

# UNDERSTANDING EXPOSURE TO AVALANCHE TERRAIN AND AVALANCHE INFORMATION PRODUCT USE OF SNOWSHOERS AND WINTER HIKERS: INSIGHTS FROM MOUNT SEYMOUR PROVINCIAL PARK

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**ABSTRACT:** Snowshoeing and winter hiking has experienced a tremendous boom in the last decade. To better serve this community with effective avalanche safety messages, it is critical to have an in-depth understanding of the extent they travel in avalanche terrain, what level of avalanche skills training they possess, and where they get their information for undertaking winter backcountry trips. To obtain this information, we conducted intercept interviews with snowshoers and winter hikers at the main trailhead of several popular snowshoe and winter hiking trails in Mount Seymour Provincial Park outside of Vancouver, B.C, Canada. Our analysis dataset included responses of 510 participants. We used the maximum ATES (Avalanche Terrain Exposure Scale) rating of typical trip destinations participants shared with us as a general measure for their exposure to avalanche terrain. We found that all study participants expose themselves to at least some levels of avalanche terrain: 58% of participants reported to travel in challenging terrain, followed by 29% in simple terrain, and 13% in complex terrain. This is in stark contrast to the low awareness and concern for avalanches in general, low levels of formal avalanche skills training and use of avalanche safety gear, and low awareness and use of existing avalanche safety products and services including the public avalanche forecast. The main reason participants did not use the forecast or take an avalanche safety course was because they do not think that they expose themselves to avalanche terrain, which contradicts their exposure on their stated trip destinations. These results highlight that initiatives raising awareness of what constitutes avalanche terrain and how to recognize it, as well as decision support tools that indicate appropriate trails under existing conditions offer promising avenues for improving avalanche safety among snowshoers and winter hikers.

**KEYWORDS:** Risk communication, avalanche safety, user characteristics

## 1. INTRODUCTION

Avalanche safety organizations around the world provide various products and services to help recreationists make informed decisions about when and where to travel in the backcountry without unnecessarily exposing themselves to avalanche hazard. In developed countries, these products and services typically include daily avalanche forecasts that summarize the hazard conditions of the day, a diversity of mapping products that display the seriousness of the terrain (e.g., Stat-ham & Campbell, 2024; Harvey et al., 2018), decision support tools that help users to apply the hazard information from the forecast to terrain (e.g., Haegeli, 2010, Schmudlach & Köhler, 2016), and avalanche skills courses that teach recreationists how to use the available tools to make informed risk management decisions.

While it is critical that the provided information is trustworthy, credible, and accurate, it is equally

important that it resonates with the intended target audience. Hence, having an in-depth understanding of the context, needs, and capabilities of the audience is a critical prerequisite for designing effective avalanche safety interventions (National Research Council, 1996: Lundgren & McMakin, 2018;).

There is a growing body of social science research on avalanche risk communication, but existing studies have predominantly looked at backcountry users in general, which are typically dominated by backcountry skiers and snowboarders (e.g., Neweduk, 2023; Finn, 2020, Engeset et al., 2018, Ng et al., 2015). More specific user-group focused research has also been done to understand the risk characteristics of recreationist groups such as out-of-bounds skiers and snowboarders (Gunn, 2010; Haegeli et al., 2012, Nichols et al., 2018) and mountain snowmobilers (Strong-Cvetich, 2014; Haegeli et al., 2020) to facilitate the design of effective avalanche safety messaging.

The activity of snowshoeing and winter hiking has seen a dramatic increase in popularity in the last decade. Bürgi et al. (2020) shows that the proportion of the Swiss population participating in snowshoeing has almost tripled from 2008 to 2020

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(1.3% to 3.3%). While there are no comparable population wide trend statistics available for Canada, indirect indicators such as sales of snowshoes have also increased (Campbell & Haegeli, 2022), and consistently busy trails and sold-out rental fleets of snowshoes on busy weekends at popular mountain resorts signal a growing community.

However, snowshoeing and winter hiking in mountainous terrain is not without risk. Over the last ten winters (2014-2023), 15 of 110 avalanche fatalities in Canada (Avalanche Canada, n.d.) and 11 of 270 in the United States (Colorado Avalanche Information Center, n.d.) were snowshoers or winter hikers. In 2017, for example, five snowshoers on Mount Harvey, B.C., and two snowshoers near Mount Hector in Banff National Park, Alberta, were killed in avalanches in Canada (Avalanche Canada, n.d.). In 2021, one snowshoer and two dogs were killed at Yule Creek, CO, and another two snowshoers and one dog at Hoosier Pass, North Star Mountain, CO (CAIC, n.d.). These events highlight that snowshoers and winter hikers do expose themselves to serious avalanche hazard and should be considered when designing avalanche safety information products.

Despite the considerable need to help snowshoers and winter hikers to make better informed avalanche safety decisions, to our knowledge, there has not been any research specifically targeting this user group so far. To address this knowledge gap, this study aimed to collect information on the following three questions:

1. What are the general levels of avalanche terrain that snowshoers and winter hikers expose themselves to?
2. What are snowshoers' and winter hikers' use of formal avalanche safety products and services (avalanche skills courses, public avalanche forecast, etc.) and how do their practices relate to their exposure to avalanche terrain?
3. What are the common reasons for the use or non-use of formal avalanche safety products and services?

A better understanding of these questions will identify challenges with existing avalanche information products and highlight opportunities for new developments that better resonate with the needs and common practices among snowshoers and winter hikers.

## 2. METHODS

### 2.1 Study location

To address our research questions, we conducted intercept interviews at the main trailhead on Mount Seymour, a popular snowshoeing and winter hiking

area on the North Shore Mountains close to the metropolitan area of Vancouver, British Columbia (B.C.). Both the resort-maintained snowshoe trails and the uncontrolled routes outside the resort for backcountry skiing/snowboarding, snowshoeing and winter hiking see a lot of traffic and offer varied terrain in close proximity to Vancouver, making this location an effective area to connect with a broad demographic of snowshoers and winter hikers.

### 2.2 Study design

The design of our study and interview script was informed by two roundtable discussions with multiple community partners including Mt Seymour Resorts, B.C. Parks, B.C. Parks Foundation, Avalanche Canada, B.C. Adventure Smart, North Shore Rescue and Canada West Mountain School. The roundtable allowed us to build on the existing community knowledge about avalanche awareness challenges among snowshoers and winter hikers, facilitate access to the snowshoeing and winter hiking communities, and ensure the relevance of our research for avalanche warning services and educators.

Our primary research instrument was an in-person 10–15-minute trailhead intercept structured interview, which consisted of multiple sections aimed at addressing our research questions and central objectives. The interview included questions on a) *socio-demographic* variables and b) *experience levels* to get a general overview of the population; c) *Typical trip destinations* to get a sense of where participants go snowshoeing and winter hiking in general; d) *Perceived hazards and risks* to get a general sense of participants' concern for and awareness of avalanches; e) *Formal and informal information sources* to understand how participants plan winter backcountry trips, including questions specifically about the avalanche forecast and the avalanche bulletin user typology (St. Clair et al., 2021); and f) *Formal level of avalanche skills training*, to see where participants have taken a course to develop their avalanche risk management skills.

### 2.3 Data collection

The interview script and recording method were initially tested in the winter of 2022/23, which helped amend the final methods. The main data collection effort took place throughout the 2023/24 winter season (Dec. 23, 2023, to Apr. 1, 2024), between 10:00 am and 2:00 pm on weekends and holidays.

Interviews were conducted at the Mount Seymour main trail trailhead by one lead researcher with the help of up to two research assistants (Fig. 1). Snowshoers and winter hikers either departing or returning from their trip were approached for this study, and it is possible that multiple members of a single group were interviewed. Since our study targeted the recre-



Figure 1: Setup for intercept interviews at Mount Seymour.

ational audience, we did not interview professionals employed in the avalanche industry (e.g., guides, forecasters).

We conducted the interviews as natural conversations with study participants without providing response options and letting participants come up with their own answers. However, researchers recorded participants' responses in a structured way using a survey form implemented on the Survey Monkey app on a tablet.

Since the interview questions focused on participants' snowshoe and winter hike practices in general and did not relate to the conditions of the day of the interview, we will not report on the avalanche conditions during the data collection period.

#### 2.4 *Data analysis*

We conducted our analysis in the R statistical environment (R Core Team, 2024) and used general descriptive statistics to understand the distribution of each variable. We employed Pearson Chi-Squared or Wilcoxon rank-sum tests to examine differences between groups and considered  $p$ -values  $< 0.05$  to be indicative of statistically significant differences.

Participants' exposure to avalanche terrain, one of the foundational variables for the present analysis, was derived from the participants' stated typical trip destinations. For each trip, we found the relevant

ATES (Avalanche Terrain Exposure Scale) rating from the trip planning website of Avalanche Canada (<https://avalanche.ca/planning/trip-planner>). If no rating was available for a destination, the trip was rated by Cam Campbell of Alpine Solutions Services, one of the key contributors to the latest versions of ATES (Statham and Campbell, 2024) and highly experienced avalanche terrain mapper.

ATES is an avalanche terrain classification system used to assess and communicate the exposure of backcountry terrain to the threat from avalanches, independent of daily hazard conditions (Statham and Campbell, 2024). The terrain ratings range from Non-Avalanche, Simple, Challenging, Complex, and Extreme based on a variety of characteristics such as slope angle, defined avalanche paths and start zones, and presence of terrain traps, among other factors. We used the highest ATES rating of participants' stated trip destinations as a general measure for their exposure to backcountry terrain capable of producing avalanches. We then used Kendall rank correlation coefficients to relate participants' avalanche safety practices to their maximum exposure to avalanche terrain.

### 3. RESULTS

We interviewed a total of 510 snowshoers or winter hikers. Since not all participants answered all questions, response totals for each question vary throughout the analysis.

Our sample covered a wide range of experience levels ranging from people in their first winter of snowshoeing or winter hiking (11% of sample) to participants who had been pursuing these activities for more than 20 years (11%). However, the bulk of our participants had 3-5 years (34%) or 6-10 years (23%) of snowshoeing or winter hiking experience. The number of days participants spend snowshoeing or winter hiking each winter also varied substantially, but the mode of the distribution was at 3-5 days per winter (31%), and there was a strong positive correlation with years of experience (Kendall tau = 0.32;  $p$ -value  $< 0.001$ ).

Most of our participants (78%) did not engage in any other winter backcountry activities exposed to avalanche hazard, but the ones who did were primarily engaged in backcountry or out-of-bounds skiing/snowboarding (17% and 10% respectively). Exactly half of our sample use their own snowshoes and microspikes for travelling in the backcountry. An additional 23% only travel with microspikes, 13% just with hiking boots, 7% only with their own snowshoes and the remaining 7% rent snowshoes at least sometimes. Most of our participants (80%) reported not to be part of an organized outdoor community (e.g., club, online community). English was the first language for about two thirds of our sample, followed by Mandarin/Cantonese (6%), Spanish (3%) and

French (3%). However, 84% of participants whose first language was not English, stated that they understand technical information in English as well as in that of their native language.

The responses to our question about typical trip destinations revealed that all study participants expose themselves to at least some levels of avalanche terrain: 58% of participants reported to travel in challenging terrain, followed by 29% in simple terrain, and 13% in complex terrain. None of the participants reported traveling in extreme or only non-avalanche terrain. They mostly travel in self-organized groups (88%) where they contribute substantially to the decision-making process (45%) or are the primary decision-maker (31%). Only 11% of participants stated that they generally travel alone. Overall, 30% of our sample reported to at least sometimes leave marked/established trails, but this proportion depended strongly on the type of terrain people travelled in (Kendall tau = 0.26; p-value < 0.01). It was 56% among participants hiking in complex terrain compared to 15% among participants only travelling in simple terrain.

Concerns about avalanche hazard varied widely among participants. Almost half of the participants were either unaware that avalanches could be a concern on their trips or not concerned about avalanches (15% and 31%). Another 18% considered avalanches a minor concern on their trip, 31% a key concern, and 5% the most serious concern. These proportions varied substantially across our sample with higher levels of concern among participants travelling in more serious avalanche terrain (Kendall tau = 0.15; p-value < 0.01). However, even among participants travelling in complex terrain (n = 64), the proportion of unaware (6%) or not concerned (28%) was still substantial (Fig. 2).

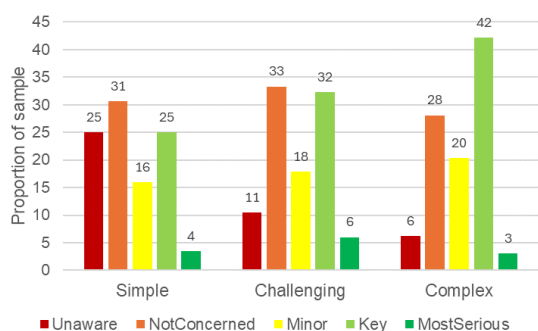


Figure 2: Distribution of participants' concern about avalanche hazard in relation to their maximum exposure.

Of the participants who considered avalanches at least a key concern on their trips (n = 179), this awareness came from a variety of sources. For 38% of these participants, friends played a critical role, 22% mentioned the internet as a source, and 21% highlighted social media. Another 20% stated that an

avalanche skills course contributed to their awareness, but only 11% mentioned trailhead signs.

Of the many information sources participants use for planning their trips into the backcountry, online trip description websites like AllTrails were the most popular (58%), followed by the weather forecast (52%), and the local mountain website (33%). Only 27% reported using Avalanche Canada's avalanche forecast as an information source on their own. However, an additional 8% shared that they use the forecast when we explicitly asked them about it. Another 17% stated that they were aware of the forecast but do not use it. The remaining 47% of participants were not at all aware of the avalanche forecast, and two thirds of them were also not aware of Avalanche Canada. Similar to the concern about avalanches, the proportion of participants using the avalanche forecast was higher among those who expose themselves to more serious avalanche terrain (Kendall tau = 0.26; p-value < 0.01), but the proportions of non-users were substantial at all levels (Fig. 3): 47% among participants travelling in complex terrain, 61% among participants travelling in challenging terrain, and 78% among participants travelling in simple terrain. The most mentioned reason for not or only rarely using the forecast by participants who were aware of it (n = 47) was that they did not feel that they expose themselves to avalanche terrain (72%).

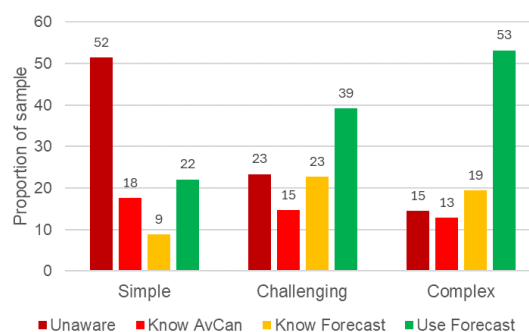


Figure 3: Distributions of participants awareness and use of avalanche forecasts in relation to their maximum exposure.

Of the participants who use the avalanche forecast (n = 152), 39% self-identified as Type B avalanche forecast users (St. Clair et al., 2021), which means they base their decision whether to go into the backcountry or not purely on the danger rating. Of these 59 users, 25% limit themselves to only travel when the danger rating is Low, and another 49% only when the danger rating is Low or Moderate. The remaining 26% still travel under Considerable or higher danger rating levels. Type C forecast users who combine the avalanche danger rating with information about the severity of the terrain to make their trip planning decisions are considerably less prevalent at 17% (n = 26). However, only a few self-identified Type C forecast users answered our destination-specific danger rating threshold questions in a way that indicates that

they would seek out more conservative terrain choices when the danger rating increases. 31% of our sample self-identified as Type D forecast user and 13% as Type E. While forecast use among people travelling in more serious terrain is generally more sophisticated (Kendall tau = 0.20; p-value = 0.007), 61% of Type B users still travel in challenging terrain and 12% in complex terrain. See St. Clair et al. (2021) for a full description of forecast user types.

Satisfaction with the forecast was high among users with no negative ratings, and 68% and 23% stating that the information is very or extremely useful, respectively. Interestingly, the satisfaction did not increase with a more sophisticated avalanche forecast user type (Kendall tau = -0.003; p-value = 0.969)

With only 21% of the sample having introductory (e.g., AST1) or higher-level avalanche skills training, the formal avalanche skills training level was generally low among our sample of snowshoers and winter hikers. When compared with their level of exposure, the expected pattern emerged with the proportion of participants with formal training increasing with snowshoers and winter hikers travelling in more serious terrain (Kendall tau = 0.25; p-value < 0.001). While only 7% of the participants travelling in simple terrain had formal avalanche training, it was 41% among those travelling in complex terrain.

Participants did not take an avalanche skills course largely for the same reason they did not use the avalanche forecast: They do not think that they expose themselves to avalanche terrain. Close to two-thirds of all participants (65%) provided this answer, and this percentage did not vary dramatically between the different exposure levels (Pearson Chi-Squared test: p-value = 0.191): It was 68% among participants travelling in simple terrain, 67% for participants in challenging terrain, and 53% for participants travelling in complex terrain. Interestingly, among the participants who did not say that they do not expose themselves to avalanche terrain (n = 136), the most common reasons for not taking a course were no enough time (25%), being lazy (23%), too expensive (20%), being unaware of avalanche skills courses (14%) or not snowshoeing frequently enough to warrant taking a course (13%).

The use of standard avalanche safety gear (transceiver, shovel and probe) follows a similar pattern. Overall, 66% of participants never travel with avalanche safety gear, whereas only 3% always travel in groups where everybody carries standard avalanche safety gear, and 15% travel in groups that carry avalanche safety equipment when they travel in avalanche terrain. The use of avalanche safety gear does increase with exposure to avalanche terrain (Kendall tau = 0.21; p-value < 0.001), but the proportion of groups that carry it in complex terrain is still only 38%.

#### 4. DISCUSSION

While there is considerable variability in our sample, we found that basic awareness of exposure to avalanche terrain, awareness and use of existing avalanche safety products and services, prevalence of formal avalanche skills training, and use of standard avalanche safety gear is all quite low among snowshoers and winter hikers interviewed at Mount Seymour. While it is possible to enjoy snowshoeing and winter hiking safely away from avalanche terrain, the observed awareness levels and safety practices stand in strong contrast to our participants' exposure to avalanche terrain based on their stated trip destinations. Our analysis of ATES ratings of common trip destinations showed that all snowshoers and winter hikers included in our study expose themselves to avalanche terrain. There was not a single participant who was only travelling in non-avalanche terrain.

Participants' limited mentioning of avalanches as a potential concern on their trips clearly reflects that avalanches are just not on the minds of many snowshoers and winter hikers. This is a serious hurdle for the promotion of avalanche safety among this user group as many health behavior models (e.g., Lindell & Perry, 2012; Lui et al., 2022; Yang et al., 2014) highlight that having at least some awareness of the potential threat is critical for the desire to seek relevant safety information and engage in precautionary actions if necessary. But even among participants with general awareness of avalanches and the available products, the use of existing information products and services was low, and the most common response to our questions about why was "because I am not travelling in terrain threatened by avalanches". These observations further highlight participants' general sense of safety and the perception that seeking avalanche safety information is not necessary, or that the existing services and products are not relevant for snowshoeing and winter hiking.

While we did not explicitly ask this question in our interviews, likely sources of this sense of safety are snowshoeing and winter hiking's similarity to summer hiking and the fact that it is generally portrayed as an easier winter backcountry activity for everybody (e.g., <https://world.scarpa.com/post/snowshoeing-snow-sport-for-everyone.html>, <https://undiscoveredmountains.com/what-is-snowshoeing>). Marked and/or established trails can also potentially cause an inaccurate sense of security. Particularly among participants who only travel in simple or challenging terrain, the proportion of participants exclusively following existing trails was quite high. While we did not explicitly talk about this in our interviews, assuming that marked trails were purposefully routed to avoid avalanche terrain does not seem unreasonable. However, this assumption is not necessarily true as exposure can vary depending on avalanche conditions and crossing avalanche terrain might be unavoidable to reach certain destinations. At our study

site, the situation is even more nuanced as there are distinct summer and winter trails that are marked differently. A substantial proportion of our sample reported following the markers of the summer trail, which is more exposed to avalanche terrain than the more conservative winter trail. While participants' familiarity with the summer trail as regular hikers during the snow free period is a likely explanation for this behavior, it also showcases the power of habits or familiarity on backcountry decisions as highlighted in McCammon's (2003, 2004) heuristic traps and further illustrates participants' limited understanding of avalanche terrain and the difference between summer and winter hazards.

While the avalanche forecast is only used by a small portion of snowshoers and winter hikers in our sample, their satisfaction with the product is relatively high, independent of their user type. However, the responses to our danger rating threshold questions for Type B and C forecast users reflect a relatively simple use of the avalanche forecast, but our sample for these questions is relatively small.

#### 4.1 Management implications

Our results clearly highlight that snowshoers and winter hikers do not use existing avalanche safety products and services because they think they do not expose themselves to terrain capable of producing dangerous avalanches. Hence the first key task for promoting avalanche safety in this community is to make people more aware that they are travelling in avalanche terrain. Snowshoers and winter hikers would benefit most from messages focusing on identifying avalanche terrain, explaining the difference between summer and winter trails, and clarifying that marked trails are not necessarily safe. Providing this information on websites that this community already frequents (e.g., AllTrails), in retail or rental shops, or at trailheads likely has the best chance of success. Once this basic awareness is established, it is much more likely that people will seek relevant safety information and take the necessary safety precautions.

Highlighting that travelling into avalanche terrain and leaving marked trails requires proper training and equipment to manage personal risk remains important, but the cost and time investment for even introductory level avalanche skills courses and safety equipment might be too high for somebody who just snowshoes or winter hikes a few days a winter. A relatively short and inexpensive (online) course focusing on avalanche terrain recognition might be most useful given our participants' reasons for not taking existing courses.

Consistent with other studies (e.g., Fisher et al., 2021; Haegeli et al., 2023), our superficial analysis of the danger rating thresholds used by Type B and C forecast users indicates that applying the forecast information to terrain remains a challenging task. While

we did not ask our participants about their motivations for travelling in the backcountry like Neweduk (2023), we suspect that most of them have limited interest in exposing themselves to avalanche hazard and would therefore benefit from decision aids that offer concrete (and potentially quite conservative) location-specific guidance on what trails are appropriate under the existing conditions.

#### 4.2 Limitations

While our study offers interesting insights, there are several limitations that might restrict the generalizability of the presented results. Although the trailheads on Mount Seymour are frequented by a wide range of different snowshoers and winter hikers, our approach produced a convenience sample that is constrained by the available resources and the times the interviews were conducted. Approaching potential participants during weekdays might have captured a slightly different demographic of snowshoers and winter hikers, but we believe that focusing on weekends and holidays produced the biggest and most diverse study sample.

Another factor that most likely affected our sample was language. Our interviewers shared that a substantial number of potential participants avoided or declined to participate in the study because they might not have been comfortable with their language skills. Unfortunately, this means that there is an unknown cohort of snowshoers and winter hikers who were not interviewed yet could have provided important responses and insight for the study. It seems reasonable to assume that avalanche safety challenges identified in this study are even larger in this group since the language barrier makes accessing relevant safety information even more difficult.

## 5. CONCLUSIONS

The objective of this study was to better understand snowshoers and winter hikers' exposure to avalanche terrain, their avalanche awareness and existing avalanche safety practices in relation to their exposure and provide insight into the reasons why they do or do not use available avalanche safety products and services.

The analysis of our intercept interviews indicate that the snowshoeing and winter hiking community would first and foremost benefit from initiatives that raise the general awareness of what constitutes avalanche terrain and how to avoid it. Simple decision support tools that indicate what trails are appropriate under the existing conditions would also help the community to better manage their risk from avalanches. While this study offers useful insight into possible initiatives, development of actual courses or decision support tools would require close collaboration with the snowshoeing and winter hiking community to ensure relevance, accessibility, and buy-in.

## ACKNOWLEDGEMENT

We are grateful to the Coast Salish peoples on whose traditional and unceded territories Simon Fraser University and our research program resides. We thank Cam Campbell for providing the missing ATES ratings and the participants of the research for their responses. Funding for the research was provided by Avalanche Canada and MITACS.

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