ANALYSIS OF UTAH AVALANCHE FATALITIES IN THE MODERN ERA

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1 Utah Avalanche Center

ABSTRACT: The Utah Avalanche Center (UAC) has records of Utah avalanche fatalities for the modern era, totaling 116 deaths. For this study, the first avalanche fatality of the modern recreational era occurred near Alta on January 1, 1940. Fatalities in the mining era, ending in the early 1900s, were not considered. The primary aims of this study were to understand who was getting killed in avalanches, where they were getting killed, and what types of avalanches were killing them. By understanding these factors, and looking at trends over time, we might start to better understand how to forecast, educate, and otherwise influence the decision making of winter backcountry recreationists in Utah. As with any papers looking at statistics, it might be tempting to look at these fatalities as just numbers. But at the end of the day, each incident is not a number at all. Each incident is a human being – a person with a family and a community, with dreams and aspirations whose life was taken from them by an avalanche.

1. INTRODUCTION
Utah is located in the central Rocky Mountains of North America and is characterized by an intermountain snow climate, known for its abundant snowfall, moderate temperatures, and excellent winter recreation. Avalanches pose significant risk to the backcountry traveler in the winter environment and have been responsible for 116 recorded deaths since the winter of 1939/1940. The Forest Service Utah Avalanche Center was founded in the spring of 1980 and began issuing daily avalanche bulletins the winter of 1980/1981 in an effort to “keep people on top of the greatest snow on earth instead of buried beneath it.” The Utah Avalanche Center (UAC) issues danger ratings with special emphasis on the particular avalanche problems, to include aspect, elevation, likelihood, size, and trend. By looking at the data to determine trends and patterns, we might be able to determine what user groups and regions might need particular targeting as well as forecasting improvements that might be made in the future.

2. METHODS
Data used for this study were gathered via Snowy Torrents accident reports, the Center for Snow Science at Alta, querying historical news databases, and (often typed or handwritten) incidents recorded and maintained by the Utah Avalanche Center.

2.1 Danger Ratings
The earliest avalanche forecast centers, based in Seattle, Washington, and Boulder, Colorado began issuing danger ratings on a 4-point scale (Low, Moderate, High, Extreme). The term ‘Considerable’ was added to the danger scale for the winter 1996/1997 in an effort to better describe what was then referred to as “Moderate to High danger”. In 2010/2011, the danger scale was amended to reflect travel recommendations as well as likelihood of triggering and expected size. Each avalanche center issues a single word Bottom Line danger rating to depict the overall danger for the day; however the Utah Avalanche Center (and others) often spatially and temporally segregate the day’s danger, sometimes with the use of “pockets” of the next higher danger rating. In this study, I “rounded up” pockets to the next higher danger level while defaulting to the highest danger rating on a day where the danger was segregated. For this study, I utilized the Bottom Line danger rating for the day and in some cases extrapolated a High danger rating for the day when an Avalanche Warning was issued. A few are Unknown. NR refers to No Rating. These include years prior to the creation of the Utah Avalanche Center in 80/81 or when a rating was not issued for that region or day.

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2.2 Assigning Avalanche Problems

After the Utah Avalanche Center began issuing avalanche advisories with info-graphic–supported Avalanche Problems in 2005/2006, the format has been widely adopted around the world. Since then, the newly "coined" Avalanche Problems have become central to any discussion of the avalanche phenomenon among practitioners and educators. The Avalanche Problems have included location (aspect/elevation), likelihood of triggering, expected size, and forecasted trend. Following up on the UAC’s work, the Colorado Avalanche and Information Center (CAIC) published forecaster guidelines for assigning and grouping the avalanche problems. For a study looking at avalanche fatalities 1998/1999-2012/2013, the CAIC developed additional criteria to assign avalanche problems, and these criteria can be found in Appendix A. As avalanches were not formally described by Avalanche Problem prior to 2005, I combed through the reports to determine the failure plane, fracture line depth, and snowpack history and retro-actively assigned an Avalanche Problem name for each incident.

3. RESULTS

3.1 Fatalities by Year

With 116 fatalities since January 01, 1940, Utah averages 1.52 deaths/year. Utah averaged 0.54 deaths per year from 1939/1940-1985/1986; 1.8 deaths per year from 1986/1987-1995/1996; 4.1 deaths per year from 1996/1997-2005/2006; and 3.2 deaths per year from 2006/2007-2015/2016 with a 30 year running average of 3.03 deaths/year. See Figure 1, below.

3.2 Fatalities by Region

Until the mid-1990s, the great majority of avalanche deaths occurred in the greater Wasatch range, as access and interest may have been greatest out of Salt Lake City, Park City, Ogden and Provo. There may also be some correlation with proximity to ski areas with 24 of the total 116 avalanche deaths stemming from access into either out of bounds terrain within or adjacent to the ski area. Figure 2 below gives an overall view of the proportion of avalanche fatalities by the seven regions as partitioned and forecasted for by the Utah Avalanche Center (Logan, Ogden, Salt Lake City, Provo, Uintas, Skyline, and La Sals). Figure 3 depicts trends over the last 30 years and clearly shows that the Uintas and Skyline areas have become regions of significant and growing avalanche activity. While Logan accounts for only six fatalities, it’s worth noting that there the Logan forecaster continues to investigate increasing numbers of close calls and severe accidents just across the Idaho border in the Caribou-Targhee National Forest. The La Sals suffered an incident in the spring of 1992 that killed four people, including the avalanche forecaster for that region, with a more recent snowmobiler fatality in 2006.

Fig. 1: Fatalities by Year

Fig. 2: Fatalities by Region

Fig. 3: Fatality Trends by Region

3.3 Fatalities by User Group
Figure 4 depicts the proportion of avalanche fatalities by user group (skier/snowboarder, snowshoer, snowmobiler, and other (camper, foot, climber, etc.). With the lone exception of a snowboarder fatality in upper Big Cottonwood Canyon of the central Wasatch Range in February of 1986, all of the avalanche fatalities until 1994/1995 involved backcountry or “side-country” skiers or those on foot (hiker, etc.). Figure 5 depicts the trends of user group fatalities from the past three decades as well as the winters spanning 1939/40-1985-86. Over the past twenty years, snowmobilers have overtaken skiers as the user group with the most fatalities. There is a strong correlation between user group and region and it should be noted that snowmobile use is prohibited in many areas of the central Wasatch adjacent to Salt Lake City due to water quality concerns. Significant innovations with mountain-specific snowmobiles occurred in the mid-1990s and there was a corresponding jump in snowmobile avalanche fatalities at that time.

It should be noted again that 24 of the total 116 avalanche deaths stemmed from access into either out of bounds terrain within or adjacent to the ski area – and these data trends are noted in Figure 5. As almost 1 in 5 fatalities are from recreationists leaving the ski area to enter either closed terrain or out of bounds terrain (sometimes called “side-country” terrain), they may be of a different mind-set and experience than those that begin their outing from a trailhead. While the overall numbers take into consideration in-bounds fatalities or pre-season fatalities prior to the resort being open for the winter, for this study, they are not included in the “side-country” numbers of those accessing terrain from an open ski area.

3.4 Fatalities by Aspect and Elevation

It did not come as a surprise that most fatalities occur on the northerly facing slopes. See Figure 7. Northwest through north through northeast facing slopes held just over 75% of the fatalities while terrain above 9500’ (upper elevation band) accounted for more (59%) than the mid and low elevations combined. Snow quality is of the highest quality on these aspects and it’s no coincidence that ski resorts are built with this in mind. Aspect also plays a role in relation to sun and wind, which, in turn, plays a role in the type of Avalanche Problem one may encounter. While recreational elevations in the winter environment range from 4500’ in the foothills above towns and municipalities to over 13,500’ on King’s Peak in the Uinta Mountains, most backcountry winter recreation occurs between 8000’ and 11,000’. The Utah Avalanche Center issues danger ratings for separate elevation bands for the three bands noted below in Figure 8.
3.5 Fatalities by Danger

As the term Considerable was not added until the 1996/97 winter, fatalities by danger rating for this study begin in that year. Utah has recorded 73 avalanche fatalities since then. Zero fatalities were recorded during Low or Extreme danger ratings, while Moderate, Considerable, and High account for 16%, 47%, and 37%, respectively, on days when a bottom line rating was provided. For 16 fatalities, no rating was given for the day (typically early season or on “off days” in the outlying areas). See Figure 9, below.

3.6 Fatalities by Avalanche Problem

Beyond issuing an overall danger rating, the Utah Avalanche Center further details the expected Avalanche Problem(s) the winter backcountry user is expected to find. Each Avalanche Problem is then further described and rated for aspect and elevation, likelihood, size, and trend. One of the main goals of this study was to look at which Avalanche Problems contributed to more deaths than others. In other words, Which Avalanche Problem(s) might be construed as “more lethal” than others? Surface hoar, faceted grains, and depth hoar played a role in most fatalities and this is best represented by the sheer numbers in the Persistent and Deep Slab categories. Figure 10 shows them in proportion to one another with the Persistent and Deep Persistent Slabs accounting for 69% of the fatalities. Snow cascading off a roof in Midway, Utah in January 1995 accounts for the lone roof-a-lanche in Utah. The two fatalities in Stairs Gulch of Big Cottonwood Canyon on April 28, 2001 may be the only reported glide avalanche deaths in the United States. Cornice fall resulted in the fatalities of six individuals. In each case, the weight of the victim(s) and cornice subsequently triggered another avalanche on the slope; however, for the purposes of this study, they were categorized as Cornice Fall.

3.7 Fatalities by Danger Rating and Avalanche Problem

Human triggered avalanches on persistent weak layers may be triggered days, weeks, even months after they formed while the danger for triggering avalanches on non-persistent weak layers may diminish to zero over the matter of a few hours to a few days. As such, persistent weak layers (noted here by Persistent and Deep Slab avalanches) often carry a Moderate (L2) danger long after they have been buried and ceased to be widely reactive. One of the goals of this study was to look at the proportion of Avalanche Problems that resulted in fatalities per danger rating. For this analysis, I grouped Persistent and Deep Slab avalanches together in one group while putting everything else into the “Other” group. For this study, I included Cornice Fall into the “Other” cat-
egory regardless of subsequent avalanching. See Figure 11 below.

![Avalanche Problem by Danger](image)

**Fig. 11: Fatalities by Avalanche Problem on a Particular Danger Rating**

## 4. CONCLUSIONS

In this study, I investigated the reported 116 avalanche fatalities in Utah for the modern era beginning in 1940; that is, fatalities in the post-industrial era aligned with recreation in the winter environment. Not surprisingly, the Wasatch Front areas (Ogden, Salt Lake City, Park City, and Provo) make up 69% of the fatalities since 1940. Still, the trends are clear, as one can clearly see a growing population recreating in the Uinta Mountains and the Skyline, terrain responsible for almost one-third of the fatalities over the past 30 years. While skiers and snowboarders comprise two-thirds of the fatalities since 1940, over the past 20 years alone, snowmobilers account for just over one-third of all avalanche related deaths. Nearly one in five fatalities involve people going into closed or out of bounds terrain from one of the mountain resorts.

In summary, while backcountry recreation continues its explosive growth in the Utah winter environment, evidence suggests that the number of avalanche fatalities has plateaued or even diminished over the past decade. It is noteworthy and clear that fatalities per user day have plummeted over the past few decades. Still, it must be concluded that continued outreach and education to snowmobilers in areas beyond the central Wasatch as well as recreational “side-country” skiers and snowboarders – and improved teaching and forecasting for Persistent and Deep Slab avalanche problems may well reduce the numbers of accidents and fatalities in the coming years.

### APPENDIX A: AVALANCHE PROBLEMS

#### Deep Persistent Slab (DS):
- Persistent weak layer of either faceted grains or depth hoar
- Average crown of 1.2 m (4 ft) or greater
- Destructive size of D3 or greater. Estimated destructive potential for broken trees gathered via reports.

#### Persistent Slab (PS):
- Persistent weak layer of surface hoar, faceted grains, or depth hoar, or bed surface in old snow (O)
- Average crown of 4 feet (1.2m) or less
- Destructive size of 2 or 2.5. Estimated destructive potential for broken trees gathered via reports.

#### Storm Slab (SS):
- Bed surface in recent storm snow (S) or at the new/old snow interface (I)
- Accident investigator described Storm Slab

#### Wind Slab (WIND):
- Bed surface in recent storm snow (S) or at the new/old snow interface (I)
- Accident investigator described Wind Slab
- Photographs showed characteristic lens shape of Wind Slabs

#### Wet Loose (WL):
- Snow was moist or wet
- Did not release as a cohesive slab

#### Wet Slab (WET):
- Snow was moist or wet in the starting zone
- Released as cohesive slab

#### Glide (G):
- Released as wet, cohesive slab
• Released on the ground

**Cornice Fall Avalanches (C):**
• Failure of overhanging masses of snow

**Roof (ROOF):**
• Occurred on the roof of a structure
• Bed surface was the structure

**Unknown (U) avalanches:**
• Lack of data prevented us from coding into one of the above avalanche problems