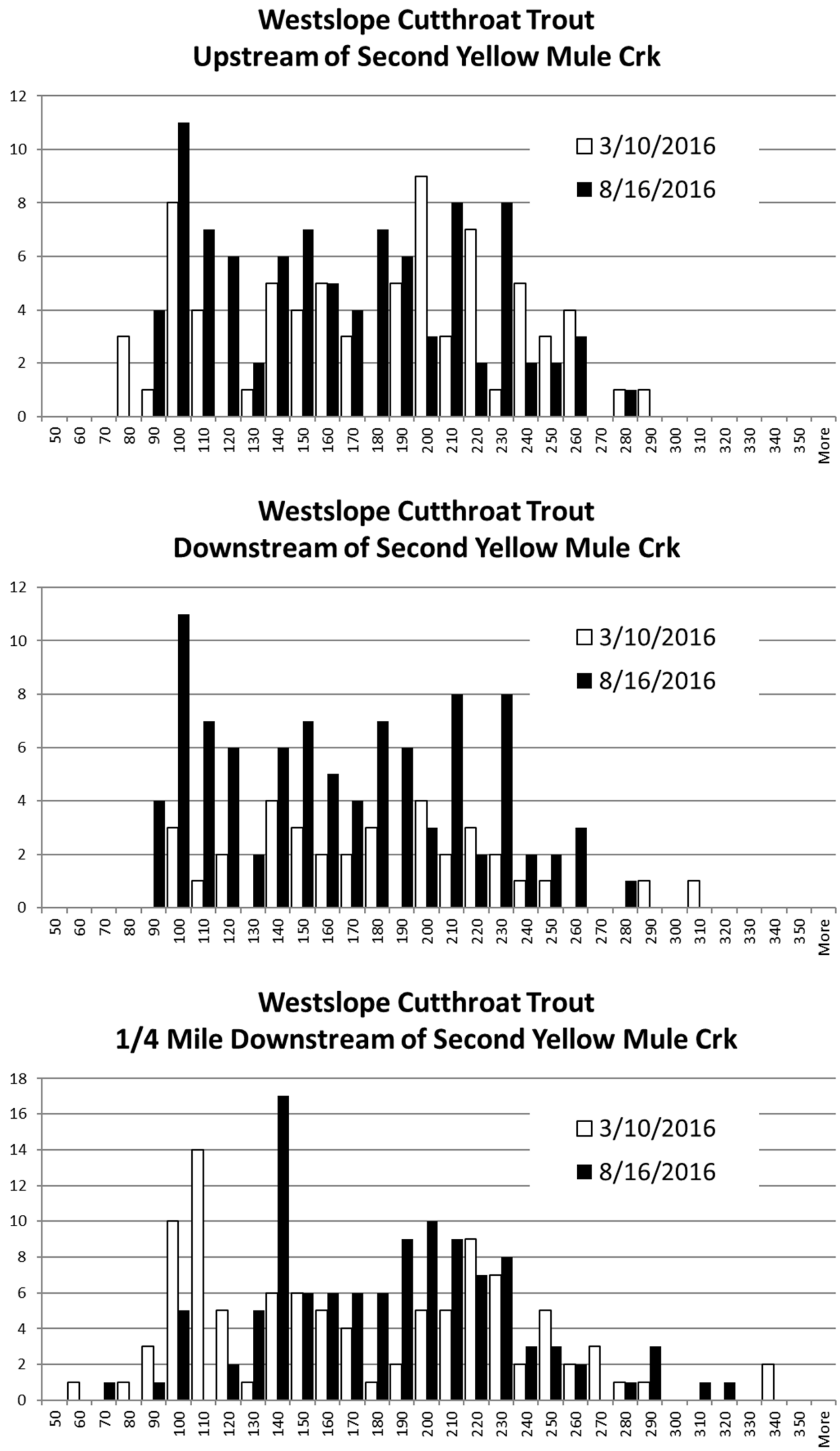
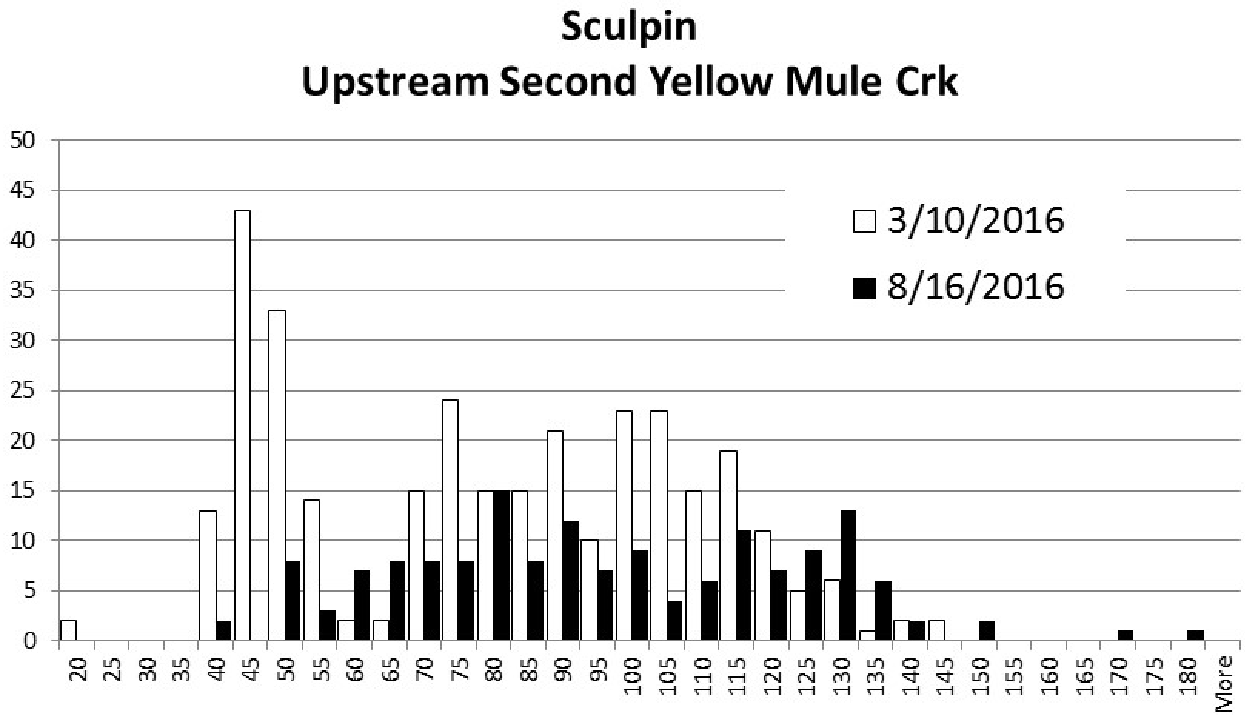


Figure 3. Length frequency histograms of Westslope Cutthroat Trout at three sampling sites



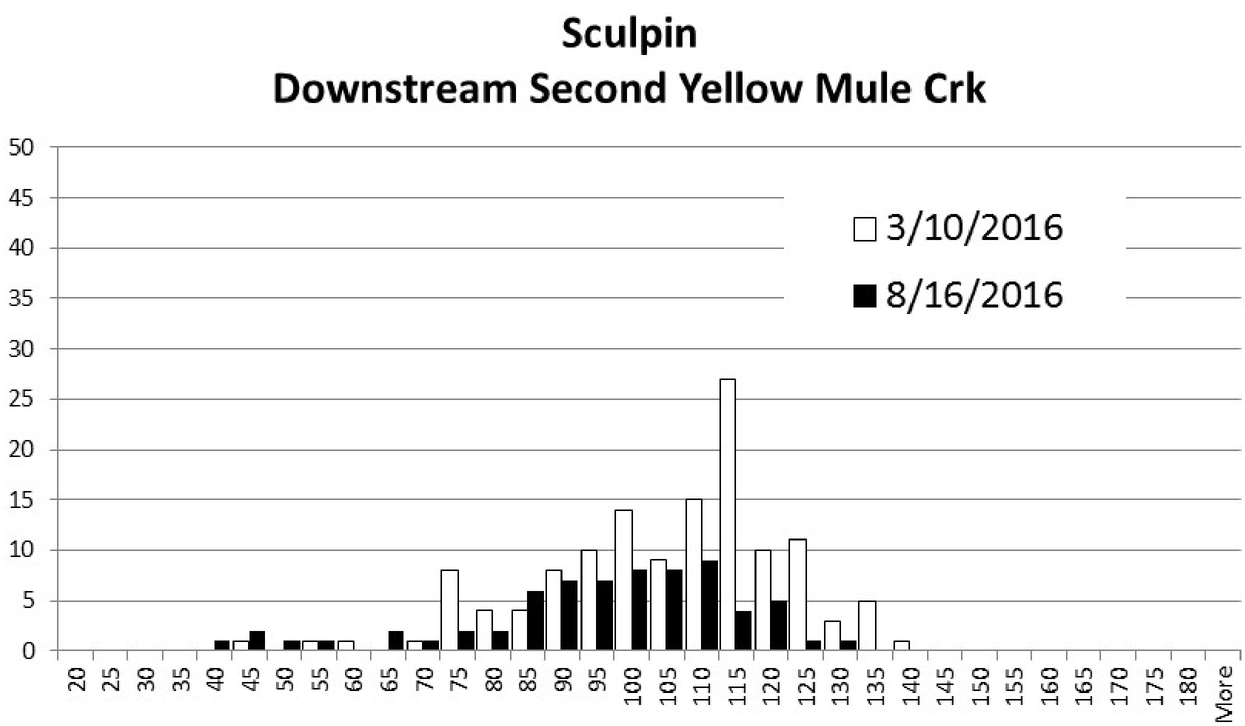


Figure 4. Length frequency histograms of Rocky Mountain Sculpin at two sampling sites

Figure 5. Example of fin erosion on Rocky Mountain Sculpin, Section 2 SFWF Gallatin, March 10 2016.