Assessment of the Sullivan Creek Mass Failure
Spotted Bear Ranger District, Flathead National Forest
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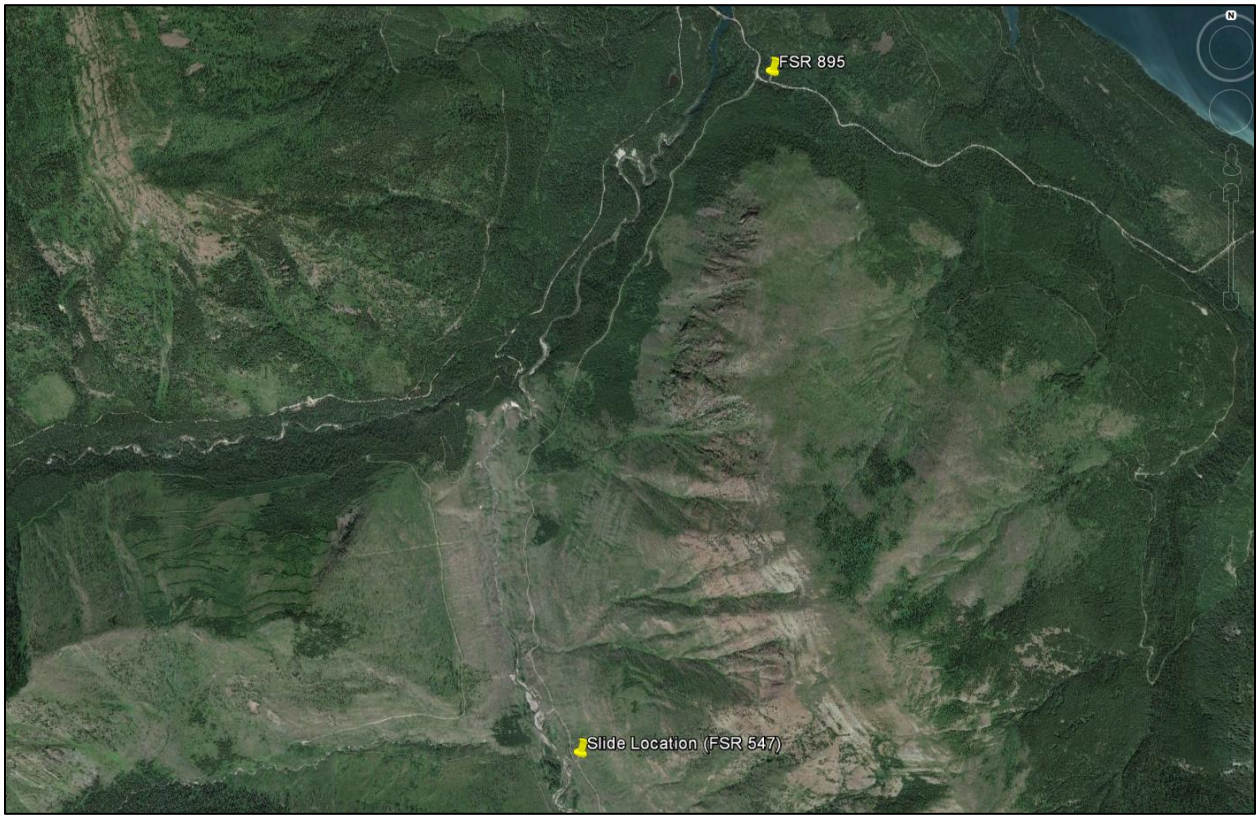
Assessment

On July 21, 2014, Keith Hammer notified the forest supervisor and other agency officials about a mass failure along Sullivan Creek. On July 22, Craig Kendall (hydrologist), Shawn Boelman (civil engineer), and Kathy Hyde (engineering technician) visited the site and conducted an assessment of the failure and associated damage to FSR 547. The failure is approximately 3.5 miles up FSR 547 from the West-side Reservoir Road (Figure 1). It likely occurred sometime in the spring or early summer.

Sullivan Creek is designated as Critical Habitat for bull trout. At the slide location, the creek provides rearing habitat for bull trout and westslope cutthroat trout. The bull trout population in Sullivan Creek is adfluvial. Adult fish spawn upstream of the slide location. Juvenile bull trout rear in the creek until they reach age 2-3. At that point, they migrate to Hungry Horse Reservoir where they grow to maturity.



The failure is located in a deep glacial till deposit along the margin of Sullivan Creek and mapped as Landtype 26-C. The till deposit is a complex mixture of silt, sand, gravel, cobble, and small boulders. There is no apparent sorting and the deposit is unconsolidated. The failure itself can be characterized as a translational slide, although the vertical scarp at the top indicates there may have been some level of rotation (Figure 2). But, given the unconsolidated nature of the material, rotation was likely minimal or non-existent. The slide transitions into an earthflow at the bottom (Figure 3). Based on the relatively uniform distribution of material on the valley floor, the

material must have been relatively wet at the time of movement. The slide area on the upper hillslope is roughly 250 feet wide and 150 feet long. The depositional area is roughly 300 feet wide and 150 feet long.

Figure 2. Top of slide looking south. Note vertical scarp.

Figure 3. Earthflow at the bottom of the slide. The earthflow covered a braided section of Sullivan Creek that consisted of floodplain deposits.

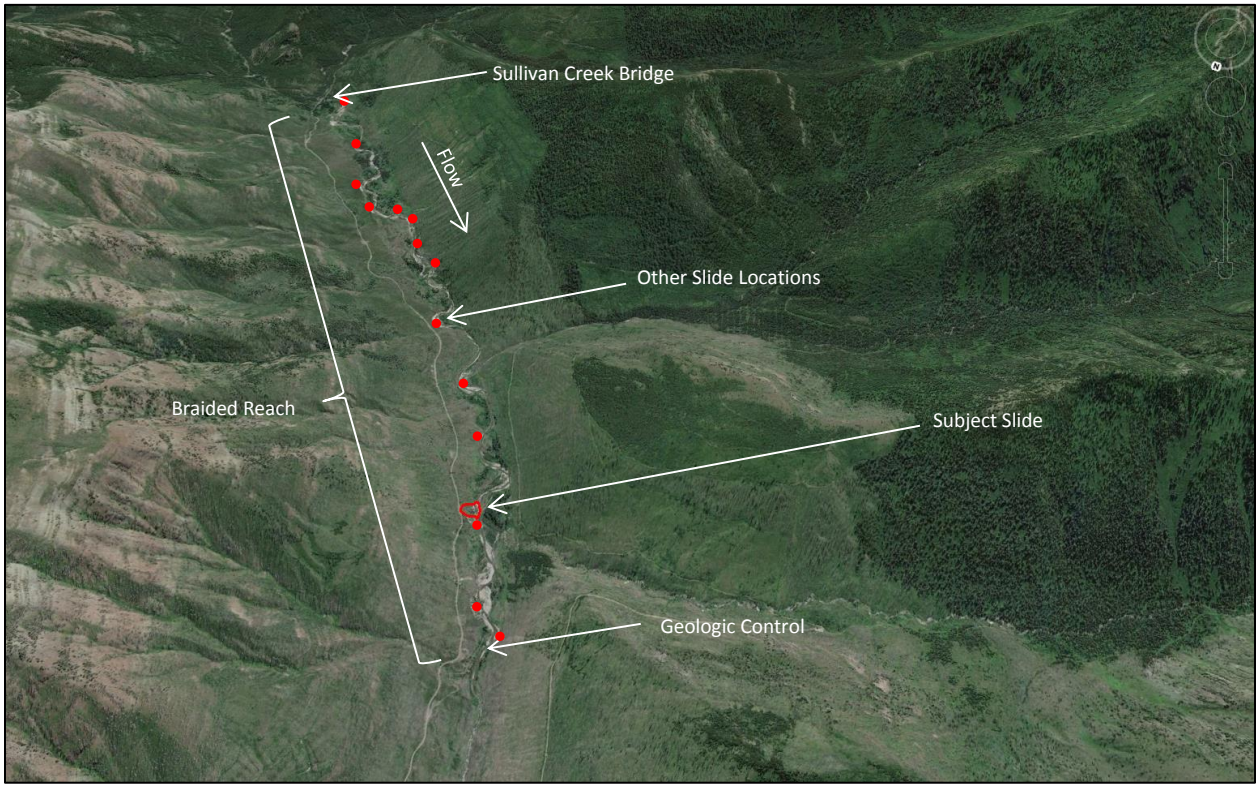


Figure 4. Sullivan Creek looking south (upstream). The slide area is shown in red outline. This reach of Sullivan Creek is a depositional (energy limited) reach characterized by a low gradient and braided morphology. Red dots indicate other slide locations on both sides of the creek.

Sullivan Creek has eroded through deep till deposits and has formed a wide floodplain (Figure 4). The valley and stream morphology suggest a structural geologic control just downstream of the Ball Creek confluence. Downstream of this control, the channel transitions into a more confined morphology and steeper gradient (Figure 4). Upstream of the control the channel has a flatter gradient and a braided morphology. This energy-limited morphology causes the channel to braid and migrate back and forth across the valley bottom. In many places, the channel is eroding into hillslopes (glacial till) and causing mass failures. Between the downstream control (near Ball Creek) and the Sullivan Creek Bridge, there are 14 mass failures caused by channel erosion (6 on the west side and 8 on the east side). The valley length of this reach is approximately 2.8 miles, so this equates to roughly 5 mass failures per mile. This indicates that hillslope failures caused by stream erosion are common in this valley. These mass failures are likely exacerbated by wildfire. In 2003, the Ball Creek Fire burned through this valley. The lack of forest canopy makes more water available for soil moisture and shallow groundwater flow. A rapid assessment of nearby drainages reveals that burned areas in similar settings (valley and stream morphology) have more mass failures than un-burned areas.

Because the slide occurred directly adjacent to FSR 547, there was some concern that the road may have caused the slide by changing sub-surface hydrologic patterns and concentrating surface runoff. Therefore, the section of road directly above the slide was assessed in detail. There were no visual signs of scour or deposition on the road surface, which suggests that no surface runoff was occurring on the road surface. The ditch is well vegetated with grass and shrubs. The road and ditch are generally flat near the slide, so it was difficult to determine the direction of water flow. Ditch gradients were measured using a clinometer. Figure 5 contains a rough sketch of the site and describes the general direction of water flow in the ditches. South of the slide, approximately 80 feet of road is

draining toward the slide. North of the road, the ditch gradient is at or close to zero. If the slide was caused by saturation of the hillslope from concentration of surface runoff (by the road), there would be evidence of overland flow along and across the road surface. No such evidence was found based on visual observation.

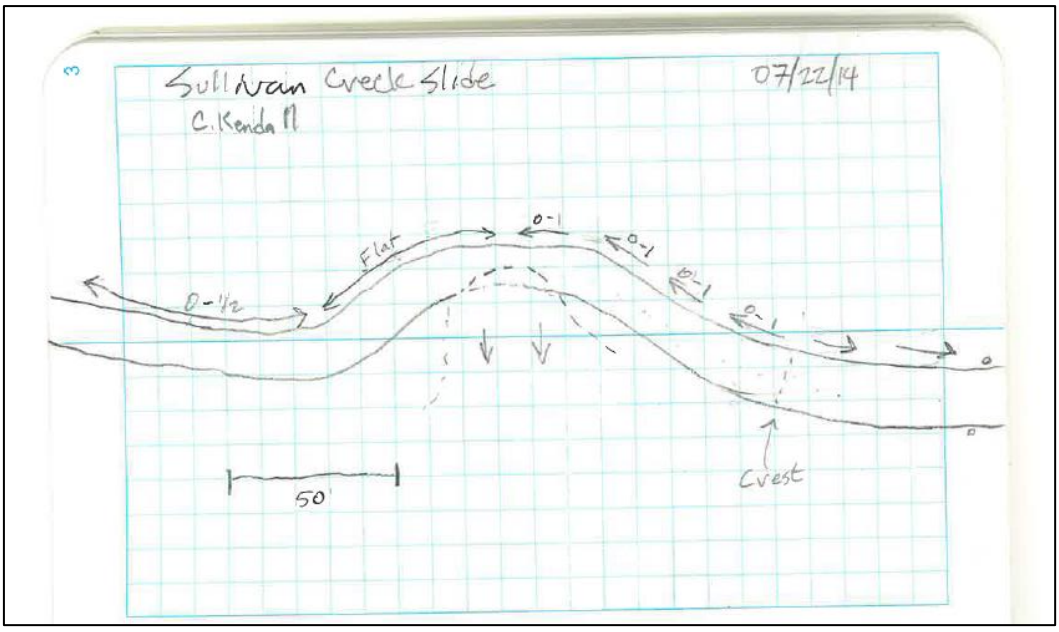


Figure 5. Field sketch of FSR 547 at the slide location. The arrows indicate the direction of water flow in the ditch. The numbers above the arrows indicate the gradient in percent.

Figure 6. A rough outline of the slide area (in red). Note the older slides within the adjacent to the current slide.

About 0.25 miles north of the current slide, two small mass failures were noted (Figure 7). Road and ditch gradients were measured at this site to determine if surface water had been draining toward the slide areas. Measurements indicated that these two slides are at a high point along the road, so road-generated water actually flows away from the slide areas. Close inspection of Figure 7 also reveals stress fractures above the road which indicates the small mass failures are part of a much larger hillslope that is unstable. The site shown in Figure 7 demonstrates that hillslope failures are not necessarily associated with direct road drainage.

Figure 7. Small mass failures 0.25 miles north of subject slide.

Conclusions

Conclusions about the cause of this mass failure are based on field inspection and general observations of the landscape in and around the slide. The slide appears to have been caused by channel erosion. This conclusion is based on the following rationale.

1. Road and ditch gradients on FSR 547 are relatively flat. About 80 feet of road ditch drains toward the slide area, but there are no visible signs of surface runoff, scour, or deposition on the road prism at the slide location. Approximately 0.25 miles north of the slide, there are two small mass failures below the road. At this location, the road is at a high point and water does not drain toward the unstable areas. This provides evidence that slides occur in this area without receiving direct surface drainage from roads.
2. A close inspection of Sullivan Creek at the slide location reveals that the creek has been eroding the toe of the hillslope (Figure 6). Older slides are certainly evident within and adjacent to the existing slide. This was caused by a mid-channel gravel bar that triggered the stream to migrate toward the hillslope. Inspections of other slide locations upstream reveal similar patterns of channel migration and associated hillslope failure. Therefore, the mass failure was most likely caused by the channel eroding the toe of the hillslope.
3. The current slide appears to be similar to several other slides in the valley bottom where the creek has eroded into hillslopes. In the 2.8 mile section of relatively consistent channel and valley morphology, there are 14 mass failures on both sides of the creek (Figure 4).
4. In the broad geographic area, channel braiding occurs in both roaded and un-roaded watersheds. These braiding patterns appear to be associated with high sediment load and geologic controls that reduce gradient. These types of fluvial systems are generally considered “energy limited”. Ball Creek and Upper

Sullivan Creeks have similar channel morphology and thus have mass failures along the their floodplain margins.

5. Landslides are prevalent in both roaded and un-roaded areas. They are more prevalent in areas that have recently burned. Burned areas generally have higher soil moisture levels and more shallow sub-surface flow due to evapotranspiration losses.