2010 SADDLE PEAK AVALANCHE: SIDECOUNTRY CHALLENGES, MISCONCEPTIONS, AND LESSONS

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ABSTRACT: On February 16th, 2010 a person accidentally kicked off a cornice that triggered a large slide on Saddle Peak immediately outside Bridger Bowl's boundary. This slide narrowly missed killing several people, and the immense snow cloud was seen throughout the ski area. While the avalanche surprised many, avalanche professionals at the Gallatin National Forest Avalanche Center (GNFAC) and Bridger Bowl Ski Area have anticipated such an event since this sidecountry area was opened up two years ago. We have tried to educate the public about the accident potential through signage, articles, a special DVD, and education efforts targeting youth and their parents. Despite our best efforts Saddle Peak is heavily skied by all ages, with multiple people on the slope at the same time and with no regards for, and apparent knowledge of, safe backcountry travel techniques. Moreover, the slide demonstrated the fallacy of skier compaction for preventing large hard slab avalanches. In December 2009 a layer of facets was buried by a supportable hard slab impervious to the thousands of skiers who skied the slope during the season. A mid-February storm dropped over three inches of SWE, setting up the conditions leading to the slide.

1. PRE-EVENT

Bridger Bowl Ski Area, near Bozeman, Montana opened the new Schlashman's lift to its southern flank during the winter of 2008-2009. This expansion resulted in a new backcountry boundary gate accessing Forest Service land. This new gate was located at the ridge crest, eliminating both the need for skins and a chance to think about stability on the climb up. Schlashman's added expert skiing terrain within Bridger Bowl boundaries and greatly improved sidecountry access. It was hugely popular with hundreds of skiers a day lapping the sidecountry of the adjacent Saddle Peak (9,162') after fresh snows. The descent lines are in full view of the lift and the sight increased the popularity of sidecountry terrain (Figure 1).

Figure 1: A view of Saddle Peak from the top of the Schlashman's lift. (K. Birkeland)

Bridger Bowl requires all riders on Schlashman's to wear an avalanche transceiver since the in-bound terrain is serious and avalanches are possible and it aids Search and Rescue operations outside the boundary if people are buried. Bridger has had a beacon policy for all skiers accessing their in-bounds ridge since 1976. Consequently, most locals own transceivers and wear them regularly at the ski area.

Bridger is a local ski hill with a large population of adolescents who ski the "Ridge", a two mile long crest above lift served terrain. They own beacons, hike to get turns and most are expert skiers. The adolescent population was the

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Avalanche Center's and Bridger Bowl's primary concern with the new boundary gate. There was never any doubt that the sidecountry of Saddle Peak would be popular, even though the slopes were uncontrolled and required snow assessment and travel skills that many adults and most adolescents do not have. Parents routinely drop the kids off at the ski area without appreciating the ease or risks of entering the sidecountry. Adolescents' inexperience and immaturity in making complex decisions about avalanche danger is a grave concern. Because of their adventurous spirit, we anticipated that many would head out-of-bounds first chance they got with far less avalanche judgment than the rest of the Saddle Peak skiers who ranged from Montana State University students to middle aged adults with decades of Bridger history.

From the new lift, riders watch folks ski en masse with huge rooster tails of powder silhouetted against the sky-- a powerful allure adding to the illusion it was safe. Although the backcountry gates were always open, the lift accessing them was not, especially after larger storms. This time lapse between storm and skiers sometimes but not always allowed the slopes to stabilize before they laid tracks.

From the summit of Saddle Peak a skier can descend 2,000 feet of powder and traverse back to the lift without any specialized touring gear. This increased traffic on slopes laced with terrain traps prone to avalanche presented a *new* education challenge for the Avalanche Center.

1.1 Avalanche Education and Awareness

In early 2008, eight months before the scheduled opening of the new lift, the Avalanche Center began working with Bridger Bowl to put together a sidecountry education package for the community. Parents not familiar with the avalanche potential outside the boundary were our first target, followed by the teenagers themselves and then the general adult population. Our Friends of the Avalanche Center hired Sam Lowe-Anker, a local teen, to film a 10-minute movie on the dangers of sidecountry skiing. The Avalanche Center wrote the script, Sam filmed it, and Bridger burned 5,000 copies which were handed out free to all season pass holders as well as posted online. Signs at the ticket window, at both bottom and top of the new lift and on the ridge at the boundary all warned of the danger.

We mentioned our concerns in avalanche advisories, monitored conditions, dug regular pits, posted photos and videos of our stability tests and kept an open dialogue with the ski patrol and regular skiers. We also wrote about the impending danger in a monthly column in the Bozeman Daily Chronicle.

1.2 Sidecountry User Challenges

The skiers and snow boarders who used this new access point into the sidecountry had concerns of their own. Because Saddle Peak is expansive, descending one at a time is impossible with heavy traffic and the terrain provides no true safe zone on the descent. Safe travel protocol is often discarded with solo skiers also frequenting the sidecountry.

Our avalanche awareness and education programs work, but not with everyone. Cognitive dissonance and self justification play roles in skiers' decision making (Tavis and Aronson, 2007). Despite our best efforts, we watched the sidecountry experience turn into a free-for-all----everyone skiing at the same time and bumps on the most popular lines. This was unthinkable a year ago when this was truly backcountry and not so easily accessible.

1.3 Weather, Snowpack and Avalanches

Although these human factor and terrain challenges exist every day, an avalanche hazard requires an unstable snowpack, and last winter's snowpack was the most unstable in the 20 year history of the Avalanche Center. The snowpack began with small storms from the end of September through October, followed by a three foot storm on November 12th. At the beginning of December five days of -25° F temperatures

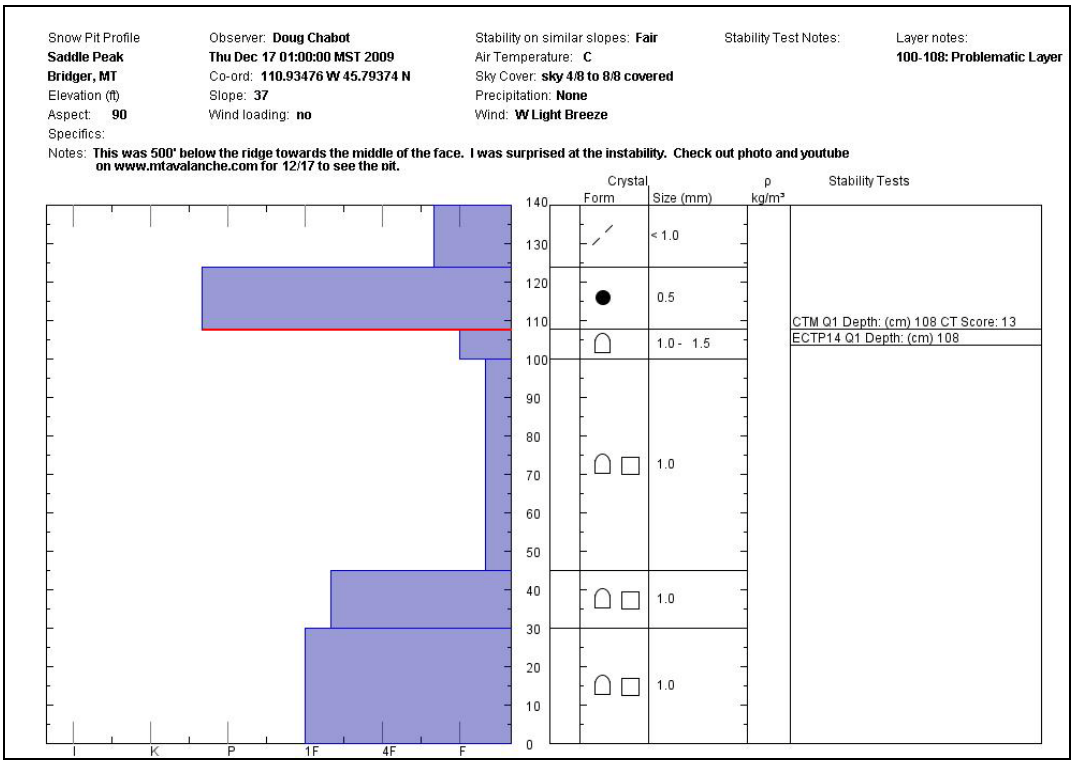

Figure 2: December 17, 2009 snowpit.

(-32° C) created large facets throughout the snowpack that persisted all winter. On December 17th a snowpit on Saddle Peak showed a 30 cm thick P+ hardness slab capping 50 cm of fist hardness facets (Figure 2). We made a video of the stability test (ECTP14, Q1) viewed 5,000 times on YouTube, pointing out that skier compaction would not affect this capped weak layer.

At the beginning of January, 2010 southwest Montana got a little over 2" of SWE which prompted an avalanche warning over our entire 10,000 sq. km forecast area—a first. Another 2.5 inches of SWE fell during the next five weeks, enough to keep slopes unstable. These weeks ended up being one of the most active human triggered avalanche periods in the Avalanche Center's history. For the Bridger Range, and specifically Saddle Peak, the real event began on Friday, February 12th and ended two days later. A storm dropped 2 ½ feet of snow (3.5" of SWE) with strong westerly winds which loaded Saddle Peak's east face and triggered avalanches throughout the Bridger Range (Figure 3). The new lift did not run over the weekend, shutting down access to the sidecountry. The lift reopened Monday morning, February 15th. Saddle Peak had a lot of traffic that day, even though the avalanche danger was rated *Considerable*. The mountain range had a stubborn, deep slab instability exacerbated by the massive load.

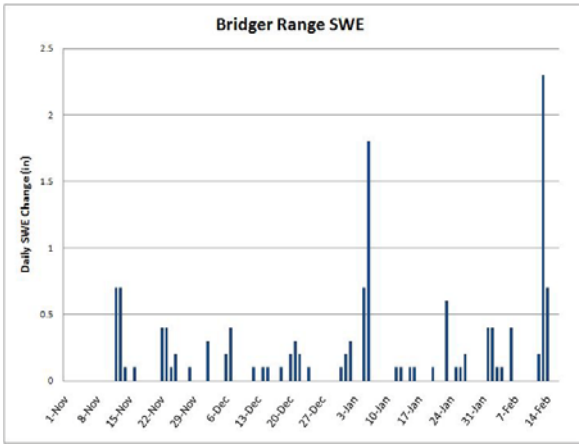

Figure 3: Daily snow water equivalent measured at Bridger Bowl Ski Area's Alpine Weather Station.

Figure 4: Crown line on Saddle Peak. The path of the triggering cornice off the ridge can be seen in the center of the photograph. (S. Perry)

1.4 Skier Compaction, Misconceptions

Observations and conversations with folks prior to the avalanche revealed some widespread misconceptions about the danger. The terrain, weather and snowpack all pointed to unstable conditions, yet the "human factor" acted as blinders to the instability (Fredston and Fesler, 1994). A robust "herding instinct" had skiers unquestionably following one another all season long and added a false sense of security (Tremper, 2009). Skiers and boarders consistently descended on top of each other, despite education efforts pointing out the dangers of this behavior. The most deeply held belief was that a tracked slope was safe—it would not slide because others already skied and tested it. Folks believed that months of skier compaction would make it stable, even though the weak layer was deeper than skis could reach. This belief was even shared by some fellow avalanche/ski patrol professionals who verbally expressed it to us. In fairness, we know that skier compaction matters, especially in a ski area where tracks are numerous and a slope's history is carefully tracked. However, the key is that the skier compaction affects the weak layer, but we knew from our December snowpack investigations that a hard slab capped the weak layer which would be unaffected by skiers.

Further, in the backcountry there are entire days without tracks, entire slices of the slope that don't see compaction. When, how, and exactly where compaction happens is unknown, and we don't know if it occurs during crucial times. Finally, we know it certainly doesn't work with deep or hard slabs. Unlike a ski area, there's no testing with explosives. The avalanche problem is a different beast in the sidecountry, yet it

certainly does not look that way to the public that only sees tracks, bumps and dozens of skiers.

2. EVENT

At the normal opening time of 10 a.m. on Tuesday, February 16th, the public rode the lift and hiked out-of-bounds to the summit of Saddle Peak. Skies were clear and tracks from the day before were in full view. They immediately started skiing the east face. At 11 a.m. a snowboarder hiked too close to the edge and accidentally broke off an ever growing van-sized cornice. To everyone's horror, it tumbled downhill 100 feet and fractured the slope at a buried rock band five deep and 1,000 wide and it ran 2,000 feet vertical down one of the most popular and heavily skied slopes on Saddle Peak (Figures 4 and 5). As predicted, it broke on the layer of facets formed in December. The avalanche danger was rated *Considerable* that morning. Twenty to thirty people were estimated to be on the ridge when it released, with less than ten folks having already skied it that morning. An unprecedented number of pictures and videos from the ridge, on the slope and from the ski area documented the avalanche and powder blast.

The official avalanche classification is: HS-ACu-R4-D3.5. As large as it was, it did not run full width. Half the slope stayed intact. A look at past events showed that in 1980 it pulled out the entire width, clearing out trees to create the run we ski today.

2.1 Who were these people?

On the day of the slide many of the folks on Saddle Peak were older and experienced and thought they were savvy to the current snow stability. An informal study weeks later showed 70% of folks skiing Saddle Peak were repeat customers. Surprisingly to us, adolescents and college students were anxious about the event and questioned us repeatedly about the circumstances leading up to the slide. Much of the older crowd had a different reaction: they felt like they knew the terrain and snowpack better than anyone else and were the most likely to self justify being there.

Figure 5: Full track of Saddle Peak. (J. Shankland)

2.2 Search and Rescue

People immediately sprang into action following the slide. Skiers on Saddle Peak performed multiple beacon searches in teams. Many were well practiced in avalanche rescue and their speed and thorough searches were invaluable during the critical first minutes. Bridger Bowl alerted Gallatin County Search and Rescue and then quickly responded with patrollers and dog teams. The Avalanche Center was in the first wave of SAR personnel and coordinated with the public and patrollers already searching. All obvious burial locations and debris were searched with no result. There was no one reported missing. The size of the slide and steep, rocky cliffs meant the avalanche was

unsurvivable. The runout zone was at risk from acres of hangfire since the entire second half of the bowl had not slid. As we searched winds picked up. Plumes of snow loaded the slope above as searchers looked for an unlikely victim. At 3 p.m. we called off the search for rescuer safety because of this rapid wind-loading. It was, thankfully, a victimless avalanche.

3. POST EVENT

The fact that no one was caught, injured or died provided the Avalanche Center with a unique opportunity to educate the community since the slide was front page news. Had someone perished, it is unlikely we could have been as critical or brutally honest about the situation. We wrote about it in our daily advisories for the next week. Our web traffic spiked 680% (950 hits to 6,500) the day after the slide. We posted pictures and video clips that day, did a live radio interview the next week, went back and did a post avalanche investigation, and held an hour long public forum at the library to present our findings and answer questions. This forum was filmed and posted online. We uploaded a total of six different videos on YouTube that have over 24,000 views, and one additional video posted by a person on the slope was viewed an additional 4,600 times. Our goal was to let as many people as possible know why the avalanche released and how luck was a large reason why no one died that day. We had to challenge some tightly held misconceptions about snow, avalanches and the terrain on Saddle Peak.

Verbal and written comments on the avalanche were varied. Some skiers acknowledged that they made serious mistakes. Others claimed the slide was a fluke or that the adjacent line they regularly skied was really okay. In one instance after the slide, despite all the incontrovertible evidence that the slope was unstable, a person walked into the General Manager's office at Bridger Bowl and claimed that if the Schlashman's lift was opened immediately after the storm on Saturday the avalanche would not have happened because skiers would have compacted the layers. The fact that the weak layer was too deep to be affected by skis was not something this 20+ year pass holder wanted to hear.

3.1 Misconceptions

1. Tracks on a slope create stability by breaking up the weak layer. Also, a season of tracks will always make a slope even more stable.
2. The stress from a skier's weight was not enough to trigger this avalanche. Only something enormous like a large cornice could have fractured the slope.
3. The ski area needed to open the lift, and consequently access to the backcountry, days earlier so it would have been further tracked and further stabilized.
4. Self justification: It was safe when I skied it the day before; or, because I ski this terrain all the time I inherently know about the snowpack and its potential danger.
5. Herding instinct: Others skied it without consequence so it must be safe.

The first and second misconceptions have grains of truth to them. Yes, skier compaction is known to help stabilize slopes, but not after the weak layer is deeply buried under a hard slab. Bigger triggers increase the odds of triggering an avalanche, but small triggers in the right spot trigger them as well. As educators, we focused our lessons away from these nuances of avalanches since they were not helping the public make good decisions.

The Avalanche Center confronted these common and dangerous misconceptions in our advisories, media interviews, articles and in our post avalanche public forum. Even so, we were surprised at how strongly people held onto these views even *after it slid*!

3.2 Lessons and Solutions

In the future we can teach the public better ways to identify information that matters most. Making

Figure 6: "We'll have to watch this weak layer. There's not enough weight on it now, but if…" (D. Richmond)

safe decisions involves searching for "Bulls Eye" data to determine if a slope is stable (Fredston and Fesler, 1994). We hope to get people away from assessing the snow using outlier data such as what type of trigger is needed or how many tracks are on a slope. We're focusing the discussion on the fact that it snowed a lot in a short period of time, that there was a known weak layer, and that there was ample evidence of recent avalanche activity on similar slopes in the range. We are also highlighting the lurking cornice and wind pillow hazard that is a regular occurrence in the Bridger Range (Figure 6).

The daily avalanche advisory has pertinent information every morning that answer the questions every backcountry skier needs to make a stability assessment. We concentrate on answering Bulls Eye data:

1. How much did it snow?
2. Where did it snow?
3. What were the winds doing and where is the wind-loading occurring?
4. Was there recent avalanche activity?
5. Are there weak layers in the snowpack?

Because of the popularity and visibility of Saddle Peak, we will continue to highlight this avalanche. This incident provides a unique opportunity to learn, since snowpack, terrain and the human factor dovetail tightly together and were so thoroughly documented. Through an updated "Stay Alive" movie posted on both Bridger Bowl's and our web site, a dedicated education program for high school, and advertising the dangers of sidecountry skiing to parents we hope raise the avalanche awareness of side country skiing even more.

3.3 Sidecountry versus Backcountry

Sidecountry terrain creates special challenges for both ski areas and backcountry avalanche centers. We have come to the conclusion that this terrain is more dangerous than backcountry terrain for two reasons. First, because there are so many people on this terrain, it is almost impossible to follow standard backcountry protocols like skiing one at a time. Second, the increased traffic creates a sense of safety that is often unwarranted, and this sense of safety leads to poor decision-making and poor travel habits. A challenge we face at the avalanche center is to effectively convey this message to the public.

4. CONCLUDING THOUGHTS

One surprising twist to this event is that it has shown us that it is impossible to educate some members of the public. For the past two years the Avalanche Center has constantly reminded people that Saddle Peak could avalanche and that they should be careful. Hundreds of skiers skied the peak every day and some in the community warned the Avalanche Center that we were risking our credibility by warning people too much about a slope that was safe due to skier compaction. After this avalanche we mistakenly believed that everyone would take a giant step backwards and give this area the proper amount of respect. Fortunately, some people have done this. However, much to our amazement, there is a sizable population that cannot or will not be reached. Even with the massive avalanche clearly evident, people continued skiing adjacent terrain that did not slide in the days following the avalanche. For some people, no amount of avalanche education or in-your-face evidence will dissuade them from their powder turns or the certainty of their belief that they know exactly what is going on in the snowpack. We need to realize that these people exist, but our time, our energies and our message will only reach those members of the public who are willing to listen. We do not have all the answers, but our strength lies in our ability and willingness to quickly adapt to learning and teaching opportunities as they arise.

5. ACKNOWLEDGEMENTS

This avalanche summary is made possible by the exceptional support of Bridger Bowl Ski Area: Randy Elliot (General Manager), Doug Richmond (Ski Patrol Director) and the entire ski patrol. We also could not have created this paper without the help of the Bozeman community who provided us with an incredible volume of pictures, videos and firsthand accounts, some of which arrived at our office as emails even as rescue attempts were being launched.

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