

OPERATIONAL STRATEGIES FOR IMPROVING AVALANCHE RISK PERCEPTION AMONGST WORKERS: A PRACTICAL APPROACH TO CULTURE CHANGE

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ABSTRACT: The Snowbird Snow Safety team has identified a need to better communicate the avalanche risk analysis process to ski patrollers on the front line. Recently, we have recognized that patrollers have been uninformed of the expectations that we, as forecasters, hold for them regarding the level of residual risk they accept while performing avalanche hazard mitigation. This lack of communication has led to misunderstandings of risk acceptance and misgivings toward the forecasting team. By implementing new operational strategies, our goal has been to address these deficiencies to improve our workplace culture.

In this paper we will discuss three operational strategies that have been implemented at Snowbird to shift the culture towards more transparency and mutual trust between ski patrollers and the Snow Safety (forecaster) team. The first operational strategy outlines methodic record-keeping of patrol avalanche involvements, made accessible to both patrollers and forecasters. The second strategy will discuss targeted communication of methods for reducing vulnerability and exposure to patrollers performing avalanche hazard mitigation. This was a crucial step towards getting patrollers and forecasters on the same page with perceived risk, and segued into the question of what *is* an acceptable level of risk for patrollers? In answering this query, the forecast team developed their third strategy: an operational risk band specifically for patrollers, presented in pre-season training.

Since integrating these strategies, we have noticed a shift toward higher levels of reporting avalanche involvements and near-misses, more open discourse about these events, and a stronger relationship between patrollers and the forecasting team. This paper will discuss how these strategies were developed and the challenges faced in communicating them to the team.

KEYWORDS: Risk communication, operational risk band, culture change, risk acceptance

1. INTRODUCTION

Risk communication and assessment are nuanced processes that involve and impact the work and safety of over eighty ski patrollers at Snowbird Resort. Snowbird's avalanche program has a rich history of developing industry-leading techniques and protocols for avalanche mitigation work (Hoopingarner et al., 1971; Fitzgerald, 2022) which, until recently, did not address risk perception or expectations of risk acceptance thresholds for patrollers conducting avalanche mitigation. The Snow Safety team has acknowledged a trend of misunderstanding and, sometimes, mistrust from the patrol which has led to strained relations between patrollers and forecasters. We, as forecasters, have implemented three operational strategies over the past several years to improve risk perception and acceptance expectations, communication and trust between the patrol and Snow Safety.

2. LOCATION AND PROGRAM DESCRIPTION

Located in Little Cottonwood Canyon in the Wasatch Range of the Southern Rockies, Snowbird Resort was founded in 1971 and spans over 2500 acres with three drainages. Salt Lake City lies less than twelve miles down-canyon, and in the metropolitan area, boasts a population of approximately 1.2 million people (U.S. Census, 2025).

Snowbird's avalanche program is currently overseen by an Assistant Director of Snow Safety and two Snow Safety supervisors, including the author. The three of us work closely with three Ski Patrol super-

visors and the six of us collectively report to the Director of Ski Patrol. Our group of three is responsible for producing daily avalanche hazard forecasts, planning and executing risk treatments, delegating personnel and resources to carry out risk treatment, and training patrollers

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and workers in other departments. We are expected to communicate closely with stakeholders in the company including the Senior Director of Mountain Operations and the President to ensure operational risk tolerances are aligned for opening terrain and providing a product for the paying public.

The ski area has a comprehensive avalanche program that addresses over seven hundred start zones using artillery, heli-bombing, twenty-one remote avalanche control systems (RACS), two avalaunchers, and over forty hand routes (Snowbird Ski Patrol Winter Operations Manual, 2024). The program requires over eighty full and part-time patrollers with around thirty-five scheduled each day.

3. PROGRAM HISTORY

Since 1971 when the first avalanche control plan was written (Hoopingarner et al., 1971), limited updates have occurred to our procedures. To our knowledge, the topic of risk was never addressed in a written manual but passed down generationally in on-the-job experience and through anecdotal accounts from patrollers. In the last ten years, the Snow Safety team has created a more structured training regimen for patrollers consisting of explosives handling, communication (snowpack observations, avalanche observations, safety protocols), route running procedures, avalanche forecasting, and avalanche rescue (Snowbird Ski Patrol Winter Operations Manual, 2024). These topics were covered in both a written format for patrollers to reference, and as hands-on exercises where appropriate. This established a standardized Snow Safety curriculum, but we were still experiencing strained relations with the patrol which hindered opportunities for open dialogue and more cohesive teamwork.

To try and understand why these issues persisted, we conducted annual, anonymous online surveys for ski patrollers. Subsequent to these surveys, casual and formal one-on-one interviews were carried out with the intention of providing workers the opportunity to share concerns and give feedback to Snow Safety. In the case of the anonymous surveys, much of the feedback could be distilled into two grievances: lack of communication and feeling heard by Snow Safety, and that Snow Safety was overlooking patrollers' personal safety. One-on-one interviews rarely provided actionable, critical feedback.

Looking back at how patrollers have navigated accidents and hardships in the line of duty also played an important role in understanding the historic relationship between patrol and Snow Safety. During periods of hardship, it was apparent that patrollers were not comfortable bringing their concerns and feedback directly to us, and without open lines of communication, there was a growing sense of frustration and mistrust towards leadership.

4. CHALLENGES

Reflecting on patrol feedback and observed behavior over multiple years, we identified a possible lack in communication to patrol of our risk assessment process (Canadian Standards Association, 2018). Sharing the daily hazard forecast and mitigation plans for the day had been standard practice but other considerations such as forecaster uncertainty, heuristics, and perceived consequences, had not been shared in depth on a regular basis. We also recognized that there had been no standard or written reference for expectations for patrollers accepting residual risk during avalanche mitigation. Without these expectations clearly laid out, there was no opportunity for us to ensure both parties were on the same page with what an acceptable level of risk was.

In assessing the big picture of how a patrol team of over eighty functions, time and the ability to gather evidence were significant hurdles. A focused study of team dynamics was not realistic due to operational demands and so correlations have been drawn through candid observation and survey feedback. With so many unknown variables at play, conjecture with trial and error were the primary methods used to establish the following operational strategies for improving trust with the patrol, communication, and risk perception and acceptance thresholds.

5. OPERATIONAL STRATEGIES

5.1 Record keeping

At the beginning of the 2023-2024 season, we introduced monthly summaries to detail weather events, snowpack characteristics, avalanche cycles, and near-misses, incidents, and accidents- also referred to as 'events' (Reference guide for employer incident investigations, 2023). A season summary was released with a complete catalogue of these events that provided commentary on factors and trends that may have contributed to each one. These summaries were made available in both hard copy and digital formats for the patrol to reference at any time. Our intent behind these summaries was to show a level of transparency with critical introspection about what went well and what we could do better in the future.

5.2 Communication

In the Fall of 2024, we introduced risk perception presentations to pre-season training. These presentations communicated what our daily objective was (to safely open as much terrain as possible each day) and also touched on the inherent risks associated with being a ski patroller, such as the possibility of being caught in an avalanche. We made sure to explain the elements of risk, how we use data and weather products on a daily basis to create an informed hazard analysis, and the steps we take to reduce both the vulnerability and exposure of patrollers performing hazard mitigation. We also revisited an existing tool in our toolbox: the morning meeting. We knew that these meetings needed to be brief while imparting the anticipated avalanche hazard, mitigation plan, and 'big picture' objectives for the day. However, we theorized that these meetings required more candid information sharing such as forecaster uncertainty, possible consequences and outcomes of mitigation work, and human factors at play such as fatigue or inexperience. Our hypothesis was that by sharing these thought processes we could open up discussion on risk perception and acceptance.

5.3 Operational Risk Band

An Operational Risk Band (ORB) (Figure 1) was adapted to Snowbird's avalanche program by the Assistant Director of Snow Safety, Chris Bremer (Bremer, 2023), and incorporated into pre-season training presentations in 2024. The purpose of the ORB was to provide an infographic that clearly laid out risk acceptance expectations for patrollers while they were performing avalanche mitigation. In the context of expected risk acceptance at Snowbird, we felt that it was acceptable for workers to be involved in up to a size 1.5 avalanche (relatively harmless to people (Snow, Weather, and Avalanches, 2022)). Above the upper limit of acceptable risk (unacceptable risk) is one patroller being involved in a size 2 or greater avalanche (could bury, injure, or kill a person (Snow, Weather, and Avalanches, 2022)), or several workers being caught in less than a size 2 avalanche. The lower limit of the Risk Band broaches the possibility of missed opportunities to control a slope or not engaging avalanche terrain at all.

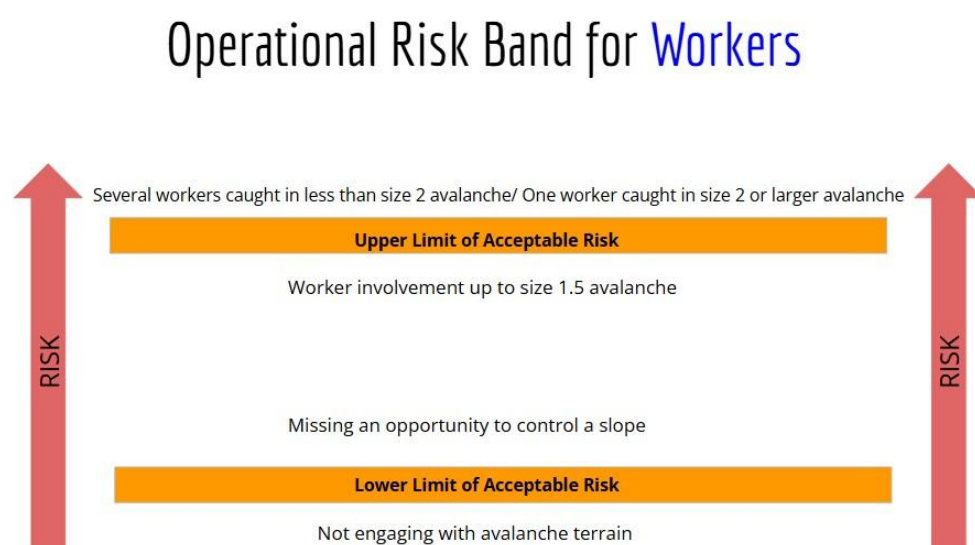


Figure 1: Operational Risk Band for Workers developed by Chris Bremer, Snowbird

This infographic is a relatively new addition to our training curriculum, and strategies for incorporating its content into training and discussions still have room for improvement. We will continue integrating these expectations into the avalanche program so that incoming and longtime patrollers can be made aware of what we expect of them; if both parties can be on the same page with what an acceptable level of risk is, misunderstandings and misgivings should trend downwards.

6. OUTCOMES AND FUTURE WORK

The process of creating culture change has been slow and at times, met with much resistance. My personal motto of, 'nothing worth doing is easy' has been a constant companion throughout this journey. In the past few years small changes have started to take place that over time, have indicated a trend toward more direct and open communication from patrollers to Snow Safety and vice versa. While these observations are mostly anecdotal, we feel that many patrollers are developing a better understanding of risk perception and acceptance evidenced in the way they undertake avalanche mitigation, their comfort level with discussing uncertainty, and their candor about unintended consequences (near-misses, incidents, accidents). They have been more open to debriefing these unintended consequences and in turn we have met them without judgement or repercussions. Our hope is that this positive feedback loop continues to gain traction and momentum, encouraging higher rates of event reporting, discussion, and feedback sharing. Though we are on our way to strengthening the foundation of the patrol-Snow Safety relationship, there is more work to be done. Continuing to integrate and fully optimize the operational strategies outlined in section 5 will be a large part of this work. Equally important is that current and future ski patrol leadership (Snow Safety and Ski Patrol supervisors) continues to prioritize their relationship with patrol, recognizing the need to adapt and revise our approach as the culture demands.

Future considerations of this topic include speaking to other avalanche programs to ascertain whether they have an ORB in place and how they align with Snowbird's. We believe that there is an opportunity to explore the implications of adapting an Operational Risk Band for patrollers and intend to conduct industry outreach to get a general impression of what others view as an acceptable level of risk for patrollers conducting avalanche mitigation. Based on these findings, an ORB could be adapted not only for other ski areas but also for guiding and industrial workers in the avalanche industry.

7. CONCLUSION

Snowbird's Snow Safety team highly values its relationship with the patrollers who carry out mitigation work on the mountain. Without this team it would be impossible to achieve our daily objective to safely open as much terrain as possible. We have recognized the barriers to a strong relationship between patrol and Snow Safety and have acknowledged the need for change. Record keeping, communication, and an ORB are three operational strategies that have been implemented over the past several years to improve patrollers' risk perception, communication practices, and clearly outline risk acceptance expectations. While change has been slow and uncomfortable, little-by-little our culture is shifting towards transparency and trust. Continuing to support this shift will be a work in progress for the foreseeable future and hopefully bring value to the avalanche industry on a larger scale.

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