

# Crown Butte Avalanche Fatality

North of Cooke City, Montana  
Gallatin National Forest  
11 March 2014

## Synopsis

On March 11, 2014, a group of seven snowmobilers was riding north of Cooke City. In the morning they rode in meadows and on low angle slopes. By mid-afternoon three of them climbed onto a steep, northwest facing slope on Crown Butte. The victim stopped approximately 1/3 of the way up the slope just below the area that ultimately fractured. Two others were continuing to climb when the avalanche released. They turned downhill and barely escaped the avalanche. Many others including riders in other groups were in the run out zone and scrambled to get out of the way. The avalanche impacted the victim, carried him downhill and fully buried him. No one in the group of seven, including the victim, was wearing avalanche beacons or carrying shovels and probes. Other groups responded and began probing. Cooke City Search and Rescue located the victim about 1.5 hours later with avalanche probes. He was buried about 6 feet deep and excavation took additional time.

The avalanche broke 700 feet wide and 2-5 feet deep on depth hoar crystals about 1 foot above the ground. The avalanche ran 800 feet vertical and 1600 feet slope distance. Debris ranged from 5 to 15 feet deep and covered an area 900 by 400 feet. Slope angles in the starting zone ranged from 36-38 degrees. Alpha angle at the toe of the debris (angle from horizontal to the crown line) was 25 degrees at the northern lobe of debris and 27 degrees at the southern lobe. U.S. classification of the avalanche is HS-AM-D3-R4-O (hard slab, artificially triggered by a snowmobile, large enough to destroy a house, large in size relative to the size of the slope, broke within old snow). At the time of the accident an Avalanche Warning had been issued by the GNFAAC and the danger was rated as HIGH on all slopes.

## Coordinates:

Northern toe of debris N 45.05556 W 109.96716

Southern toe of debris N 45.05413 W 109.96835

Burial location: N 45.05442 W 109.66773

Accident Description Video: <http://www.youtube.com/watch?v=-J75hKVyEC4>

Snowpack Description Video: <http://www.youtube.com/watch?v=HIA2Hm7OjB0>

## Weather

Weather data was collected from two sites: [Fisher Creek SNOTEL](#) site (1 mile NE) and Cooke City/Lulu Pass weather station (1 mile N). The Fisher Creek SNOTEL site recorded 1.4 inches of [snow water equivalent \(SWE\)](#) over 16 hours on March 10, the previous day. During the first half of the storm, winds blew 15-25 mph out of the SW with gust over 50 mph. During the second half of the storm winds shifted

to the NW blowing 20-30 mph with gusts near 50 mph. Snowfall stopped at 7 p.m. on March 10 and winds calmed.

At the time of the accident, Fisher Creek SNOTEL site recorded a temperature of 23 degrees F and Cooke City weather station recorded winds of 5-10 mph out of the east. Skies were mostly clear and sunny. The mountains around Cooke City received an enormous amount of snow during the month of February and first part of March. Fisher Creek SNOTEL site recorded 16.5 inches of SWE from February 1 to March 10 (Figure 1).

### Snowpack

GNFAC forecasters Mark Staples and Eric Knoff investigated the crown the day after the accident. The crown averaged 3 feet deep (Figure 3), but broke up to 5 feet deep in places. The slab ranged from fist hardness at the surface to pencil hardness above the weak layer (Figure 2). The slab rested on a layer of depth hoar crystals near the ground (Figure 4). This layer initially formed during extreme cold weather between December 3 and 8. However, it likely became weaker and more faceted since then because this slope had such a thin snowpack (Figure 5). The combination of a thin snowpack and normal winter temperatures created strong temperature gradients that furthered the faceting process, ultimately creating the depth hoar crystals (aka sugar snow). At the crown the snowpack was about 4 feet deep (120 cm). Total snow depth at the Fisher Creek SNOTEL site at the time of the accident was nearly 11 feet (335 cm). Wind events through the winter scoured this slope and prevented the snowpack from becoming as deep as it was in other areas.

The thin snowpack contributed to this accident in two ways. One, it allowed the facets near the ground to become much weaker than on many other slopes. Two, it made it easier to trigger this avalanche because the weak layer was only buried three feet deep. This depth is deep enough to create a large avalanche yet shallow enough for riders to initiate a fracture in the weak layer. Although the snow at the ground was very weak, the slab was supportable allowing for easy travel and climbing. At the time of the accident there were many tracks on this slope. Most of these tracks were below the area that fractured and only a few reached onto the slab that released. There were no other, recent avalanches visible in the immediate area.

### Avalanche

The seven riders were from Minnesota and consisted of two older and five younger men. The younger men ranged in age from 18-21 years old. The victim was 18 years old. Of the seven members, most had ridden in these mountains in previous years. The victim was the only member who had not been to Cooke City prior to this trip. It was their second day riding in Cooke City. They rode the previous day without incident. Although every member of the group was experienced in snowmobiling, they had little experience with avalanches and none of them carried avalanche rescue gear. The older men of the group felt that carrying avalanche rescue gear would only encourage them to ride in avalanche terrain.

They were aware of the Avalanche Warning and had no intention of riding in avalanche terrain. Their plan was to ride in meadows and low angle slopes. Once they left town the morning of the accident, they stopped near Daisy Pass and discussed avoiding steep slopes.

As the day progressed, other snowmobilers began riding in avalanche terrain and leaving tracks visible to the group involved in the accident. The northwest face of Crown Butte had dozens of tracks on it before three members of the group (Rider1-the victim, Rider2, and Rider3) climbed it. Only a few sets of tracks reached into the portion of the slope that fractured (Figure 9). Despite their original intentions and directions from two older members of the group to avoid such slopes, those tracks deceived them into thinking it was a stable slope and would be safe from avalanches.

Rider1 was first on the slope. For an unknown reason he stopped about 1/3 of the way up the face where the slope angle was roughly 30 degrees. Rider2 climbed above and past Rider1 in a rising traverse to the northeast. At the same time Rider3 climbed in a rising traverse to the northeast also above Rider1. While Rider2 and Rider3 were climbing and traversing, the avalanche released (Figure 6). Both of them were able to ride off and away from the descending slab. Rider2 headed downhill towards trees and aimed for a gap between them. The debris caught up to him and pushed him through that gap uninjured and not buried. Rider3 was able to outrun it. The avalanche hit Rider1 and carried him approximately 500 feet downslope. He was buried 6 feet deep near the toe of the debris. Many snowmobilers were in the run out zone. Some were able to ride away from the debris. A few others ran away and their sleds were caught. The total number of people parked in the run out zone is unclear.

### Search and Rescue

Members of Rider1's group were unable to find him. Other people immediately responded and began spot probing. Because the debris covered such a large area, about 8 acres with few terrain features, there were no obvious places to spot probe for Rider1 (Figure 7). Debris ranged from 5-15 feet deep (Figure 8). The last seen point was where he had been parked. The avalanche happened at about 3:50 p.m. One rider from the group left the scene to get help 4 minutes after the avalanche occurred.

Park County Search and Rescue (SAR) from Cooke City responded to the scene at 4:15 p.m. With an avalanche warning in effect, rescuer safety was a priority. The Park County Sheriff, SAR, and the GNFAAC were extra concerned with safety because of the highly unstable conditions. The initial public response was unorganized. SAR members took immediate control to bring organization and safety to the scene. Members of SAR and the public formed three probe lines and began a coordinated search effort. A total of 56 people were involved in probing. They located Rider1 about 6 feet deep at 5:10 p.m. He was found without his helmet. His airway was clear and there was no layer of ice in front of his face indicating that he may have died of trauma. The next day his sled and helmet were found 15 feet to the northeast at the same elevation.

Deep burials are very difficult due to the amount of snow that must be removed. Avalanche debris can weigh 600-800 pounds per cubic yard. Based on the vertical drop, this avalanche may have traveled 40-55 mph. Only 4% of people buried over 6 feet deep are recovered alive (Source: McClung, D. and P. Schaerer, The Avalanche Handbook, 3rd edition, 2006).

Station (480) WATERYEAR=2014 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision Fri Mar 14 09:24:58 PDT 2014

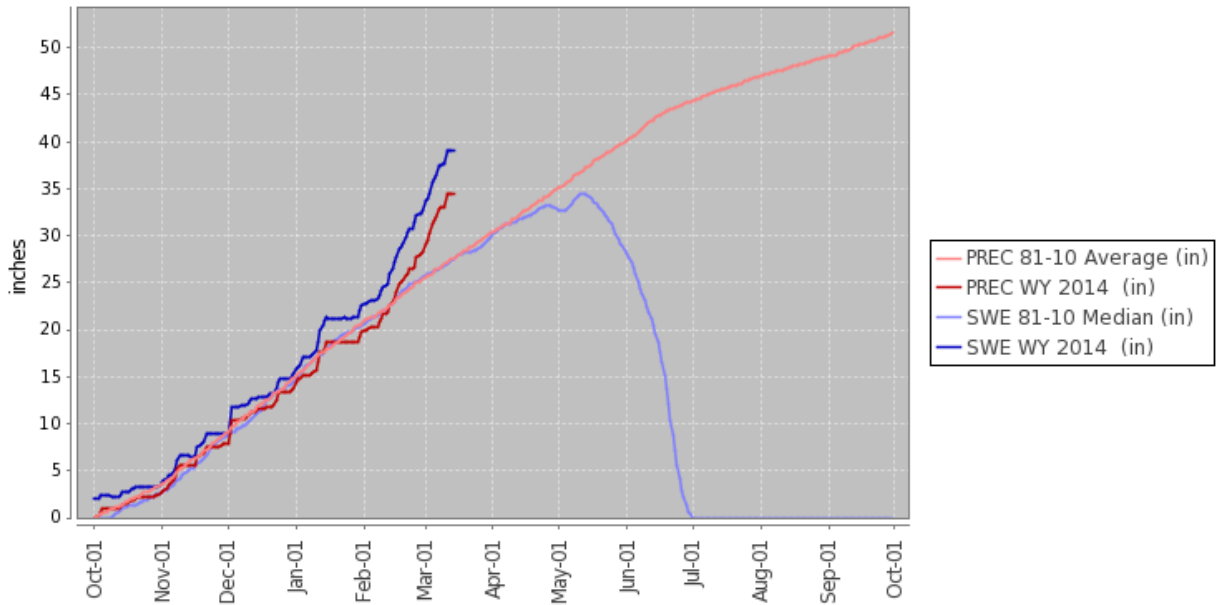


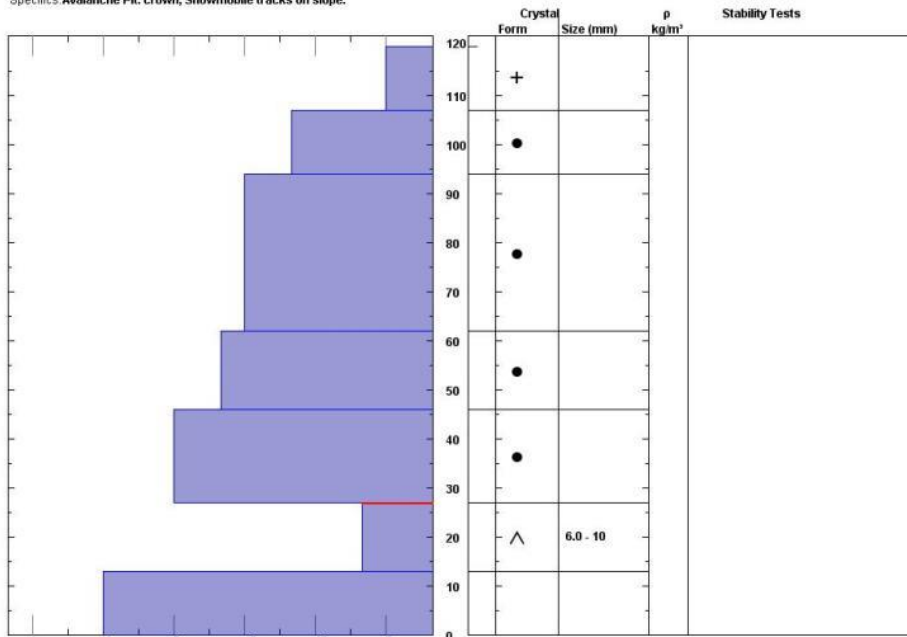
Figure 1 Snowfall at the Fisher Creek SNOTEL site showing continuous snowfall that started around the start of February. Chart: NRCS

Snow Pit Profile  
**Crown Butte**  
**Beartooth, MT**  
 Elevation (ft) **9801**  
 Aspect **272**  
 Specifics **Avalanche Pit: crown; Snowmobile tracks on slope.**

Observer: **Mark Staples**  
**Wed Mar 12 11:00:00 MDT 2014**  
 Co-ord: **45.05286 N 109.96362 W**  
 Slope: **34**  
 Wind loading:

Stability on similar slopes:  
 Air Temperature: **C**  
 Sky Cover:  
 Precipitation:  
 Wind:

Stability Test Notes:  
 Layer notes:  
**13-27: Problematic Layer**



Notes: Right side of crown face of a fatal avalanche that occurred on Tuesday, March 11, 2014. Avalanche broke when 3 snowmobilers were on the slope. 2 were moving and 1 was stopped. This depth hoar is the weakest snow we have seen anywhere this season. At this time nearby the Fisher Creek SNOTEL has 39.2 inches of SWE and 129 inches of snow. Crown depths averaged 3 feet. Average starting zone angles were 36 degrees.

Figure 2 Crown profile recorded on the lower right side of the crown face. Profile: GNFAc

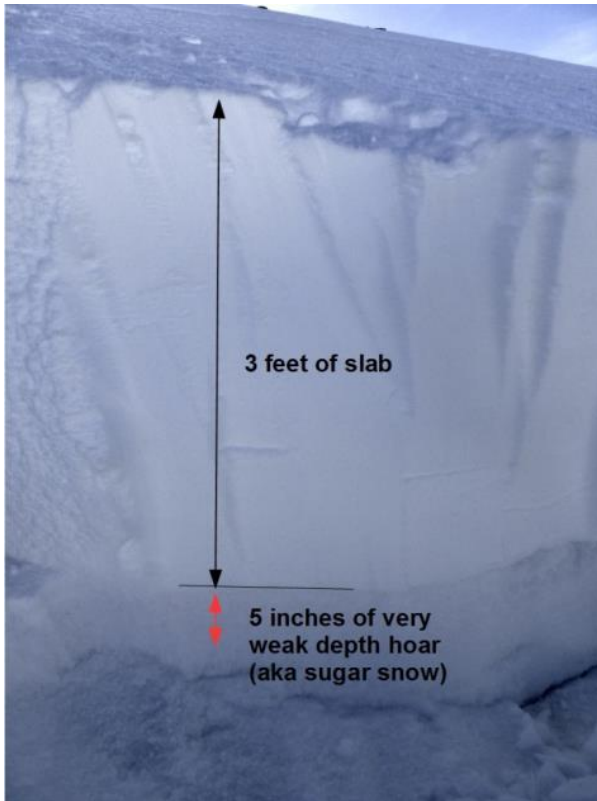


Figure 3 Crown face on the lower right side where the profile was recorded. Photo: GNFAC



Figure 4 Close up of the depth hoar crystals which were 6-10 mm in size. Photo: GNFAC



Figure 5 The crown averaged about 3 feet deep and the snowpack was only about 4 feet deep which is very thin for this area. The Fisher Creek SNOTEL site had nearly 11 feet of settle snow at the time of the avalanche. This area was about 700 feet wide and it took less than 4 seconds for the weak layer fracture to cover this area. Photo: GNFAC



Figure 6 Locations of the three riders when the avalanche released are shown with red X's. The paths and escape routes of the two riders are shown with red dashed lines. Photo: S. Walsh



Figure 7 The debris covered an area roughly 900 feet by 400 feet which is about 8 acres. Photo: GNFAC



Figure 8 Depth of debris ranged from 5 to 15 feet. Photo: GNFAC



Figure 9 Photo of Crown Butte before the avalanche. Most tracks were below the area that fractured. Photo: D. Abney

This avalanche accident was investigated by Eric Knoff and Mark Staples on Wednesday, March 12, 2014. Any questions regarding this report can be directed to them.

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