IDENTIFYING COMMON TRENDS IN PROFESSIONAL SNOW WORKER ACCIDENTS DURING AVALANCHE HAZARD REDUCTION WORK

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ABSTRACT: We examined 20 years (winters 1995-2014) of snow safety records at 3 Colorado ski areas to determine operational periods when avalanche incidents involving working patrollers were more frequent. We also analyzed fatalities that occurred during wildland fire suppression over the same period for similar increases in frequency. Records showed 51 ski area incidents over the study period, 53% of which occurred in a 30-day period centered on the first opening of upper elevation, expert, avalanche-prone terrain. The wildland fatalities showed a similar though less pronounced spike, with roughly a third of fatalities occurring in a 30-day period centered on the first date of Preparedness Level 5. We conclude that physical and organizational factors combine to create periods of peak stress in which accidents are more frequent.

KEYWORDS: snow safety operations, workplace safety, avalanche accidents, Colorado.

1. INTRODUCTION

Perhaps foremost among the safety concerns within the avalanche community are accidents involving professional snow workers being caught, injured or killed in avalanche incidents while working. One way to minimize the number of such accidents may be by identifying periods of increased accident frequency during a typical operational season. By creating an awareness of our vulnerability during these periods, we can adjust decision-making accordingly to help reduce workplace accidents.

In this paper, our goal is to identify peak periods of stress in a ski area snow safety operation that might allow us earlier recognition of when we and our coworkers are more likely to be involved in an avalanche while conducting our duties. We analyzed twenty years of archived snow data, snow safety staff field books and institutional knowledge at three Aspen Skiing Company mountains that have avalanche terrain. Our hypothesis is that physical and organizational factors combine with a weak snow structure to create a peak period of stress where there is a spike in accidents.

The idea of identifying peak stress periods grew as a result of an anecdotal conversation concerning a concentration of fatalities at certain times of the wildland fire season. A spike in line-of-duty deaths has been observed at the first onset of significant national fire activity. At this time, certain regions have already been immersed in activity; firefighters in these regions are mentally focused and on top of their game. Other regions have remained dormant, and it stands to reason that firefighters in these areas are less mentally focused on fire and safety. As the fire season ramps up, these converging factors - fatigue in some firefighters and unawareness in others - play together to create an environment where mistakes leading to death are more likely. We believe a similar pattern can be identified in snow safety operations.

2. DATA AND METHODS

2.1 Study Area

Data was collected from three of the four ski areas owned and operated by the Aspen Skiing Company. These are located within fifteen miles of each other in the central Rocky Mountains, near Aspen, Colorado. The snow climate is a typical continental climate with high elevations (up to 3718 m a.s.l.), cold temperatures and a settled snowpack with a height-of-snow less than 200 cm (Mock and Birkeland, 2000).

At the opening of the ski season the Snowmass Ski Patrol brings patrollers back to work in a staggered progression. The five full time snow safety staff (a.k.a. “Flakes”) are the first back to work. Their return to work coincides with the onset of snow near October 1, and their primary focus is...
compaction and layer disruption of early-season snowfall. A large portion of patrollers are then brought back to work around November 1 for the ski area set-up and to help with compaction work in avalanche terrain. Bootpacking is the most common method of early season compaction work. Bootpacking days start early and are physically demanding, leaving patrollers fatigued. As the ski area opens more terrain, more patrollers are called back to work and assist with the early season compaction work. In an effort to reduce fatigue for the bootpackers, they are rotated between days of front-side work and bootpacking. As terrain is opened, avalanche hazard reduction methods switch from compaction and layer disruption on foot to explosives testing and layer disruption by skier traffic and explosives.

2.2 Data Collection – Ski Areas

We collected data through discussions with patrollers and from documentation in snow safety staff field books. Each data point represents an avalanche incident, defined as one patroller, working, within the ski area permit boundary, unexpectedly being caught while doing avalanche hazard reduction work in the snow and taken for a ride. We excluded any incidents described in discussions that did not have a clear date or occurred before the winter of 1994/1995. We considered documentation of an incident in a field book significant enough to use the event as a data point. We then rated the severity of each incident on a scale from 1 to 5 as follows:

1. The least severe situation. Includes going for a ride with no injury or loss of equipment.
2. Going for a ride and losing equipment.
3. Going for a ride with an injury documented.
4. Going for a ride with an injury requiring hospitalization.
5. Death.

We chose to normalize our data points to the opening of an area of upper-elevation, expert terrain known as Hanging Valley. The opening of this terrain typically coincides with a significant portion of the ski area being opened for the first time and the majority of employees being brought back to work. We retrieved opening dates first from snow safety staff field books and then verified the dates using archived newspaper articles. For each incident, we calculated the number of days between the opening of Hanging Valley and the date it occurred. We assigned a negative value to any event occurring before the opening day, and a positive value to any incident occurring after the opening day.

We then compared the number of days from the opening of Hanging Valley to the number of incidents that occurred on each normalized date. To help visualize the data, we binned and graphed the number of incidents per normalized date in five- and seven-day intervals.

2.3 Data Collection – Wildland Fire

We compiled dates of wildland fire fatalities from 1994 to 2014 that occurred between the first of May and the 31st of October. We used this time frame for two reasons: it is the active fire season, and it has a similar duration to our ski season. We omitted any fatalities due to medical issues such as heart attacks because our goal was a data set where fatalities were based on operational causes, not on an individual’s health.

We then found the first occurrence of each Preparedness Level (PL; 2, 3, 4, & 5) for each year (https://www.nifc.gov/safety/safety_documents/Fatalities-by-Year.pdf). We normalized each fatality to the first date of PL’s 2, 3, 4, and 5 separately, for the year in which they happened. We created four separate graphs, one for each PL, comparing the number of fatalities to the number of days from the first occurrence of that preparedness level. Any fatality prior to the first time the preparedness level was reached has a negative value, and each fatality after the first occurrence of the PL has a positive value.

We looked closer at PL 5 because circumstances at this level closely resemble our early season operations. It is a time when there are a multitude of fires throughout the US. The amount of activity has the potential to exhaust all fire resources; 80% of incident management teams and crews are committed to fire at this time. We took the graph for PL 5 and binned the days by seven. This created a graph analogous to our graph for the incidents in snow.

3. RESULTS

We gathered 56 data points from three of the four mountains within Aspen Ski Co. We omitted five of the incidents; these happened prior to the start of the study or did not have a clear date of occurrence. We ended up with 51 data points; the majority of incidents came from the Snowmass and Aspen Ski areas.
The 51 incidents were spread among the 20 years of the study with significantly more incidents occurring in some years while no incidents occurred in five of the 20 years (Fig. 1; Table 1). The severity of incidents was generally low for all years, with 49 of the 51 incidents rated as non-severe (severity 1-3). The remaining two incidents were both fatalities. Though incidents occurred throughout the winter, they were concentrated in December and January (33 of 51, or 65%), with only 15 incidents (29%) recorded in the 2.5 months after January 31.

We found a similar though less pronounced spike in wildland fire deaths in the two weeks before and after the first date of PL 5. The dataset totaled 66 fatalities. Of these, 21 (32%) occurred in a 28-day period centered on the first date of PL5 (Fig. 3).
4. DISCUSSION

Our analysis shows that during the 20-winter study period there was a consistent spike in avalanche incidents involving snow workers during the 15 days around the first opening of expert, avalanche-prone terrain. One obvious explanation for the observed spike in incidents is the area’s weak, continental snowpack. However, if this were true, we would expect to see a continued trend of incidents throughout the season, but in fact the number of incidents diminishes as the calendar year progresses except for a small spike later in the season. It does appear that the number of triggered avalanches remains similar throughout a typical season, but because triggered avalanches are not consistently recorded in fieldbooks we could not draw a definitive conclusion.

Thus we conclude that there are other causes for the distinct spike in incidents around the opening of Hanging Valley, although snowpack structure may be a contributing factor. Snow workers who have been bootpacking are physically fatigued and, additionally, are experiencing pressure to open terrain seeking snowpack compaction. Also, concerns about low snow cover and the hazard it presents to skiers have to be taken into account.

Meanwhile, patrollers with later call back dates are not mentally acclimated to working in avalanche terrain. While the early season compaction these patrollers provide is critical, bringing them up to speed can also reduce the overall effectiveness of the program causing additional mental stress for snow safety staff.

Taking into account the pressures stated above it would make sense that incidents are occurring more frequently prior to terrain opening. Lack of acclimatization, combined with the other external pressures that go into first opening terrain are intensified during this period. Once Hanging Valley has been opened for the season, roughly half of the avalanche terrain at Snowmass has been deemed relatively safe for the skiing public, significantly reducing stress and workload.

We found a similar trend in incidents involving wildland firefighters. Although we expected to see the spike in deaths occurring earlier in the fire season, our data shows that the highest fatality rate occurs closest to the initial move to a preparedness level of five. The firefighters working at this time have been working for months prior, and are likely experiencing a great deal of mental and physical fatigue.

When comparing the fire data to snow incidents it makes sense that the spike occurs later than we expected. The time of the spike in accidents during preparedness level five closely resembles the 30 day period around the opening of Hanging Valley where we saw a higher number of avalanche incidents. During this period, not only are snow safety workers fully immersed, but other patrollers are working hard to get the front-side of the mountain open as well. In both situations everyone involved is at their maximum workload. Considering the similarities of both operations it would be wise to use knowledge from one to improve the other.

5. CONCLUSION

We have found an obvious peak period within our operation when a significantly greater number of avalanche accidents occur. There are procedures that have proven to be effective in fire management that are designed to mitigate fatigue and improve decision making during peak stress periods. We believe the snow industry can use these strategies to create a safer operation.

We can identify procedures within our operations to change. Allowing supervisors the discretion to grant extra days off to patrollers who are overworked would help to reduce fatigue. Bringing back patrollers earlier than needed will supply a larger staff with greater mental focus, as well as provide enough employees to grant the days off needed to reduce fatigue. Although identifying and implementing these procedures is an important step, the real solution is creating a conscientious work environment so that acuity is not lost during stressful periods.

Snow safety operations are extremely dynamic; between terrain, staffing, and operational organization, there are no two that are identical. Although we were able to identify our peak stress period, this time frame is not universal within the ski industry. Likewise the solutions that work for us will not work for everyone. It is creating an awareness of the timing of high stress periods at each operation that can reduce the exposure of ourselves and coworkers. Once each ski operation identifies its high stress period they can implement changes that make sense to their situation and create a safer environment.
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