Mountain Snowmobilers and Avalanches: An Examination of Precautionary Behaviour

by

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Abstract

In response to the marked rise of snowmobile avalanche fatalities and the tragic season of 2008-2009, the BC Coroner's Death Review Panel convened to investigate the circumstances surrounding the accidents. One of the overarching conclusions of the panel was that a more collective effort is needed to build greater awareness and create a culture of avalanche safety within the snowmobiling community. Since there was limited information available on mountain snowmobilers, an in-depth understanding of their motivations, attitudes and preferences was identified as a necessary step in the effort to address their needs. The goals of this study were to gain a better understanding of the general characteristics of mountain snowmobilers (e.g. demographics, snowmobile characteristics, experience, training, trip details, etc.), and identify what factors affect their avalanche risk perception and how they adjust their terrain preferences in response to avalanche information. This study also investigated potential barriers that prevent snowmobilers from taking a formal avalanche course or checking the avalanche bulletin. The use of a Discrete Choice Experiment (DCE) investigated the terrain preference tradeoffs snowmobilers make in response to avalanche information. In addition to the DCE, this research used the Risk Information Seeking and Processing model (RISP) to identify potential factors that may influence avalanche risk information-seeking in the context of taking an avalanche course and checking the avalanche bulletin. Results from this study provide valuable information for the continued development of snowmobile specific avalanche safety material.

Keywords: Avalanche; risk; snowmobile; risk information seeking and processing; structural equation modeling; discrete choice experiment

Dedication

This work is dedicated to those who have lost friends or loved ones in avalanche accidents.

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1. Introduction

1.1. Mountain Snowmobiling and Avalanches

A snowmobile is a non-enclosed vehicle designed for transportation and recreation on snow covered terrain (Hermance, 2006). British Columbia and Alberta are host to some of the world's premier mountain snowmobiling destinations. Advancements in snowmobile technology (e.g. improved engine performance, suspension, track design, etc.) and a continued growth in the sport has lead to more and more riders entering evermore hazardous avalanche terrain in the backcountry.

Avalanche control work is regularly performed by avalanche professionals at ski areas and in transportation corridors, where avalanche conditions are continuously monitored and professionals reduce the avalanche risk by intentionally triggering controlled slides in order to clear unstable slopes. Practical and legal constraints limit avalanche control work in most of the backcountry. Consequently, mountain snowmobilers typically enter uncontrolled avalanche terrain where they are left to their own judgements concerning exposure to avalanche hazard; however, resources are available to help inform their judgement. Professional forecasters from the Canadian Avalanche Centre (CAC) provide regional avalanche bulletins that cover many of the most popular snowmobile destinations. The avalanche bulletin is easily accessible but requires a certain amount of skill and training to use effectively. Furthermore, avalanche courses are available that teach backcountry users the skills to safely manage avalanche risk during backcountry travel and recreation.

The five winters prior to the start of this study (winters 2006-2007 to 2010-2011) were marked by a dramatic increase in the percentage of avalanche fatalities involving mountain snowmobilers. In response to this development, the British Columbia Coroners Service (BCCS) convened a Death Review Panel which recommended action be taken to improve avalanche safety within the snowmobiling community (BC Coroners Service, 2009). In 2010 the Canadian Avalanche Centre (CAC) launched a new initiative to better address the avalanche safety needs of the growing community of mountain snowmobilers. One of the overarching conclusions from the panel was that a collective effort is needed by all stakeholders to build greater awareness and create a culture of avalanche safety within the snowmobiling community (BC Coroners Service, 2009). Many of the panel's recommendations called on the CAC to partner with stakeholders in the snowmobile community to improve safety. The CAC acknowledged that a necessary first step in the effort to address the needs of snowmobilers is gaining in-depth knowledge of their socio-demographics, training levels, bulletin use and behavioural characteristics, as well as the relationships these variables share.

1.2. Research Objectives

Initial studies on backcountry user groups and avalanche awareness conducted in Canada (Longland et al., 2005; Haegeli et al., 2009) provided general assessments across all primary target audiences of the CAC, namely backcountry skiers, out-of-bounds skiers, and snowmobilers. Since these user groups approach avalanche terrain very differently, a more targeted view is required for the development of effective avalanche safety programs for snowmobilers. While the studies of McCammon (2009), Gunn (2010) and Haegeli et al. (2012) examine out-of-bounds skiers and snowboarders in detail, the goal of the present study is to examine the motivations, risk perceptions, safety behaviour, avalanche safety barriers and backcountry travel practices of snowmobilers by specifically addressing the following five research questions:

1. What are the general characteristics of mountain snowmobilers (e.g. demographics, snowmobile characteristics, experience, training, trip details, etc.)?
2. What factors affect avalanche risk perception and safety behaviour of snowmobilers?
3. What barriers prevent snowmobilers from taking formal avalanche training?
4. What barriers prevent snowmobilers from checking the avalanche bulletin?
5. How do snowmobilers adjust their terrain preferences in response to avalanche safety information?

Together, the answers to these questions should provide the CAC with valuable information for the development and delivery of avalanche safety material tailored to the needs of snowmobilers.

1.3. Document Organization

This report contains six chapters and appendices. After this introduction, chapter two contains a literature review on trends in recreational snowmobiling. It also provides an overview of current avalanche safety initiatives, as well as a discussion of the role research plays in the development of effective health and safety campaigns. This is followed by an overview of the various physical and behavioural risk factors associated with avalanches, and finally the contributions that human dimensions research offers to avalanche research is presented. In the third chapter, a theoretical background of the Risk information Seeking and Processing model is given, and the model is applied to snowmobile specific avalanche information seeking in the context of taking a course and checking the avalanche bulletin. Chapter four describes the general survey design, data collection and statistical techniques used to investigate the research questions. The analysis is found in chapter five. Chapter six contains a discussion of the key findings in relation to the research objectives, management implications, limitations, suggestions and the conclusion. Appendices include copies of the intercept and online survey, several expanded results sections, comparisons of the two survey populations, and specific details on intercept survey distribution and collection.

2. Literature Review

2.1. Trends in Recreational Snowmobiling

Recreational snowmobiling has grown in popularity over the years (CAC, 2012; Pierz, 2003). Over half a million snowmobiles were registered in Canada in 2012, nearly 100,000 of these were in Alberta and British Columbia (International Snowmobile Manufacturers Association, 2012). Mountain snowmobiling is now a common pursuit within recreational snowmobiling. British Columbia is home to some of the world's premier mountain snowmobile destinations, with nearly 100 snowmobile clubs (British Columbia Snowmobile Federation, 2013; Association of British Columbia Snowmobile Clubs, 2013) who maintain over 12,000 kilometres of groomed snowmobile trails (International Snowmobile Manufacturers Association, 2012). Snow covered meadows, hillsides, mountains and glaciers are all accessible depending on snowmobile performance and the rider's ability. While some snowmobilers enjoy riding in fields and on the groomed trails, other riders prefer powder conditions on forested hills and steeper mountains. The most extreme snowmobilers pursue highly technical riding that involves hill-climbing, steep descents and in some cases catching big air or ascending tight chutes.

Early mountain snowmobilers were limited in terrain options by their machines' capabilities. Improvements in snowmobile design and the addition of performance enhancing modifications have helped rapidly progress the sport (BCCS, 2009). Today, there are numerous ready-to-ride mountain snowmobiles available from all of the major manufacturers (Ski-Doo, Arctic Cat, Yamaha, and Polaris, 2013). A skilled rider on a modern mountain snowmobile is easily capable of entering avalanche terrain.

2.1.1. Snowmobile Avalanche Fatalities

Snowmobilers have become some of the most frequent avalanche victims in Canada (CAC, 2012) and the United States (Colorado Avalanche Information Center, 2012). Snowmobile avalanche deaths outside of North America are not as common as the sport is prohibited in much of Europe (Hill, Wiesinger, & Abromeit, 2004) and just being introduced in other parts of the world.

In Canada, the period from 2006-2007 to the 2010-2011 season marked a dramatic increase in the percentage of avalanche fatalities involving mountain snowmobilers. Over that time period, snowmobilers accounted for 53% (41 of 77) of all recreational avalanche fatalities in Canada, a significant increase from the 28% (18 of 64) during the previous five-year span. The 2008-2009 season resulted in a record number of snowmobiler deaths, when 19 snowmobilers lost their lives in avalanches, accounting for 78% of all avalanche fatalities in Canada (CAC, 2011). In the absence of other easy to capture indicators, the problems surrounding snowmobiler avalanche safety have been measured primarily in terms of deaths per year. However, this is not a reliable measure because of the large variability in conditions from year to year, and it only offers limited insight for the development of prevention initiatives. The current research offers new insight that could also be used to indicate progress and change within the snowmobile community (e.g., levels of training, bulletin checking, etc.).

2.1.2. Avalanche Victims

Relatively little is known about mountain snowmobilers, aside from what information is collected on the victims of accidents. This next section offers a glimpse of that information. A study on avalanche victims by Boyd et al. (2009) found the average deceased snowmobiler was 36 years old, which is comparable to the findings of Jamieson, Haegeli, & Gauthier (2010). All but one of the victims were male (Jamieson, Haegeli, & Gauthier, 2010), this comes as no surprise given that the majority of all backcountry recreationists (including snowmobilers) tend to be male (Tase, 2004) and since women are generally more conservative risk takers (Byrnes, Miller, & Schafer, 1999). Most fatal accidents happened in the mountain ranges of interior British Columbia (Jamieson, Haegeli, & Gauthier, 2010). Data on the victims' training and proper use of safety equipment is also limited (BCCS, 2009). In an intercept survey, Longland et al. (2005) found snowmobilers had lower levels of formal training than backcountry skiers and out-of-bounds skiers. More general studies on winter recreationists and backcountry users found that most fatal avalanches occurred under 'considerable' or 'high' avalanche danger (Jamieson, Haegeli, & Gauthier, 2010). The most common size of a fatal avalanche was 3.0 according to the Canadian avalanche size classification[1] (Jamieson, Haegeli, & Gauthier, 2010), and the victims were likely to have triggered the avalanche that buried them (Jamieson, Haegeli, & Gauthier, 2010; McClung & Schaerer, 2006).

2.1.3. Snowmobiling in the Media

Canadian news media have traditionally only reported on fatal avalanches. The tragic events in December of 2008 on Harvey Pass highlight the complexity associated with many accidents. The victims were skilled riders who came prepared and planned accordingly. Multiple avalanches caught the group off guard and multiple burials occurred after the initial avalanche released. At one point all 11 people involved in the accident were buried by avalanches that proceeded after the first (Canadian Broadcasting Company, 2009). In the end, the series of avalanches claimed eight lives. This incident kicked off the deadliest year for snowmobilers in British Columbia and the season's tragedies brought snowmobiling to the forefront of public avalanche concern. In response, the CAC made a public appeal for increased awareness and caution among snowmobilers. The CAC also acknowledged shortcomings in their relationship with the snowmobile community and recognized the need to better understand mountain snowmobilers in order to develop a more effective approach to avalanche safety (Kelly, 2009a).

More recently in March 2010, the snowmobile related media reports focused extensively on the Boulder Mountain, Turbo Hill incident, a major accident that occurred near Revelstoke, BC. The Big Iron Shootout, a popular hill-climbing contest, was held under high avalanche danger, and an avalanche broke above where a crowd of spectators had gathered after the main event. Two victims were killed and another 32 injured (Canadian

[1] A size three avalanche can bury and destroy a car, damage a truck, destroy a wood frame house, and break trees (CAA, 2007).

Broadcast Corporation, 2010). The assembly of such large a group under such adverse conditions led RCMP to consider filing criminal negligence charges against the organizers and some participants (Canadian Press, 2010). In the end the organizers were not deemed responsible, but snowmobilers were once again the primary focus of public avalanche concern.

The growth in popularity of snowmobiling has also been accompanied by a rise in snowmobile related entertainment media. Videos and magazines along with the X-games and other high profile events have brought snowmobiling into the mainstream media in which professional snowmobilers have openly acknowledged the physical risks associated with extreme riding (Mutrie, 2012), but so far no wider safety campaigns have been promoted in the mainstream media.

2.2. CAC Programs and Services

Avalanche safety in Canada is coordinated by the CAC. A range of products and services are offered to the public including public avalanche bulletins, special public avalanche warnings (SPAW), and avalanche training for non-professional winter recreation. The CAC is also responsible for the coordination of public avalanche safety programming, acting as a point of contact for avalanche information, and promoting the future of Canadian avalanche research (CAC, 2013).

The public avalanche bulletin is a warning product that provides winter recreationists with information about current avalanche conditions and also advises on backcountry travel. The bulletin can be accessed online (avalanche.ca), and in some cases paper copies are posted in areas frequented by winter recreationists (e.g. ski areas, backcountry gates, staging areas, trailheads, gas stations, hotels, etc..). One of the key pieces of information included in the bulletin is a danger rating according to a five-point North American public avalanche danger scale (Statham et al., 2010) that indicates avalanche danger for the present day (low, moderate, considerable, high and extreme) as well as a forecast for the next two. The danger ratings make recommendations regarding terrain choice and advise on potential avalanche type(s), the likelihood and expected size of avalanches. Details on avalanche activity, snowpack and weather are also included in the bulletin. In the 2011-2012 season over 1.4 million requests for public avalanche bulletins were made, a 20% increase from the previous year (CAC, 2012). A SPAW is intended to warn the public when particularly risky avalanche conditions exist.

The Avalanche Skills and Training (AST) program was developed to provide winter recreationists with the skills and knowledge needed to safely recreate in avalanche terrain. These courses are taught by certified avalanche instructors. About 7,000 individuals completed an AST1 or AST2 course in the 2011-2012 season (CAC, 2012). Avalanche information sessions and online courses are delivered by the CAC, whereas professional avalanche training is primarily a responsibility of the Canadian Avalanche Association (CAA), a sister organization of the CAC. The benefits of taking an avalanche safety course and checking the bulletin are recognized as an important first step in managing avalanche hazard in the backcountry (Jamieson, Haegeli, & Gauthier, 2010; McClung & Schaerer, 2006; Kurzeder & Feist, 2003).

2.2.1. Snowmobile Specific Safety Initiatives

Since its inception, the CAC has had a close relationship with backcountry skiers and mountaineers, whereas snowmobilers are a relatively recent addition to the avalanche community. In the last decade snowmobile-specific avalanche safety courses and educational material have been developed in Canada and the United States (Chabot, 2002). Jamieson, Svederus & Zacaruk (2007) present the interested reader with a snowmobile-specific avalanche safety handbook of best practices.

Given this increase in snowmobile avalanche fatalities, along with the findings of the British Columbia Coroner Service Death Review Panel (BCCS, 2009), a new approach to avalanche safety is clearly needed. In May of 2009, the CAC launched the Snowmobile Action Plan. Through consultation, three initial measures won support: trail head signage to alert snowmobilers of avalanche hazard; snowmobiler specific community avalanche bulletins to convey avalanche information before weekends and holidays; and a “Sledder on Staff” to act as liaison between the CAC and the snowmobile community (Kelly, 2009a). The Snowmobile Action Plan gained the support of the National Search and Rescue Secretariat’s New Initiatives Fund for a three-year project aimed at reducing snowmobile avalanche deaths through more comprehensive means. The first objective of the project (presented in this research) is to gain a better understanding of how mountain snowmobilers make decisions in avalanche terrain and how they perceive avalanche hazard. Based on the insight from this first stage, the project then aims to improve on the existing weaknesses, particularly in the development and delivery of avalanche safety material that would meet the needs of the mountain snowmobiling community (Kelly, 2009b). The goal of the second objective sets out to increase the knowledge base within the snowmobiling community through promotion of the CAC's AST courses for snowmobilers, and the creation of a bursary program for the CAA professional course in order to facilitate the training of future course providers. Candidates for this bursary are peer-identified mountain snowmobilers who want to build a career in avalanche safety (Kelly, 2009b). These programs are funded in part by the "Buck-a-Day" for avalanche safety program, in which the Association of British Columbia Snowmobile Clubs contributes one dollar from every trail fee they collect to support the core safety programs and services of the CAC. It also helps to fund the CAC's "Sledder on Staff" snowmobile coordinator position (CAC, 2011). These initiatives intend to improve communication between the Avalanche Centre and mountain snowmobilers, and ultimately hope to reduce snowmobiler fatalities in the long run.

2.3. Risk Communication

The CAC's risk communication objectives are similar to more general risk communication goals in other heath behaviour contexts. Their aim is to help improve the quality of decisions made by individuals at risk of a certain threat through better communication (Palenchar & Heath, 2002), and to influence behaviours so that future crisis situations can be avoided (Sellnow, Ulmer, Seeger, & Littlefield, 2009). A well thought out approach to risk communication is needed if a message is to have its intended effect. Campaign designers need to decide whether the message intends to promote a healthy behaviour or to discourage an undesirable or destructive behaviour (Atkin & Rice, 2013). They must also decide whether a campaign is to inform its audience of a risk or to persuade them that a risk is serious (Atkin & Rice, 2013). In any case, an in-depth understanding of the at-risk target audience and insight into the behaviour(s) associated with the risk will all contribute to the success of the campaign (Lundgren & McMakin, 2009; Hutchinson & Wundersitz, 2011).

Historically, a large portion of risk communication strategies were founded on expert opinion, as opposed to broader quantitative research (National Research Council, 1989; Lundgren & McMakin, 2009). Such strategies were largely ineffective as they lacked consultation or input from their intended audiences (Williams & Olaniran, 1998; Heath, 1995). It has been shown from past research, that in order to improve the development and maintenance of preventative health behaviours, campaigns need to use an integrative approach. Risk communication campaigns that incorporate the perspectives of the intended audience are often more effective in facilitating behavioural change (Lundgren & McMakin, 2009).

In the case of communicating avalanche safety, several distinct user groups with specific needs exist; snowmobilers being one of them. Risk communication needs to be an interactive process in which stakeholders (mountain snowmobilers) and risk communicators (CAC Avalanche Professionals) engage in some sort of dialogue (Sellnow, Ulmer, Seeger, & Littlefield, 2009). Formative research is an important first step and is fundamental in the development of a strategic risk communication campaign (Palenchar & Heath, 2007). Formative research can identify groups or subpopulations that may face higher levels of exposure to the risk (Atkin & Freimuth, 2013), which allows for communications efforts to better focus of high-priority targets. Formative research techniques include focus groups, expert interviews, surveys and questionnaires. In the onset of a campaign, these techniques can help to gain an understanding of the intended audience, recognize the risks they face, and identify potential barriers to communicating those risks (Atkin & Freimuth, 2013; McGrath, 1991).

2.3.1. A Health Behaviour Approach to Identifying Target Audience

Substantial bodies of literature are available on health behaviour communication as a starting point in the development of risk communication strategies for avalanche safety initiatives (McCammon, 2009). In one such example, a study on drug use identified factors associated with fatal overdoses. While all users were at risk, those who injected and those who took larger or more frequent doses were identified as high-risk and were therefore considered priority targets for health and safety campaigns (Boot, McGregor, & Hall, 2000). In another example, a study on cigarette smoking identified cancer risk groups through population segmentation. Older males who smoked were identified as the highest risk cohort and a priority target. Those who smoked at any age, regardless of gender were also indentified as targets for smoking cessation campaigns (Gawron, Hou, Ning, Berry, & Lloyd-Jones, 2012). In both studies, sample populations were assessed using multivariate analysis. By indentifying high-risk or at-risk individuals and groups, risk communicators can create a better campaign to target those who will most benefit (Atkin & Freimuth, 2013). Health behaviour studies like these are relevant to avalanche research because both share similar characteristics in which a hedonic reward is offered in the face of personal risk.

2.3.2. Using Media to Promote Health and Safety

It is possible to improve health and safety through the use of media campaigns; however, particular attention to how the issues are perceived by the intended audience is needed (McCammon, 2009). Media-based health and safety campaigns have successfully promoted safe driving (Phillips, Ulleberg, & Vaa, 2011; Noar, 2006; Lewis, 2001), smoking cessation (Vallone, Duke et al., 2011; Siegel, 1998), and condom use (Agha, 2003). In a meta-analysis of media based health and safety campaigns, Snyder et al. (2004) found that such campaigns were successful in changing behaviours in 8% of the sampled populations on average. This is not to suggest that all media campaigns are equally as effective; rather it speaks to the importance of a campaign's design and strategy.

The influence of the media can also affect behaviour in negative ways (Escobar-Chaves & Anderson, 2008; Potera, 2009; Warner, 1986). Poorly designed health and safety campaigns can unintentionally exacerbate to the problem, as they have the potential to normalize a risky activity through the "boomerang effect" (Atkin, 2001). Palmer (2002) argues that the increased presentation of extreme sports in the media does not effectively communicate the associated risks, making future accidents more likely. Fischer, Guter, & Frey (2008) found that exposure to risk-promoting media may increase risk-promoting thoughts and inclinations, ultimately perpetuating risk-taking behaviour within that group, regardless of the intention. Even if a campaign is perceived as successful, Hutchinson & Wundersitz (2011) highlight some of the difficulties in assessing the effectiveness of media-based health and safety campaigns because so many non-exclusive factors are at play. Lewis (2001) proposed that continued experimentation of methods and metrics is needed to improve the effectiveness of media use in such campaigns. Nonetheless, clear goals, adequate knowledge of the target audience, an understanding of the risks they face, and an intelligent campaign design are all crucial to the success of any avalanche safety campaign.

2.3.3. Targeting Avalanche Risk

It is difficult to pinpoint one single message to focus on when conveying avalanche hazard information. McCammon (2009) states it is unlikely there is a “silver bullet” and solutions will depend upon the receiver’s social and physical environment. Designing a campaign requires an extensive investigation of these environments. Localized avalanche information has a temporal constraint (e.g., avalanche danger bulletin), while general avalanche information (e.g., an avalanche safety course) does not. It is likely that there are several different audiences, each with their own safety needs.

Past avalanche research has focused primarily on backcountry and out-of-bounds skiers. These studies examined decision-making, levels of training, terrain preferences, sensation-seeking, self-efficacy and other indicators that may contribute to the likelihood of becoming involved in an avalanche. (Tase, 2004; Longland et al., 2005; Silverton, 2006; McCammon, 2009; Haegeli et al., 2009; Gunn, 2010). Through the use of these concepts, Tase (2004), Longland et al. (2005) and Gunn (2010) were able to identify higher risk cohorts and activities as potential target audiences for safety campaigns. These studies also illustrate the rapidly evolving approach to avalanche research which now places a greater emphasis on the human component of avalanche safety.

Tase (2004) conducted a survey on backcountry users that identified predictors of potential avalanche involvement which included snowmobilers. However, the majority of the analysis for the study’s activities were without specific reference to snowmobilers. The only snowmobile-specific hypothesis was that snowmobilers were at a higher risk of avalanche involvement, which was not confirmed in the analysis. In fact Tase (2004) only found that gender (being male), activity (AT ski/telemark), formal training, time spent in the backcountry, and having extreme adventure goals were related to avalanche involvement.

Longland et al. (2005) included snowmobile specific questions in their survey and used a dedicated analysis, which provided basic insight on snowmobiler specific characteristics. This study provided useful comparisons between backcountry user groups, revealing specific decision-making strengths and weaknesses for each group. It also provided information on the terrain choices of backcountry users given the presence of avalanche hazard information.

Gunn (2010) used a novel approach to segment out-of-bounds skiers (including telemarkers and snowboarders), into risk cohorts. His study examined the heterogeneity of out-of-bounds skiers using a more advanced integrated assessment. Gunn was able to segment heterogeneous segments within the sample population and identify a high-risk cohort that could be targeted in future campaigns. Furthermore, Gunn's approach focused only on out-of-bounds skiers, which helped better define a high-risk priority target for risk communication within that group.

As Vaske (2007) recommends, it is important to consider the scope of a survey. If it is too broad or too narrow, meaningful results are harder to assess. The motorized component of snowmobiling makes it a fundamentally different activity from other types of human-powered backcountry recreation. Snowmobilers cover much larger areas and interact with the terrain very differently, they face higher risks ascending the slopes due to their mechanized propulsion and from the additional weight of their machines. In light of these differences a targeted study focused on this specific group is clearly needed.

2.4. Avalanche Risk Factors

Early avalanche research focused on better understanding the physical nature of avalanches. One of the first academic avalanche studies was developed to calculate an avalanche's potential velocity, depth and run-out distance, in preparation for the 1924 Winter Olympics (Ancey, 2001). Authorities in land-use and transportation planning benefited from this research, as it gave them the insight to avoid building infrastructure in harm's way. Improvements in the physical understanding of avalanches have continued and have benefited many backcountry users as well. McClung & Schaerer (2006) offer the interested reader an excellent overview of the complexities that surround the physical science of avalanches. However, as backcountry recreation has grown and avalanche accidents continue, avalanche research now places a larger focus on the human component of accidents (Haegeli, Gunn, & Haider, 2012).

The social sciences are playing an increasingly important role in examining the characteristics of various target audiences and have made valuable contributions to the development of evidence-based avalanche awareness programs. Past studies have focused on identifying individual characteristics (i.e. socio-demographics) and their relationship to avalanche involvement (Tase, 2004; Silverton, 2006). Other studies have adopted models from psychology and health behaviour to fit the needs of avalanche research. Sole (2006) employed the "Recursive Model of Injury Etiology and Prevention" (van Mechelen, Hlobil H & Kemper, 1992) in which a four-step injury prevention process was used to identify commonalities in avalanche incidents. For the present research, it is important to both draw from previous studies and develop a snowmobiler specific application.

Frameworks for examining behavioural processes are often based on the Theory of Planned Behaviour (TPB - Ajzen, 1991; Ajzen and Fishbein, 1980). TPB has been used across fields in a variety of behavioural studies (Godin & Kok, 1996; Quintal, Lee, & Soutar, 2010). However, connecting values and beliefs to behaviour in the context of physical risk factors has remained a challenge. The complex nature of avalanches and the vastness of the backcountry make it difficult for avalanche researchers to effectively collect behavioural data (Haegeli, Gunn, & Haider, 2012). Moreover, the backcountry is a dynamic environment for decision-making; hazard levels vary greatly, and risk is usually defined by a multitude of factors. Previous avalanche studies have identified terrain choice, avalanche training, bulletin-use, and several other behavioural characteristics as potential risk factors, all of which are all relevant to snowmobilers as well. Given the upward trend in the number of snowmobiling avalanche fatalities and the known difficulties of avalanche safety research, a novel approach is needed that combines both the physical risks and behaviour aspects of avalanche risk.

2.4.1. Risk Factor: Terrain Choices

Selecting safe terrain appropriate for the given avalanche conditions is a crucial step in avoiding avalanche involvement. Terrain steepness and snow supply at the top of a slope are important factors to consider when assessing avalanche risk (McClung & Schaerer, 2006). Terrain traps (e.g. gullies, depressions, cliffs) can compound the potential consequences of an avalanche (Tremper, 2008). In 2006, the Avalanche Terrain Exposure Scale (ATES; Statham, McMahon, & Tomm, 2006) was developed to provide recreationists with a comprehensive assessment of the seriousness of terrain with respect to its exposure to general avalanche hazard. This scale classifies avalanche terrain as “simple”, “challenging”, or “complex”. Terrain ratings are performed by avalanche professionals, and are based on a series of weighted variables such as slope angle, slope shape, presence of terrain traps, avalanche frequency, route options, exposure time and glaciations. ATES has been applied in popular winter recreation areas managed by Parks Canada and is currently being developed for snowmobile areas as well. The ATES is designed to be used in conjunction with the daily avalanche bulletin for evaluating avalanche risk and was an integral part in the development of the AVALUATOR (Haegeli, 2010). The AVALUATOR is a decision support tool designed to aid amateur backcountry users’ decision-making in regard to avalanche hazard. While ATES ratings are included in the trip planning tool of the AVALUATOR, the slope assessment tools of the AVALUATOR helps winter recreationists assess the seriousness of individual slopes based on slope angle, slope shape, terrain traps, and forest density. The resulting terrain assessment is then combined with an assessment of avalanche conditions based on information from the avalanche bulletin and personal field observations (presence of a persistent layer, slab activity, signs of instability, recent loading, and warming) to create an overall picture of existing avalanche conditions.

Past studies have investigated the relationship between avalanche conditions and terrain choice. Haegeli et al. (2010) examined the terrain choices of amateur winter recreationists in the presence of various avalanche hazards and compared them to choices made by avalanche professionals. The introduction of a decision support tool to aid the amateur population’s decision-making resulted in a shift towards more conservative terrain choices. Gunn (2010) and Haegeli, Gunn & Haider (2012) conducted a study on terrain choices and avalanche hazard for out-of-bounds skiers, in which photographs of various out-of-bounds ski runs were used to present the character, size and gradient of the slope. Participants' terrain choices in the presence of various avalanche hazards were used to identify risk cohorts. These studies highlight the importance of investigating terrain choice in avalanche safety research. Similarly, an investigation of snowmobiler terrain choice should provide information on general terrain preferences, as well as how those preferences may be adjusted in response to avalanche safety information.

2.4.2. Risk Factor: Training and Avalanche Bulletins

Winter recreationists with formal avalanche training are generally better equipped to deal with avalanche risk. The benefits of completing a formal avalanche training course (AST) are commonly referenced (Jamieson, Haegeli, & Gauthier, 2010; McClung & Schaerer, 2006; Kurzeder & Feist, 2003). Formal avalanche training promotes best practices in risk management through educating winter recreationists on the risks they face. It also teaches winter recreationists how to properly use emergency rescue equipment in the case that someone is buried in an avalanche. Avalanche transceiver and probing techniques are key components of AST courses, which teach the most efficient search methods for locating a buried partner(s) in various avalanche scenarios (CAC, 2012; Jamieson, Svederus, & Zacaruk, 2007; McClung & Schaerer, 2006).

McCammon (2000) found that victims with higher levels of training exposed themselves to avalanche hazard more frequently, but, through better risk-mitigation practices, took fewer overall risks. Atkins (2000) suggests that poor judgement and lack of education are the two most common factors in fatal avalanche accidents. On the other hand, Tase (2004) found that backcountry users with avalanche training were more likely to have been involved in an avalanche. However, Tase (2004) did not investigate any causal relationship between the two. Past research on risk in a more general sense has found that personal experience with a risk can affect responses to other risks in the future, ultimately influencing information-seeking about that risk (Johnson & Tversky, 1983; Johnson & Meischke 1993). The fact that snowmobilers are now the most frequent victims and have less training clearly highlights the need to investigate training as a risk factor in more detail.

Winter recreationists who check the avalanche bulletin are generally better equipped to manage avalanche risk in the field, as the information presented in bulletins can provide valuable insights for helping backcountry users to make informed decisions. The bulletin offers backcountry users a professional assessment of avalanche conditions to aid decision-making on travel and terrain choice. Checking local avalanche bulletins prior to entering avalanche terrain is therefore considered compulsory by avalanche educators (Jamieson, 2000; McClung & Schaerer, 2006; Jamieson, Svederus, & Zacaruk, 2007). Longland et al., (2005) found that snowmobilers checked the avalanche bulletin less than backcountry skiers or out-of-bounds skiers: 45% of snowmobilers checked the bulletin on the day of their trip, compared to 95% of backcountry skiers. At the same time, snowmobilers used the internet significantly more frequently to check the bulletin online, as the other groups had access to a posted bulletin at their recreation sites (Glacier National Park or Kicking Horse Mountain Resort). A more detailed investigation of snowmobiler bulletin-checking habits is needed to identify any weaknesses in this area of risk mitigation.

Given the aim of identifying potential barriers that may prevent snowmobilers from taking a course and checking the bulletin, there is a need to investigate present levels of training and bulletin-use within the snowmobile community. This information will also provide the necessary foundation to examine the interplay between training, bulletin-use, and other variables relating to risk perception and safety behaviour.

2.4.3. Personal and Behavioural Risk Factors

Formal training enables snowmobilers to use the bulletin more effectively and analyze terrain with higher levels of competence; however, it does not necessitate such qualities nor does it guarantee the use of other best practices in the field. All winter recreationists who travel in avalanche terrain should carry an avalanche transceiver, probe and shovel (Jamieson, 2000; McClung & Schaerer, 2006; Tremper, 2008). Best practices also suggest that they should also always travel with partners, discuss hazards and proceed one at a time on worrisome slopes (McClung & Schaerer, 2006; Tremper, 2008; Jamieson, Svederus, & Zacaruk, 2007). McCammon (2000) found avalanche victims with training took fewer overall risks because of their advanced mitigation practices, but exposed themselves to more hazard (high avalanche danger, loaded slopes, slide paths, etc.). Proper training and regularly checking the avalanche bulletin are the first steps of risk mitigation, but they are not the only ones. Therefore, a comprehensive investigation of backcountry behaviour and other characteristics would complement information collected on levels of snowmobiler training, bulletin use and terrain choice.

The following theoretical constructs can be applied to an avalanche safety context in order to assess the individual characteristics and avalanche safety practices of mountain snowmobilers:

Self-efficacy

Self-efficacy is the perceived ability one has to achieve a desired result. Individuals with a high levels of self-efficacy are more likely to approach a task with the intention to succeed, whereas individuals with lower levels of self-efficacy are more likely to avoid the task as it may seem too difficult (Bandura,1997). Self-efficacy is a fundamental concept in the Theory of Planned Behaviour (Hagger, Chatzisarantis, & Biddle, 2002; Ajzen, 1991; Ajzen & Fishbein, 1980,) and Social Cognitive Theory (Glanz, Rimer & Lewis, 2002; Bandura, 1997; Bandura & Walters, 1963). Numerous studies based on the aforementioned theories have found a positive relationship between self-efficacy and health-promoting behaviours (Maddux, Brawley, & Boykin, 1995). In order to change from a current behaviour to one that promotes health or reduces personal risk, an individual must monitor the behaviour in question, set attainable goals and incentivize success (Bandura,1997). Once change has been achieved, it must be maintained if it is to have any lasting effect. Maintenance of a behavioral change depends on the individual's ability to self-regulate and develop a lasting sense self-efficacy (Bandura,1997). A return to unfavorable behaviours often occurs when efficacy weakens and maintenance fails. An example of this can be found in the study of drug addiction, where relapses are commonly attributed to decreased self-efficacy (Marlatt, 1996).

In contrast to the role of self-efficacy in health promoting behaviour, it has also been linked to physical and athletic ability. Participation in high-risk sports requires a certain level of self-efficacy, and successful participation in the sport can lead to and reinforce higher levels of self-efficacy (Slanger & Rudestam, 1997). In a study of rock climbers, Llewellyn et al. (2008) found that climbers with higher levels of self-efficacy were more likely to take additional risks, attempt harder routes and participate in the sport more frequently. Climbers with higher levels of self-efficacy felt that they were in more control and better able to prevent accidents. Self-efficacy is similar to the concept *locus of control* (Holt et al., 2007; Rotter, 1966), in which the locus of control is either within the individual (they are in control) or controlled by outside forces (luck, acts or god, etc.). A better understanding of the relationship self-efficacy and locus of control share with snowmobiler's precautionary behaviour and risk perception could provide valuable insights about the existing weaknesses in the avalanche safety behaviour of this community.

Precautionary Adoption Process Model

The original *Precautionary Adoption Process Model* (PAPM) scale was developed to study people's attitudes towards radon testing in the medical sector (Weinstein and Sandman, 2002). The scale has been successfully used to assess attitudes towards osteoporosis prevention (Blalock et al., 1996) and hepatitis B vaccines (Hammer, 1997). McCammon (2009) adopted the scale for a study on out-of-bounds skiers. He identified five distinct stages (Unaware, Unengaged, Engaged, Emergent and Practitioner) which out-of-bounds skiers progress through as they learn to recognize and mitigate avalanche hazard. Each stage of the scale was described by a statement. Survey participants were invited to select which of the statements best matched their personal situation. The PAPM assumes that people progress through several of these stages in their journey towards making precautionary behaviour a habit. The PAPM classification is useful for the development of avalanche safety initiatives because it highlights that individuals at each stage are more likely to respond to a particular awareness message. McCammon (2009) matches effective avalanche awareness initiatives with the different levels of the PAPM scale (Figure 2.1). In the present study, a slightly expanded PAMP scale with seven levels (Unaware, Aware, Disengaged, Engaged, Non-emergent, Emergent, and Practitioner) is used to characterize the precautionary behaviour of survey participants, the additional two levels offer participants a chance to opt out of the scale if they do not follow its assumed progression.

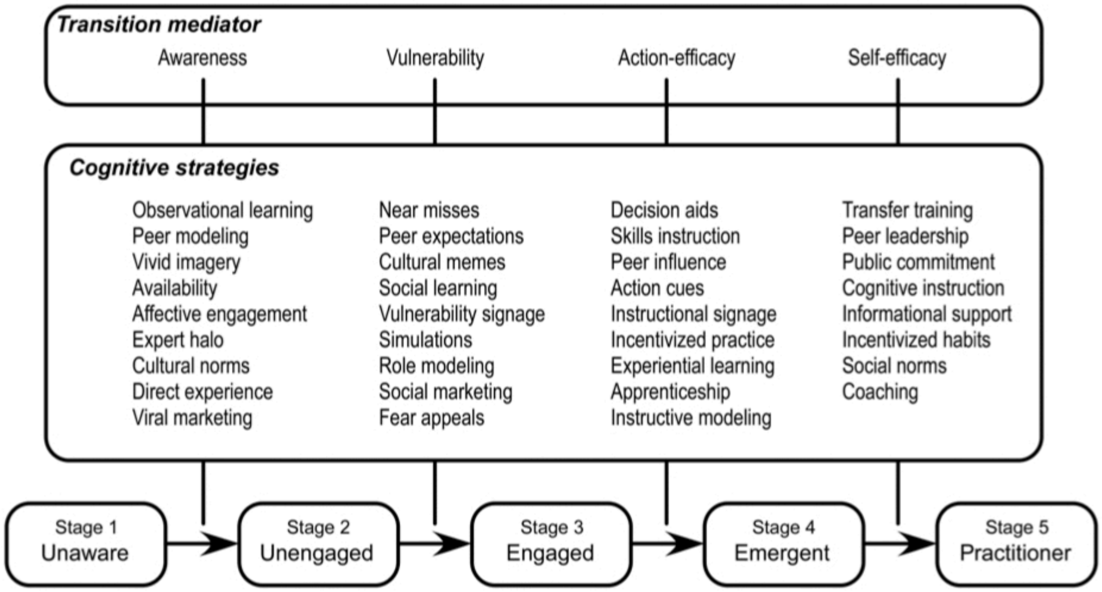

Figure 2.1 Precautionary Adoption Process Model (McCammon, 2009)

Sensation-seeking

Snowmobiling, like other motorsports and snow sports, provides participants with a thrill. The need for excitement or sensation-seeking has often been associated with participation in high-risk activities. Ulleberg & Rundmo (2003) conducted a study on predictors of risky driving behaviour, in which high sensation-seeking scores were associated with risky driving behaviour and negative attitudes towards traffic safety. Zuckerman (2007) reported that "sensation-seeking is involved in nearly every type of risky driving behavior, although the relationship with involvement in accidents is less consistent" (pg. 86). The Sensation Seeking Scale was designed to elicit information on experience-seeking, boredom susceptibility, thrill seeking, and disinhibition (the four underlying dimensions of sensation-seeking). The original 40-item scale was developed to assess differences in stimulation preferences associated with risk-taking. The Brief Sensation Seeking Scale (BSSS-8; Zuckerman, 1979; 2007; Hoyle et al., 2002) offers a condensed eight-item version of the original, which was developed to assess adolescent intent to use tobacco, marijuana and alcohol. Insight into this realm is useful because sensation-seeking individuals responded better to novel messages that appeal to affective responses and that are non-traditional (Palmgreen et al., 1991). In other words, snowmobilers who seek sensational experiences may benefit from highly sensational avalanche safety messages. Campaign designers may be able to use information on levels of sensation-seeking to better target the necessary emotions to spark behavioural change.

2.5. Decision-Making Component of Avalanche Research

To better understand the decision-making of snowmobilers in the backcountry, a novel approach is needed. Stated preference techniques attempt to illustrate intentions in the decision-making process through an examination of the trade-offs one makes, which is a useful alternative to monitoring backcountry behaviour. Discrete Choice Experiments (DCE) present participants with different hypothetical scenarios in which they are to choose their preferred scenario. Each scenario is composed of two or more attributes, defined by set levels. Participants choose their preferred scenario or a baseline alternative. DCE assumes participants will make trade-offs between attributes and choose whichever scenario maximises their overall benefit. DCE is based on random utility theory (McFadden, 1974) where utility maximization is assumed for all individuals.

Monitoring the terrain choices of snowmobilers under a variety of avalanche conditions would provide the highest quality data. However, a revealed preference technique would prove very time consuming and expensive to administer (Hensher, 2005). The researcher would also be exposed to the same avalanche hazard as the research subjects themselves, making the stated preference technique a nice alternative. Haener, Boxall, & Adamowicz (2001) found that the predictive ability of stated models were comparable to that of revealed preferences models, reaffirming their usefulness.

Stated preference DCE modeling is a decompositional approach that can account for the multi-attribute nature of many complex management issues (Timmermans, 1984), including avalanche research. This stands in contrast to a compositional approach that evaluates the attributes of management decisions individually, leaving the researcher to combine independently investigated attributes and calculate an overall utility (Haider, 2002). When individuals are posed with different hypothetical scenarios and asked to make a choice (e.g. terrain choice given a variety of avalanche conditions), preferences emerge. Stated preference DCEs have been successfully applied to a range of recreation issues to identify user preferences (Louviere & Timmermans, 1990). Use of DCE offers an effective way to assess where snowmobilers would choose to ride and under what avalanche conditions they would choose to travel. In order for a DCE to be effective, its hypothetical scenarios must reflect reality, and the choice sets must be mutually exclusive and exhaustive. However, the physical, emotional and temporal elements of backcountry travel are very difficult to fully represent in a choice experiment regarding avalanche decision-making (Haegeli et al., 2010).

To overcome the challenges of collecting data in the backcountry, Gunn (2010) and Haegeli et al., (2010) used a stated preference DCE to model terrain and travel preferences for out-of-bounds skiers. This study used pictures of ski-runs as a way to show three attributes simultaneously: slope character (open, trees, chute), slope size (small, intermediate, large) and steepness (blue, black, double back). Each scenario also contained information about the bulletin danger rating (5-levels), typical use of the slope (rarely, occasionally, regularly) and how many tracks there were (none, two, several) This technique allowed for an examination of the tradeoffs participants made between avalanche danger and slope characteristics.

The nature of a typical snowmobile trip is very different from out-of-bounds skiing. Skiers often decide to leave a resort's boundary spontaneously (Gunn, 2010), whereas snowmobile trips are often planned weeks in advance and may require overnight travel. The decision-making process for most snowmobilers is a more gradual one and a DCE should reflect this by assuming various stages of decision-making. Information gained from a DCE can help identify deficient decision makers and pinpoint specific decision-making weaknesses in the snowmobile community.

2.6. Literature Review Summary

Mountain snowmobiling has recently grown in popularity. Mountain snowmobilers are now the most frequent victims of avalanche accidents in North America. The increasing trend of snowmobiler fatalities prompted the BCCS to call for a collective effort to reduce fatalities. Several initial steps of the 'Snowmobile Action Plan' are already underway, but the lack of knowledge about this group is still cause for concern. An in-depth understanding of the target audience is crucial in the development of initiatives to improve safety. An examination of snowmobiler training, bulletin use, terrain preferences, avalanche safety behaviour, and other characteristics is needed to improve risk communication between the CAC and snowmobile community. Existing concepts used in other prevention fields can offer valuable tools for developing a better understanding of the general character of snowmobilers and their perception of personal avalanche risk. The use of DCE in avalanche safety research has proven to elicit useful information on the terrain choices in the face of avalanche hazard and identify decision-making weaknesses.

3. Theoretical Model

In addition to the use of previously established avalanche research techniques and frameworks, this study developed a theoretical approach new to avalanche research to better understand how snowmobilers seek out avalanche safety information.

3.1. Risk Information Seeking and Processing Model

In an effort to better understand how individuals seek out and process risk information, Griffin, Dunwood & Neuwirth (1999) proposed the Risk Information Seeking and Processing model (RISP), which combines elements of the Heuristic Systematic Model of Information Processing (Eagly & Chaiken, 1993) and the Theory of Planned Behaviour (Ajzen, 1991; Ajzen & Fishbein, 1980). The RISP model aims to improve the ability to develop effective risk communication initiatives by identifying factors that relate to an individuals' risk information seeking and processing behaviour (Griffin, Dunwood & Neuwirth, 1999; Griffin et al. 2004). Griffin et al. (2008) offered the following insight as to how the RISP model may be useful in campaign design:

> *Risk information campaigns might prepare target markets for risk information by first publicizing how risk knowledge and its acquisition are the norms among target populations. It also appears that, to actively engage risk information, people need to feel they have the capacity to acquire and understand whatever information is necessary to deal cognitively with a risk, manage an emotional response to it, or meet normative expectations about what they should know about the risk* (pg. 308).

3.1.1. Heuristic Systematic Model of Information Processing (HSM)

According to the HSM, the perceived gap in knowledge between what someone knows and what they think they need to know about a risk will influence how much effort they spend seeking and processing information on the given risk (Eagly & Chaiken, 1993). The HSM distinguishes between systematic and heuristic information processing. By default, individuals process information heuristically as this approach requires less effort (Eagly & Chaiken, 1993). When individuals perceive a lack of necessary information, they will expend more effort to seek and process relevant the information systematically, in more depth. It is also possible that individuals will employ a combination of these two approaches (Eagly & Chaiken, 1993, Trumbo, 2002).

3.1.2. Theory of Planned Behaviour (TPB)

The TPB is a psychological theory that connects beliefs and intentions to actual behaviour. TPB states that one's beliefs about the consequences of a behaviour shapes their attitudes toward that behaviour (expected utility of an outcome). Similarly, one's normative beliefs influences their subjective norms (felt social pressure to do something) and control beliefs influence their perceived ability to perform or control a behaviour Together, these three concepts affect an individual's behavioural intention to do something, where a behavioural intention ultimately manifests itself in an observable behaviour (Ajzen, 1991).

3.1.3. RISP Model

The RISP model combines the approaches of the HSM and TPB models to explore the antecedents of risk information seeking intent, as well as the approach to risk information processing (heuristic versus systematic). Like HSM, the RISP model links information seeking and processing to information insufficiency. Information insufficiency is the gap between current information and the perceived level of information needed to effectively manage a risk. Along with information insufficiency, perceived information gathering capacity and relevant channel beliefs are also factors that influence how information is processed. The former consists of an individual's cognitive ability to seek out, process and understand the information needed to meet their informational needs, while the latter is formed by their trust in the available information sources they could use to improve their current knowledge (Griffin, Dunwood & Neuwirth, 1999; Griffin et al., 2004; Griffin et al., 2008).

The RISP model integrates the antecedents to information insufficiency and the subsequent behavioural intentions in more detail than the traditional TPB, which only looks at three dimensions. RISP type models usually also include the following variables to provide a more comprehensive perspective:

- **Individual characteristics** - composed of the respondent's socio-demographics, beliefs, and past experiences regarding a particular risk.
- **Perceived hazard characteristics** - personal control over a particular risk, trust in the institution responsible for managing the risk, as well as the perceived probability and perceived severity of a particular risk.
- **Affective response** - an assessment of the individual's emotional response to the risk such as worry, fear, or anger.
- **Informational subjective norms** - the influence friends and family have on individuals' obligations to perform a preventative behaviour.
- **Information insufficiency** - the information gap between current knowledge and knowledge needed to mitigate a potential hazard or risk.

More specifically, the RISP model proposes that an individual's general characteristics affect their perceived hazard characteristics (Figure 3.1). In turn, perceived hazard characteristics influence their affective response (e.g., higher perceived probability or severity of a risk would lead to higher levels of worry or fear about the risk). In parallel, an individual's general characteristics also influence their informational subjective norms, as well as their levels of current information regarding the risk. Ultimately, affective response, informational subjective norms, and current knowledge influence their information sufficiency threshold, which is the behavioural antecedent associated with the initiation of information seeking and processing (Griffin et al., 2004). The RISP model's components are well established as plausible antecedents to risk information seeking and processing behaviour (Griffin et al., 2004; Huurne, Griffin & Gutteling, 2009; Yang et al. 2010; Kahlor, 2010), and offer an intuitive account of information seeking.

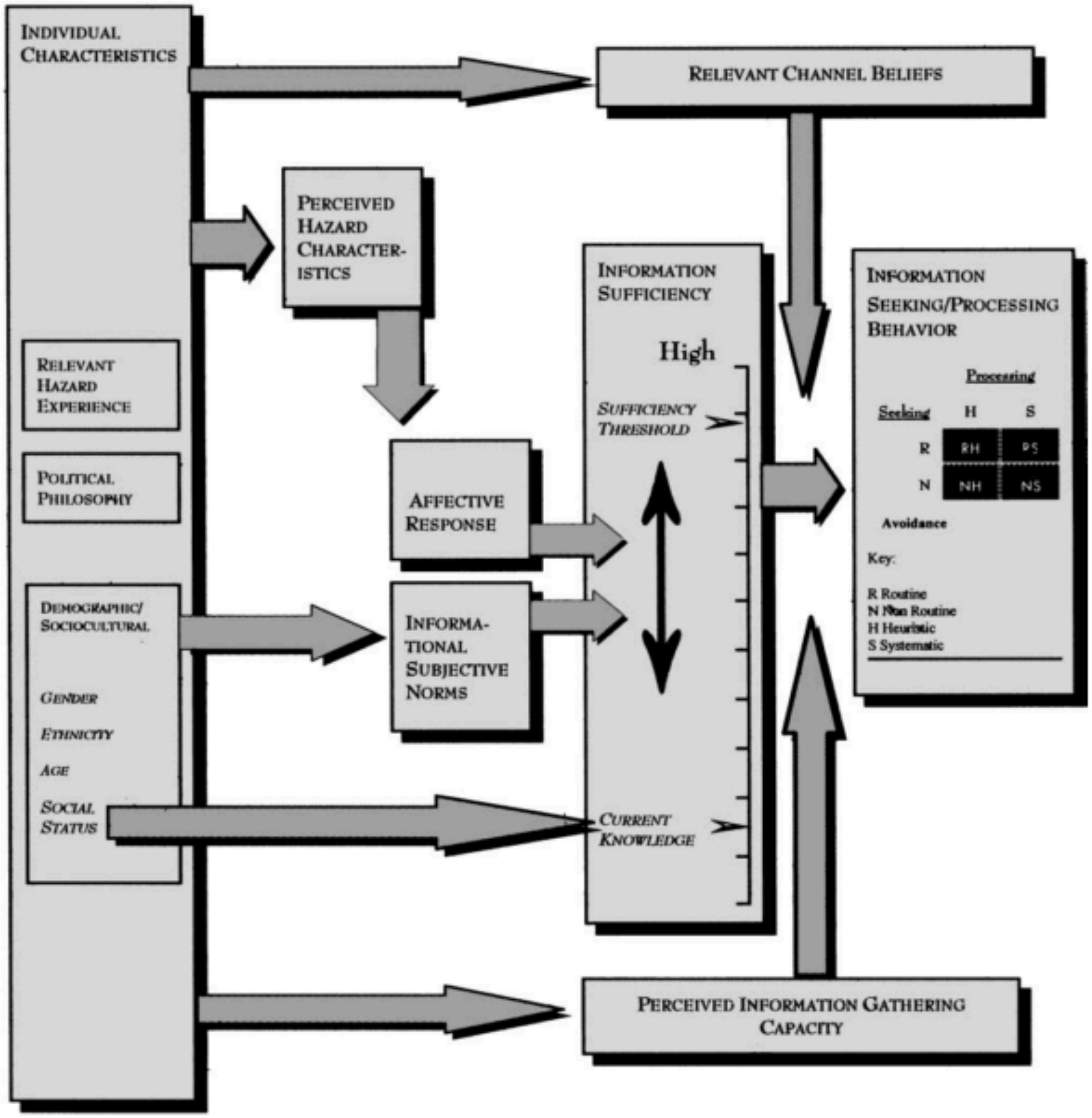

Figure 3.1. RISP model (Griffin, Dunwood & Neuwirth, 1999)

The RISP model was first operationalized by Griffin et al. (2004) to investigate information seeking and processing regarding water contamination and fish toxicity in the Great Lakes: “The primary focus was on the relation of worry and informational subjective norms to information sufficiency and the relation of key antecedent variables to worry and informational subjective norms.” (pg. 28). Griffen et al. (2004) was primarily concerned with examining the factors that initiated information seeking and processing, rather than the mode of information processing used. Later applications of the RISP model include a study on flood risks (Griffin et al., 2008), a study on the public’s perception of industrial hazards (Huurne, Griffin & Gutteling, 2009), a study on zoonotic disease (Clark, 2009), and a study concerning clinical trial enrollment (Yang et al., 2010). The RISP model has also been adjusted to include additional variables specific to the researchers' needs. Kahlor included behavioural intent in a study on global warming (Kahlor, 2007) and seeking intent in a study on health related risk information seeking (Kahlor, 2010).

The majority of the aforementioned RISP and RISP-related studies found that greater information insufficiency led to information being pursued and processed at a higher level. They also found that affective response and informational subjective norms positively relate to information insufficiency. Kahlor (2007) suggests informational subjective norms might hold a direct relationship with information seeking. Griffin et al. (2008) found informational subjective norms, as well as affective response to have direct relationships with information seeking, both studies advocate including these as alternate or additional variables to information insufficiency in future application of RISP type models.

3.2. Applying the RISP Model to Avalanche Research

The RISP model is useful in the context of avalanche safety research for it offers a broad range of established theories that have been successfully adapted to several areas of risk research. Keeping in mind the original research objectives, three different areas of information seeking and processing that relate to snowmobiler avalanche safety were identified: (a) taking an avalanche course; (b) checking current conditions prior to a backcountry trip; and (c) making observations in the field. RISP was applied to the first two areas of interest (a and b), while the third (c) was addressed in a separate part of this study.

- **RISP—Engagement**
  This model examines general information-seeking in the context of taking an avalanche course. Since taking an avalanche course is usually a one-time occurrence that significantly affects participants perception of avalanche hazard and their knowledge of it, it seems inappropriate to include snowmobilers with without formal training in the same model. As a consequence, RISP—Engagement consists of two models, one for those who have not yet taken a course and one for those who have formal training. While the first model alone can provide insight into the factors that make snowmobilers want to take an

avalanche safety course, the comparison of the two model offers information on the impact of avalanche courses on risk perception and information insufficiency.

- **RISP—Bulletin-use**
  This model applies the same basic concepts as the RISP—Engagement model, but in the context of checking the online avalanche bulletin. Because bulletin-use is an activity that should be done regularly, RISP—Bulletin-use uses a single model to better understand why some snowmobilers do not regularly check the avalanche bulletin.

Griffin et al. (2004) investigated the relation of worry and subjective norms to information insufficiency (the primary force influencing information seeking) on the risks of contracting an illness from eating contaminated fish or drinking contaminated water. Their study also examined the relation of socio-demographics and risk perception to worry and subjective norms. Together, Griffin et al. (2004) found that worry about the risk and perceptions of what others would expect of them to know about the risk were both effective predictors of information insufficiency. The application of RISP in the present research aims to identify factors that affect snowmobilers perceived level of information insufficiency concerning general avalanche knowledge (RISP—Engagement), and current avalanche knowledge before checking the bulletin (RISP—Bulletin-use). The RISP model not only facilitates the investigation of avalanche information seeking (receiving training and checking the bulletin), it also affords the present research with an improved understanding of what might influence snowmobilers' general avalanche risk perceptions, as well as their subjective norms to stay informed and become trained. Furthermore, it offers insight into factors that affecting worry about avalanche risk, such as perceived probability, perceived control and efficacy. RISP also looks at the relationship that personal characteristics have with avalanche risk perception. Any insight gained into the relatively new field of snowmobile avalanche research could potentially strengthen future risk communication campaigns by better targeting influential factors.

3.2.1. Research Questions and Hypotheses for the RISP Model

The statistical method used for analyzing RISP type models requires that a hypothesis be formulated for every relationship investigated in the model. Many of the relationships in our adaptation of RISP are exploratory, nonetheless the following research questions frame relevant hypotheses.

The first research question is unique to this adaptation of the RISP model and explores the relationship between self-efficacy (in regards to avalanche safety) and other individual characteristics. Slanger and Rudestam (1997) suggest that disinhibition (a component of sensation-seeking) and the percepts of self-efficacy to perform risky maneuvers are positively related. Bandura (1997) proposes a link between self-efficacy and experiences. Self-efficacy is usually incorporated in the RISP model at some level. Since this study was primarily concerned with the information seeking portion of the model, it was included between individual characteristics and perceived hazard characteristics. A better understanding of the relationship that self-efficacy has with other individual characteristics is quite valuable, as self-efficacy is often seen to impact motivations and behavioural changes, as well as risk-perception (Bandura,1997).

RQ1: What relationship does self-efficacy have with the other individual characteristics?

The next two research questions follow from Griffin et al. (2004), and Griffin et al. (2008). First, the affect of individual characteristics on perceived hazard characteristics is examined. Then the relationship between perceived hazard characteristics and affective response (i.e. worry) is examined. An understanding of how individual characteristics relate to perceived hazard characteristics could provide risk communicators with information to improve campaigns targeting the associated perceptions of avalanche hazard. Similarly, insight into how hazard perception relates to worry is also useful. The specific relationships between these variables are largely exploratory in this study and therefore investigated without directional hypotheses.

RQ2: What relationship do the perceived hazard characteristics have with individual characteristics?

RQ3: What relationships does worry have with the perceived hazard characteristics?

The fourth research question examines factors relating to informational subjective norms. This investigation could offer future risk campaigns with insight into the relationship between individual characteristics and subjective norms for taking an avalanche course and staying informed on conditions. Previous versions of the RISP model propose that socio-demographics (gender, income, education), political affiliation and previous hazard experience are associated with individuals' informational subjective norms. Our application of RISP focused on individual characteristics more relevant to snowmobiling and avalanche safety such as riding experience, sensation-seeking, self-efficacy, and previous avalanche involvement experience[2]. Again, the specific relationships between these individual characteristics and information subjective norms are largely exploratory and investigated without directional hypothesis.

> *RQ4: What relationship does informational subjective norms have with individual characteristics?*

The fifth research question investigates the relationship between current avalanche knowledge[3] and individual characteristics as proposed by the RISP model. An improved understanding of this relationship offers insight into determinants of avalanche knowledge which could shed light on less obvious sources of perceived knowledge.

> *RQ5: What relationship does current knowledge have with individual characteristics?*

According to the RISP model, increased affective response (worry), stronger informational subjective norms and a higher level of current knowledge all relate positively to the information sufficiency threshold. Therefore the sixth research question looks at how these factors affect information insufficiency[4] (the difference between current knowledge and information sufficiency threshold), the primary behavioural antecedent to information seeking. A better understanding of the determinants of information insufficiency could offer insight into what motivates information seeking. Given the well established relationships between these concepts, the same positive relationships proposed in the original RISP model are hypothesized here.

> *RQ6: What relationship does information insufficiency have with informational subjective norms, affective response and current knowledge?*

The final and perhaps most important piece of this research addresses information seeking in the context of intent to take a course and frequency of checking the bulletin.

[2] In RISP—Bulletin-use, *training* was included as an *individual characteristic*

[3] In RISP—Bulletin-use, *current knowledge* refers to knowledge about conditions before checking the bulletin.

[4] In RISP—Bulletin-use, *information sufficiency threshold* refers to the level of knowledge they believe is required for effectively managing avalanche danger when travelling in the backcountry.

The traditional RISP model relies on information insufficiency as the catalyst for information seeking and processing. The model then uses an assessment of participants' ability to gather enough information and their trust in those sources to predict their method of information processing (heuristic or systematic). As previously mentioned, the primary concern of this research is to identify predictors of the behavioural intent to seek information. Kahlor (2007) and Griffen et al., (2008) both suggest informational subjective norms and affective response may share a direct relationship with information seeking behaviour. In RISP—Engagement, participants who are interested in taking a course would identify as being engaged in avalanche safety (McCammon, 2009). Engagement provides a meaningful distinction between the untrained participants who are likely to get training and those who are not. A better understanding of what factors influence intention to get training could improve the potential to appeal to those factors in future avalanche safety campaigns. This same approach can be applied to RISP—Bulletin-use.

RQ7: What relationship does the engagement in precautionary behaviour have with information insufficiency, informational subjective norms and worry?

By using the adapted RISP frameworks (Figure 3.2), this study provides valuable insight into risk perception and safety behaviour. RISP—Engagement offers a better understanding of what factors contribute to a snowmobilers' intention to take an avalanche course and gives risk communicators insight into the promotion of this product. It also offers information on some of the differences between the trained and untrained. Likewise, RISP—Bulletin-use offers risk communicators insight into the factors that affect frequency of bulletin-use which could help the CAC better promote this service. The proposed hypotheses correspond in order to the seven research questions:

H1: (a) Riding experience will have a significant relationship with self-efficacy; (b) Sensation-seeking will have a significant relationship with self-efficacy; (c) previous avalanche experience will have a significant relationship with self-efficacy; and (d) Training[5] will have a significant relationship with self-efficacy.

H2: Individual characteristics will have a significant relationship with perceived hazard characteristics.

[5] Training was only included in the RISP—Bulletin-use

H3: Perceived hazard characteristics will have a significant relationship with worry (affective response).

H4: Individual characteristics will have a significant relationship with informational subjective norms.

H5: Individual characteristics will have a significant relationship with current avalanche knowledge.

H6: (a) Informational subjective norms will have a significant positive relationship with information insufficiency; (b) Worry will have a significant positive relationship with information insufficiency; (c) Current knowledge will have a significant positive with information insufficiency.

H7: (a) Informational subjective norms will have a significant positive relationship with the behavioural intention to get avalanche training; (b) Worry will have a significant positive relationship with the behavioural intention to get avalanche training; (c) Information insufficiency will have a significant positive relationship with the behavioural intention to get avalanche training.

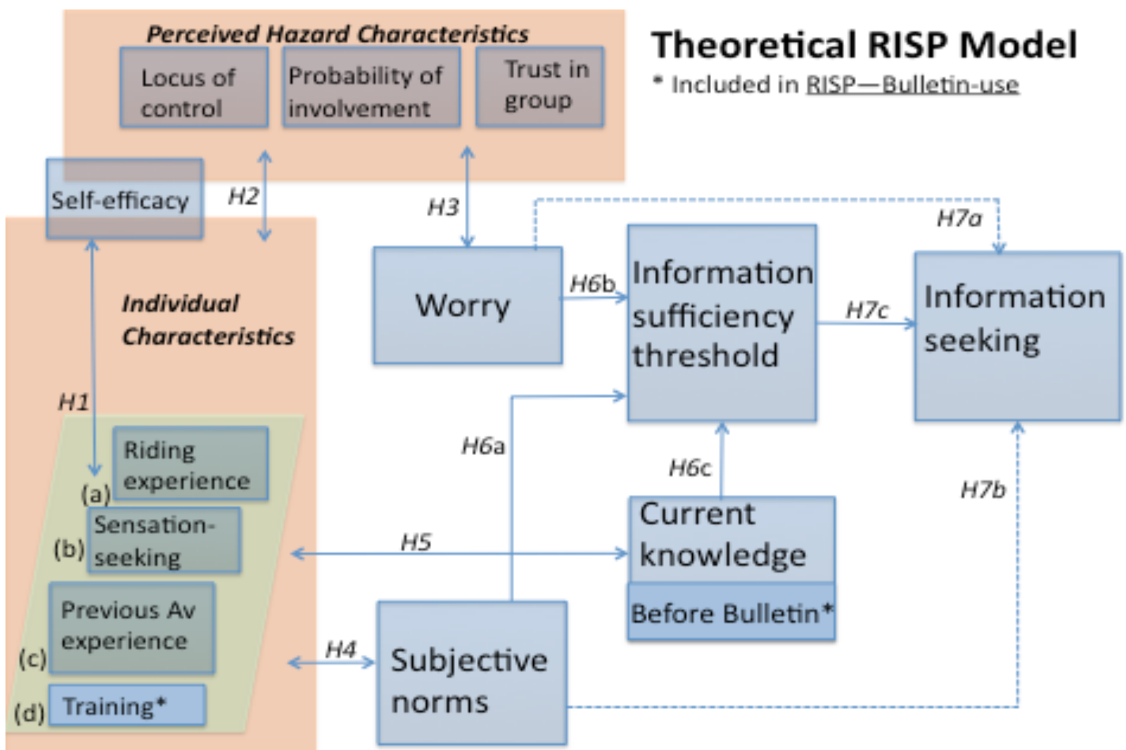

Figure 3.2. RISP model applied to mountain snowmobilers

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4. Methodology

The following section contains a description of the methods and statistical techniques used in this study. First, a description of the research strategy as it relates to the research questions is given. Next, survey implementation and the general study design are presented. Then the procedures used to assess for potential response bias are given, this is followed by a brief discussion of the split sample. Next, the statistical tests used to compare respondents with and without training, as well as those who check and do not check the bulletin are presented. A description of the RISP—Engagement, RISP—Bulletin-use, and SEM techniques is offered along with rational behind the adaptation of the RISP model's latent variable constructs. The DCE is mentioned only briefly because this portion of the study is presented in a separate paper. This section ends with a summary of how the methods used relate to the research questions.

4.1. Background Research

Given the limited amount of information available on mountain snowmobilers, an investigation of all accidents from 1997 to 2011 was conducted prior to this study. An improved accident database was created using Information from the CAC's incident report database, coroner reports and RCMP records. From these various sources of data, all recreational avalanche fatalities were isolated and snowmobile accidents were analyzed and compared to other recreational avalanche fatalities. This information, along with advice from expert interviews, guided the development of survey questions and the general implementation of the survey.

Appendix A provides an overview of past victim and accident characteristics, as well as a comparison of snowmobile accidents to the accidents involving other winter recreationists.

4.2. Survey Design and Implementation

Two survey instruments were used in this study. First, an intercept survey was administered at ten popular snowmobile staging areas throughout British Columbia. Snowmobilers recruited from the intercept along with many others who were invited to participate in the longer and more in-depth online survey.

4.2.1. Intercept Survey Instrument

The objective of the intercept survey was to gather a representative sample of mountain snowmobilers at these locations and to recruit participants for a more comprehensive online survey. The intercept survey was administered at snowmobile staging areas (trailhead parking lots) in five popular snowmobile destinations in British Columbia. The following locations were chosen based on their level of use (as communicated by Sledcom)[6] and their proximity to previous snowmobile avalanche fatalities (Figure 4.1):

- Revelstoke (Frisby Ridge and Boulder Mountain staging areas)
- Valemont (Allan Creek and Clemina Creek staging areas)
- Golden (Quartz Creek and Gorman Lake staging areas)
- Fernie (Coal Creek staging area)
- Sicamous (Owl's head, Blue Lake and Eagle Pass staging areas)

These staging areas all provide access to a similar variety of terrain, including but not limited to complex avalanche terrain. Survey administrators were hired for each location, participants were recruited in the staging area parking lots as they loaded their snowmobiles after their day of riding. Survey administrators were instructed to politely offer the survey to all riders in the staging area, however approaching everybody was not always possible during peak hours. A paper-based questionnaire, clipboard and pen were given to the participants. The survey took approximately five minutes to complete. Survey administrators collected and returned their completed surveys to Simon Fraser University, along with information on the number of declines or had previously completed the survey. Information on the day's weather was also included. Valemount Area

[6] Sledcom is the Canadian Avalanche Centre's snowmobile committee.

Recreation Development Association (VARDA) also provided total numbers of snowmobilers for each survey day in the Valemount area, giving the research team a relatively accurate overall response rate. All data was manually entered into a database along with the previous day's avalanche bulletin for the relevant forecast region. Data was initially collected on weekends and weekdays starting in December 2011, however due to low mid-week rider turnout, data collection shifted to weekends only. In addition to the regularly scheduled intercept locations, data was collected at the Brandywine staging area near Squamish, BC on December 28, 2011 during Sledfest, a British Columbia Snowmobile Federation and Sledcom event.

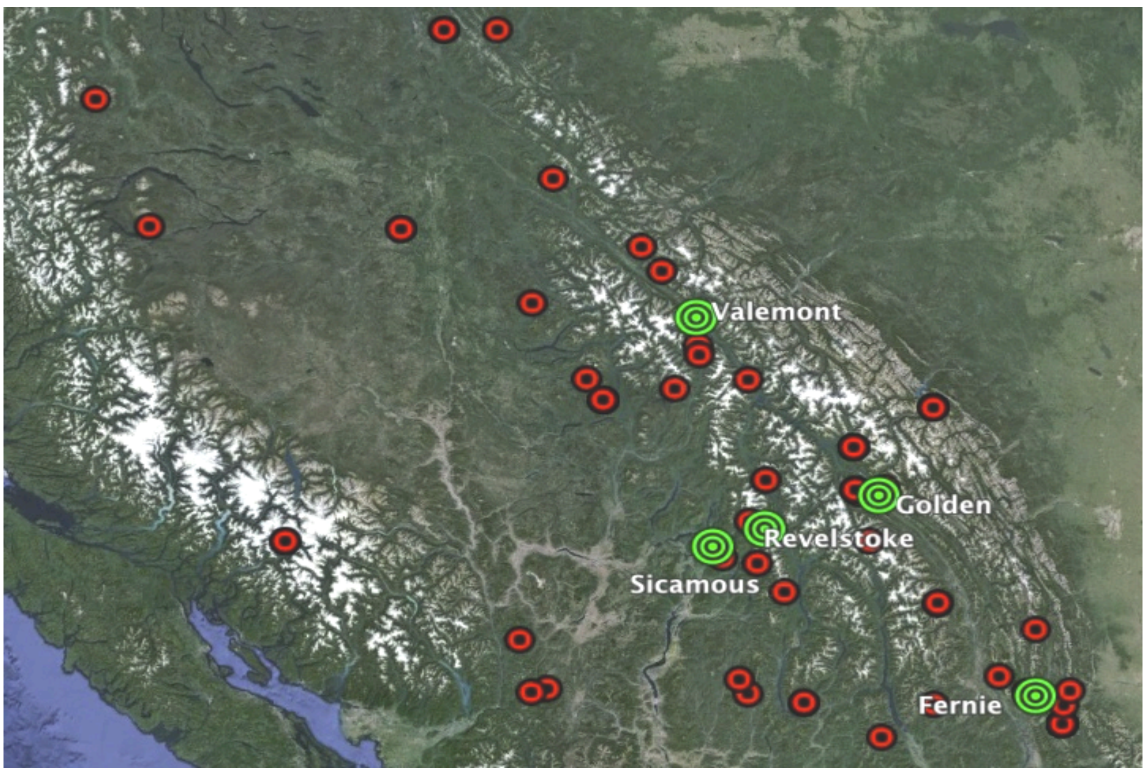


Figure 4.1. Intercept survey locations shown in green and locations of snowmobile accidents from 1997 to 2011 shown in red (n = 62) (map from Google)

Appendix C provides specific details on survey dates, time spent collecting surveys, weather conditions, avalanche bulletin danger rating and the number of surveys both collected and refused at each location.

4.2.2. Online Survey Instrument

The second survey was administered online and repeated some of the same questions as the intercept survey, allowing to test for response bias present in the results. The online survey also contained questions that addressed all of the research objectives. The online survey consisted of the following main sections:

- Personal background
- Snowmobile type and riding experience
- Characteristics of typical riding group
- Character of typical snowmobile trips
- Avalanche risk perception
- Barriers for becoming avalanche trained/taking a course
- Barriers for consulting avalanche bulletins
- Information seeking and processing in the field

In addition to the personal recruitment at staging areas, the online was also promoted by avalanche course providers, snowmobile manufacturers and dealerships, snowmobile movie companies, promotional postcard, and word of mouth (see Table 4.1 for a timeline of distribution efforts). However, most participants completed the intercept survey and provided their email address to participate in the online survey. The survey took approximately 25 to 40 minutes to complete. Participants who were underage or completed the survey in an unrealistically fast amount of time were excluded from the analysis. As an incentive, participants who completed the survey by May 30, 2012 were offered the chance to enter into a prize draw7. Data from the online survey was automatically stored in a secure database. Survey participants remained anonymous and were allowed the chance to give feedback at the end of the survey. See Appendix D for the entire survey.

[7] Five prizes were given in total, each winner received two-nights paid accommodation at a British Columbia snowmobile destination of their choice.

Table 4.1. Distribution of online survey

April 9, 2012	An email with a link to the online survey was successfully sent to all of the addresses collected during the intercept survey. Using an email service, it was determined that 639 were successfully delivered and 119 bounced. The other 18 were either duplicates or filtered by an advanced SPAM blocker. The personalized link contained the respondents information from the intercept in prefilled fields, this information could be changed if the respondent chose to. An email with the general link was sent to 15 addresses collected on the studies landing page. (See Appendix E for the email example).
April 10, 2012	A review of the bounced email addresses along with the intercepts they were recorded on produced 81 additional corrected addresses, the same personalized link to the survey was resent to all of them.
April 11, 2012	Team Thunderstruck (http://www.thunderstruckfilms.com), a snowmobile movie company posted a link to the survey on their company website and their social media pages (Twitter and Facebook).
April 12, 2012	Slednecks (http://www.slednecks.com), a snowmobile movie company posted a link to the survey on their company website and their social media pages (Twitter and Facebook). Lori Zakaruk, a safety instructor with the Alberta Snowmobile Association and owner of Zacstracs Avalanche Skills Training, sent a link to her personal mailing list.
April 13, 2012	Carole Savage, the CAC's Snowmobile Liaison, sent the link to the following organizations: • SledCom (Alberta Snowmobile Association , British Columbia Snowmobile Federation, Association of British Columbia Snowmobile Clubs, British Columbia Commerical Snowmobile Operators Association, etc.) • Arctic Cat (contact: Kory Poliaski) • Polaris (contact: Marlys Knutson, Polaris Head office) • Yamaha (contact: Randy Swenson) • SkiDoo/BRP (contact: Gerry Dusessoy) • CAC Staff • International Snowmobile Manufacturer Association • Canadian Council of Snowmobile Organization
April 17 & 18, 2012	Telephone calls were made to 43 snowmobile clubs to follow up on the promotional effort.
May 7, 2012	A reminder email was sent to 116 addresses that started the survey but had not finished it. A reminder email was sent to 542 addresses that had not started the survey.
May 30, 2012	The survey closed and the winners of the prize draw were announced.

4.2.3. Online Survey Split Sample Questions

Participants were split into three groups (roughly one third each) for the final section of the survey in order to limit the amount of time it took to complete without deleting any questions. From the three groups, 212 were asked general questions about avalanche courses and course providers, 230 were asked to about their behaviours while riding, and 220 about avalanche their use of avalanche bulletins and Internet access.

4.3. Screening for Response Bias

Response bias occurs if a portion of the target population is not fully represented in the sample. To examine for this potential, first the responses from participants who completed both the online and intercept survey were compared to those who completed only the intercept. Then the responses from all participants who completed the online survey were compared to all of those who completed the intercept. Last, key online responses from the participants recruited from the intercept were compared to the responses from participants who were directed to the online survey via another channel. The first comparison tested for non-response bias, which occurs when a portion of the target population does not respond to the survey. The second and third comparisons assessed for self-selection bias, which can arise when individuals select themselves to participate in a study. Both biases are a cause for concern.

The validation is described in detail in Appendix F

4.4. Descriptive Statistics and Comparisons

Descriptive statistics, cross tabulations and statistical comparisons for both surveys were performed using the statistical environment *R* (R Development Core Team, 2013). In the event that survey questions did not have a normal distribution or had too few categories, median scores and the interquartile range (IQR) were used to describe responses. Normally distributed data used mean scores and standard deviations to describe responses. Categorical data was compared using a Pearson's chi squared test. Ordinal data was compared using a Wilcoxon rank-sum test. Continuous data was compared using a t-test. p-values of less than 0.05 were considered statistically significant. These techniques were used for the univariate analyses comparing sub-populations and assessing for the potential of non-responses and self-selection bias. Cronbach alpha was used to measure the internal consistency of survey responses for each item's underlying concept, Cronbach alpha levels greater than 0.70 are generally considered to reflect good reliability of internal consistency and over 0.90 is considered excellent. (Vaske, 2008).

4.4.1. Online Subpopulation Comparisons: Training and Bulletin use

To identify potential barriers that prevent snowmobilers from taking formal avalanche training, response patterns from respondents with formal training were compared to those without. Several questions in the survey were designed to elicit information on respondents' perceptions of the CAC, AST courses and course providers. Specific questions on course timing and cost were also included. Through these comparisons we are able to identify some of the specific barriers for those that have not taken a course, as well as quantify the benefits of taking a course. Similarly, to identify potential barriers that prevent snowmobilers from checking the avalanche bulletin, respondents who regularly check were compared to those who do not. Questions on bulletin usefulness and accessibility were included to capture this information. Through these comparisons we are able to identify specific weaknesses in the presentation and distribution of the avalanche bulletin, as well as quantify the benefits of checking the bulletin.

4.5. Discrete Choice Experiment

The web-based survey included a discrete choice experiment to examine the choice behaviour of survey participants (Louviere et al., 2001). The DCE presented participants with hypothetical scenarios containing choices that they would have to make at different points during a typical snowmobile trip. These choices were designed to mimic decision-making in a typical day of riding. The DCE elicited information on the tradeoffs participants made and the utility they derived from those choices given the availability of different avalanche information, terrain and conditions.

The methods and results of this part of the study are presented in a separate paper (Haegeli et al., 2012), which focuses on how snowmobilers adjust their riding behaviour as avalanche information becomes available during their trip, See Appendix F.

4.6. RISP Model Measurements

RISP survey questionnaires typically use Likert-scale type questions or numerical assessments of a particular item to measure responses to cognitive concepts, which allows for statistical testing of relationships. Likert-scale variables containing five or more categories were treated as continuous (Vaske, 2008). Similar to Kahlor (2007) and Griffin et al. (2004), In this application of the RISP model some of the components were measured using a single indicator variable that best captured the essence of the RISP concept. It is recommended to use the few best indicators or even the single best indicator variable to represent a latent concept (Hayduk & Littvay 2012).

Individual Characteristics

Four different types of individual characteristics were included in RISP—Engagement, the model that examined the predictors of getting trained. Training was then included as its own independent variable along with the other individual characteristics in RISP—Bulletin-use, the model that examined predictors of checking the bulletin:

a) *Riding experience* was measured with a single item 7-point scale[8] (number of years categories) to capture their relative experience and connection with snowmobiling.

b) *Sensation-seeking* was included with an averaged score (1= strongly disagree to 7 = strongly agree) from the eight BSSS questions (Hoyle et al., 2002), two for each one of the four underlying dimensions of sensation seeking (Experience Seeking, Boredom Susceptibility, Thrill and Adventure Seeking, and Disinhibition). When averaged, the four underlying dimensions of the sensation-seeking scale offer a general account of a participants' overall sensation seeking tendencies.

c) Self-efficacy with respect to avalanche safety was measured using three items intended to assess participants' perceived personal ability to prevent involvement and perform emergency rescue measures avalanche (0 = completely unable, to 100 = highly certain can do), specifically their ability to:
   - '*recognize situations in which you are likely to trigger an avalanche',*
   - *'identify locations to safely watch other snowmobilers ride',* and
   - *'locate and rescue a partner who is completely buried by an avalanche'*.

[8] Riding experience code: 1 = first year; 2 = 1-2yrs; 3 = 3-5yrs; 4 = 6-9yrs; 5 = 10-14yrs; 6 = 15-19yrs; 7 = 20+ years

d) Previous avalanche involvement experience was measured as a single item derived from a series of questions on personal and group avalanche involvements (0 = no involvement, 1 = group or personal involvement/burial), this variable was treated as a categorical variable in the analysis.

e) Training was measured using a single item derived from the PAPM scale (0 =no training, 1 =formally trained). This variable was only included in RISP—Bulletin-use and was treated as a categorical variable in the analysis.

Perceived Hazard Characteristics

Four perceived hazard characteristics were used in the analysis:

a) Locus of control (Holt et al., 2007; Rotter, 1966) was measured using a single item regarding the role luck plays in avoiding avalanches (0 = no luck at all, to 100 = all luck), where a higher score indicates participants' viewed luck to play a larger role.

b) Probability of harm[9] was measured using a single item in which the likelihood of becoming involved in an avalanche was assessed with a scale of odds.

c) Participants' trust in their riding group was measured using two items that assessed their group's ability to prevent avalanche involvement and a rescue a buried victim (0 = cannot do at all, to 100 = highly certain can do).

d) Self-efficacy was measured using the same three items as previously described.

Affective response

Worry was measured using a single item (0 = not afraid at all, to 100 = extremely afraid) regarding participants' worry about being caught in an avalanche.

Informational Subjective Norms

The subjective norms of survey participants were examined with respect to two separate social groups: (a) family members and (b) riding partners. Following the TPB framework, participants were asked to indicate their perceived supportiveness of the two groups for becoming avalanche trained and keeping informed about avalanche conditions (normative beliefs) on a scale from -3 (not supportive) to 3 (very supportive). They then further indicated their motivation to comply with the respective normative groups on a

[9] Probability of dying in an avalanche code: 1 = less than 1 in 10,000 years; 2 = 1 in 10,000 yrs; 3 = 1 in 1,000 yrs; 4 = 1 in 100 yrs; 5 = 1 in 10 yrs; 6 = 1 in 5 yrs; 7 = 1 in 2 yrs; 8 = 1 in a year; 9 = 2 in a year; 10 = 5 in a year; 11 = more than 5 in a year.

scale from 1 (not important at all) to 7 (extremely important). For the analysis the two scores were multiplied, resulting in an informational subjective norms score of -21 to 21 for each social group.

Information Insufficiency

In the first model, RISP—Engagement, this variable was measured using (a) current information about avalanches and (b) the information sufficiency threshold. Current knowledge was measured with a single item to assess participants' current general avalanche safety knowledge (0 = know nothing at all, to 100 = know everything there is to know). Using the same scale, participants also assessed their perceived level of required knowledge needed to effectively manage avalanche danger. Information insufficiency is the resulting difference between the two.

The second model, RISP—Bulletin-use, measured current knowledge using the same scale but in reference to knowledge about conditions before checking the bulletin. Information sufficiency threshold referenced the level of knowledge they believe is required to effectively manage avalanche danger while riding in the backcountry.

4.7. RISP Model Analysis

Similar to Griffin et al. (2004), the primary concern for RISP—Engagement was to identify factors that might influence the behavioural intention to take a course. Given this interest, it made sense to distinguish participants with training from those without due to the effect training has on perceptions of personal avalanche risk. Groups were based on the participants' self-assessment of which PAPM statement best characterized their level of avalanche awareness and safety practices. Running a model with two groups allowed for a meaningful comparison, as well as the investigation of the relationships affective response, subjective norms and current information had with information insufficiency. Consistent with Cohen et al. (2003), Griffin et al. (2004), and Griffin et al. (2008), a regression approach was used in which information sufficiency threshold was entered as a dependent variable and current knowledge as one of its predictors, which accounted for the systematic variance in the threshold and helped avoid potential ceiling effects from using the difference score.

The RISP—Bulletin-use model investigated information seeking in the context of checking the bulletin. The same relationships from the RISP—Engagement were assessed, however instead of running a model with two groups like the first, this analysis was done in aggregate. Training was included as an individual characteristic and information insufficiency was assessed as the primary predictor of bulletin use.

Participants who chose PAPM statements *disengaged* or *non-emerging* were removed from this portion of the analysis because those choices represent a departure from the assumed progression of the PAPM. Missing data from normative beliefs of friends and family (component of informational subjective norms) was replaced with the row average, as was missing data from the BSSS. Missing data from any other variables was removed using listwise deletion.

4.7.1. Structural Equation Modeling

RISP model analyses use structural equation modeling to quantify the theorized relationships between variables (Griffin et al., 2004). SEM is broad term for multiple regression analysis used in confirmatory factor analysis (CFA) and for testing theories of causality using path analysis (Pearl, 2000; Raykov & Marcoulides, 2006). SEM and CFA both use multiple regression analysis, while CFA provides insight into the non-directional relationships between a latent variable's constructs, SEM investigates the theory based directional relationships, in which a structural model composed of exogenous (independent) and endogenous (dependent) latent variables is used. Latent variables are representative variables that are not directly measurable, rather derived from indicator variables (survey data), in which a structural measurement error term is incorporated (Pearl, 2000). This feature allows SEM to examine suspected causal relationships in models that include latent variables (Raykov & Marcoulides, 2006). Specific to this study, the SEM analysis uses standardized regression coefficient estimates to denote significant relationships ($p < 0.05$) between the various components of the RISP model. Multi-group models produce standardized coefficient estimates for each group, allowing for an investigation of the conceptual relationships specifically for each group. A z-test was used to test for equality in a comparison of regression coefficients between groups (Paternoster et al, 1998). Several indicator variable were further investigated using their correlation coefficients. The results of SEM are typically illustrated a path diagram.

This study used the Lavaan package for R (Rosseel, 2012) to estimate the structural equation model. Lavaan 5.13 performs many of the same functions as its commercial counterparts (e.g. LISREL, Mplus, AMOS, EQS) and offers an amalgamation of their model estimation methods as well as fit indices. This study used the Weighted Least Square Means and Variance Adjusted method (WLSMV; Muthén & Muthén 1998) to estimate the model. While the Weighted Least Squares estimator is suggested as a better option under conditions of non-normality involving any ordinal data (Muthén, du Toit, & Spisic, 1997), the WLSMV estimator only uses the diagonal components of the covariance matrix, making it a better option with smaller sample sizes (Luo, 2011). WLSMV estimates are generally more conservative in cases with multiple groups like ours (Jomeen & Martin, 2007; Mîndrila, 2010). This study used the Comparative Fit Index (CFI; Bentler, 1990), the Root Mean Square Error of Approximation (RMSEA; Steiger & Lind, 1980) and the Standardized Root Square Mean Residual (SRMR; Hu & Bentler 1998). A CFI of greater than 0.9 indicates an acceptable fit and over 0.95 indicates a good fit. A RMSEA and SRMR of less than 0.05 indicates a good fit and less than 0.08 indicates an acceptable fit.

In addition to the SEM, the RISP—Engagement model used a binary logistic regression to investigate the relationships that the group without training's informational subjective norms, worry and information insufficiency had with their PAPM stage. PAPM would have been a categorical endogenous variable, but Lavaan 5.13 only allows for continuous endogenous variables at the end of the model PAPM was therefore reduced to a binary variable, where 'engaged' participants were separated from the 'aware' and 'unaware'. This allowed us to examine both the established behaviour antecedent, information insufficiency, and the two potential behaviour antecedents, informational subjective norms and affective response as suggested by Kahlor (2007) and Griffin et al. (2008). The RISP—Bulletin-use model used continuous variable frequency of bulletin-use as the final endogenous variable in the SEM model.

5. Results

5.1. Intercept Survey Results

After removing incomplete survey questionnaires, 1,019 participants were included in this analysis[10]. In Valemount[11], out of the 1,113 asked to participate, 254 (23%) successfully completed the intercept, 695 (62%) declined to participate and 164 (15%) had completed the intercept at an earlier point in the season. In the other staging areas (Revelstoke, Golden and Fernie)[12], a total of 2,234 snowmobilers were intercepted. Ofof those, 872 (39%) successfully completed the intercept, 1,047 (47%) declined to participate and 315 (14%) had completed the intercept at an earlier point in the season.

5.1.1. Demographics

The mean age of intercept participants was 34 (n = 1,002, SD = 10.33) and 88% (880 of 1,002) were male. Ninety-eight percent (996 of 1,012) were Canadian. Alberta, British Columbia and Saskatchewan had the highest representation (Figure 5.1).

[10] 1,054 intercepts were collected in total, however some were removed due to the participant's age or incompleteness

[11] Total snowmobiler numbers were consistent and accurate for Valemount staging areas, obtaining this data at other staging areas was not possible.

[12] All Sicamous staging areas were excluded in the response rate estimations due to unreliable rider numbers and incomplete reporting. This number does not accurately reflect how many people were intercepted in total, rather it is a point of reference for an approximate response rate.

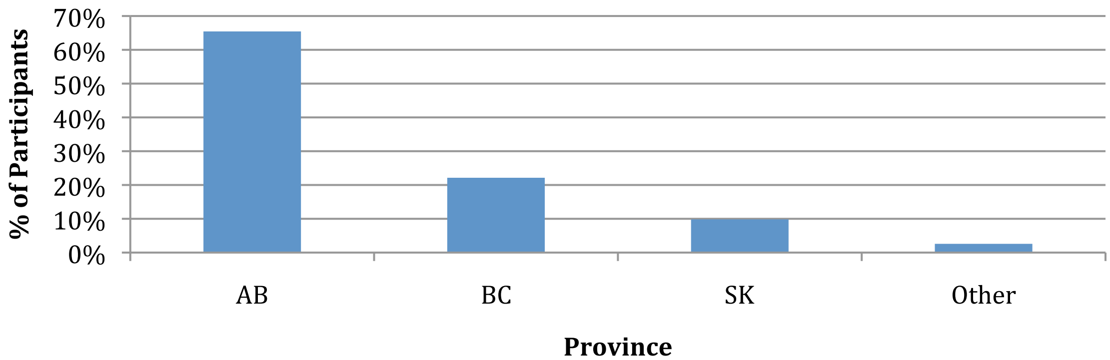


Figure 5.1. Percentage of participant by province of origin

5.1.2. Snowmobile Type and Riding Experience

All four major snowmobile manufacturers were represented in the results, 45% (443 of 985) rode a Skidoo BRP, 24% (236 of 985) an Arctic Cat, 21% (211 of 985) a Polaris and 9% (93 of 985) rode a Yamaha snowmobile. Only two of the intercept participants rode a Snowhawk, a motorbike-like design with only one ski in the front. Due to the rarity of this type of snowmobile among mountain snowmobilers, these two individuals were excluded from the analysis. Most of the survey participants rode two-stroke snowmobiles (85%, 797 of 942) with a 153-162" track (56%, 525 of 930), a 800-900cc engine (71%, 661 of 933), and no turbo (84%, 774 of 918) or other aftermarket engine modifications (74%, 657 of 889), they used regular pump fuel (88%, 813 of 929), as opposed to race fuel. Table 5.1 lists the 10 most commonly reported snowmobile configurations, which represent roughly half of the snowmobile types covered in this survey.

Table 5.1. Ten most commonly reported snowmobile configurations

Brand	Track Length	Engine Size	Engine Type	Fuel Type	Turbo	Engine Mod.	Count
BRP	153-162"	800-900cc	2-stroke	Pump fuel	No	Stock	132 (13%)
BRP	143-152"	800-900cc	2-stroke	Pump fuel	No	Stock	77 (8%)
Arctic Cat	153-162"	800-900cc	2-stroke	Pump fuel	No	Stock	75 (7%)
Polaris	153-162"	800-900cc	2-stroke	Pump fuel	No	Stock	54 (5%)
BRP	153-162"	800-900cc	2-stroke	Pump fuel	No	Modified	31 (3%)
BRP	163" +	800-900cc	2-stroke	Pump fuel	No	Stock	28 (3%)
Polaris	163" +	800-900cc	2-stroke	Pump fuel	No	Stock	24 (2%)
BRP	143-152"	600-700cc	2-stroke	Pump fuel	No	Stock	19 (2%)
Polaris	153-162"	600-700cc	2-stroke	Pump fuel	No	Stock	19 (2%)
Yamaha	163" +	1000cc +	4-stroke	Race fuel	Yes	Modified	18 (2%)
						Sum	477 of 1019 (47%)

The median riding experience among survey participants was 3 to 5 years (22%, 221 of 1,009) and 5 to 15 days of mountain snowmobile riding per year (37%, 369 of 993). Fifteen percent (131 of 861) reported being novice riders, 38% (323 of 861) intermediate, 36% (306 of 861) advanced and 12% (101 of 861) expert, and 33% (300 of 996) were members of a snowmobile club.

5.1.3. Avalanche Training and Experience

Participants were presented with all PAPM statements and asked to choose which one best describes their thoughts about avalanches (Table 5.2). These statements were also used to evaluate whether survey participants had formal avalanche training. While 60% (601 of 1005) of survey participants did not have any formal avalanche training, 40% (404 of 1005) completed at least an Avalanche Skill Training Level 1 course.

Table 5.2. PAPM statement progression and responses

Label	Characterization Statement	Count	Formal training
Unaware (1)	I generally do not think about avalanches where I ride.	30 (3%)	None 601 (60%)
Aware (2)	I know that avalanches can happen in some of the places I ride, but avalanche danger generally does not affect the choices I make.	66 (7%)	
Disengaged (3)	My personal experience in mountain snowmobiling has provided me with all the skills I need for managing avalanche danger where I ride.	116 (12%)	
Engaged (4)	I sometimes worry about being caught in an avalanche. I would like to learn more about avalanche safety, but have not taken a formal course with a field component (e.g., AST1 or more advanced) yet.	389 (39%)	
Non-emerging (5)	I have taken a formal avalanche course with a field component, but I don't regularly apply what I learned when riding.	78 (8%)	Yes 404 (40%)
Emerging (6)	I have taken a formal avalanche course with a field component and I am practicing my skills whenever I can.	186 (19%)	
Practicing (7)	I have taken a formal avalanche course and have several seasons of experience applying these skills when riding. Avalanche risk mitigation has become an integral part of my riding practice.	140 (14%)	
	Total	1005	

Using a scale from zero (Cannot do at all) to 100 (Highly certain can do) participants rated their confidence in their ability to perform the following preventative avalanche safety and rescue procedures (Figure 5.2):

- To recognize situations in which you are likely to trigger an avalanche (median: 70, IQR: 50, 80)

- To locate and rescue a partner who is completely buried by an avalanche (median: 70, IQR: 50, 80)

- Talk your partners out of riding a slope that you personally think is dangerous (median: 80, IQR: 60, 80)

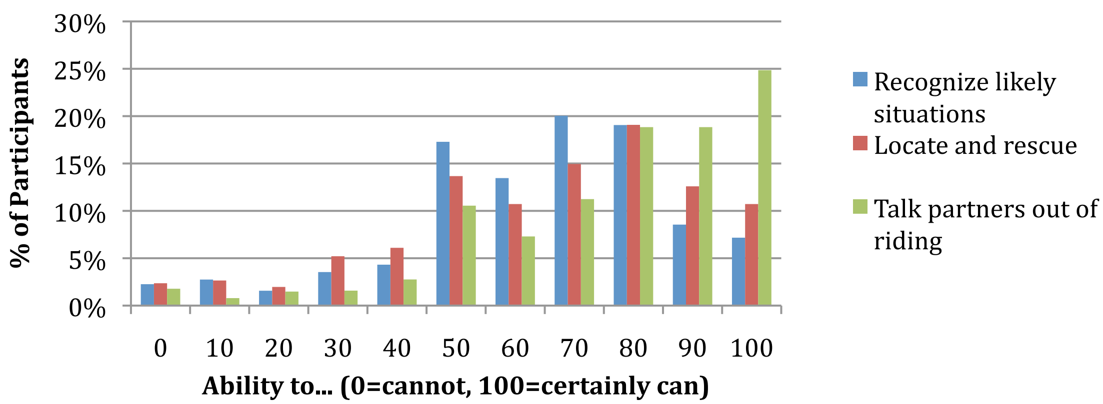


Figure 5.2. Ability to perform preventative avalanche safety and rescue procedures.

Previous avalanche experience was not uncommon, 25% (224 of 966) of survey participants reported to have been caught in an avalanche themselves or have witnessed a riding partner being caught in an avalanche.

5.1.4. Current Snowmobiling Trip

Intercept questions asked survey participants about the character of their current snowmobile trip. The majority of trips were planned well in advance, 60% planned either weeks or months in advance (451 of 949), while 32% (311 of 981) chose the specific riding area on the day of the outing and another 38% (372 of 981) decided the day prior to the outing (Figure 5.3).

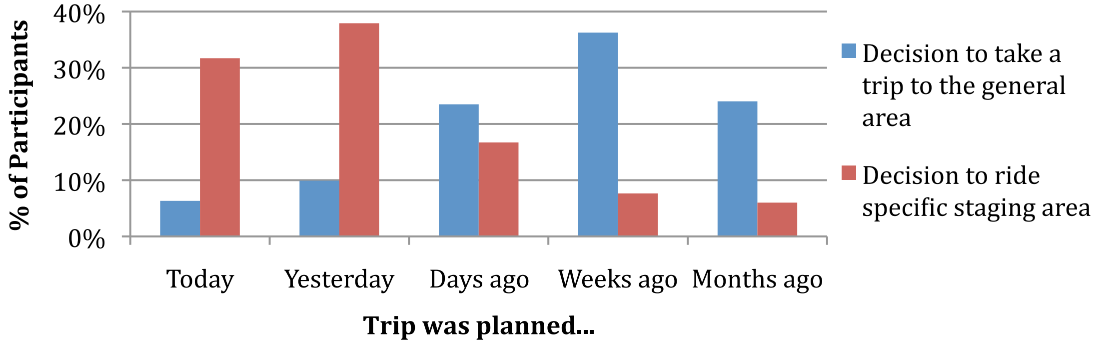


Figure 5.3. Timing of trip planning and choice for riding in a specific snowmobile area

Median length of snowmobile trips was two to three days long (58%, 577 of 1,002), and 11% (110 of 1,002) did not need to travel because they resided near the riding area (Figure 5.4).

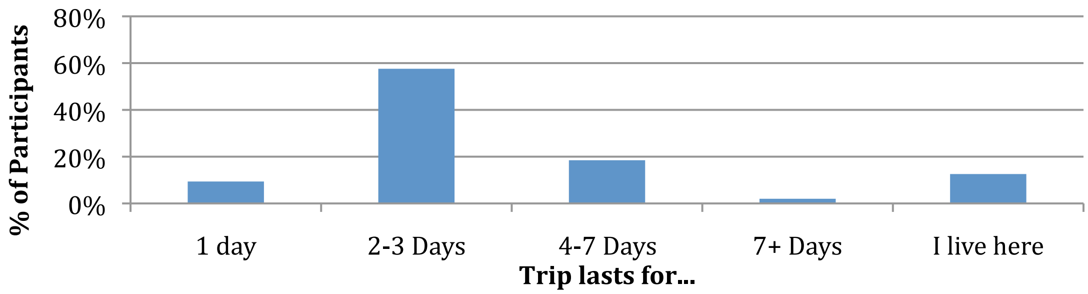


Figure 5.4. Length of trip

For the vast majority of survey participants, mountain snowmobile riding was the objective of their trip. Only 9% (65 of 708) of participants used their snowmobile to access ski or snowboard terrain on the day of the intercept. Participants indicated accessing a variety of different terrain types (as many as applied) the day they completed the survey (Figure 5.5).

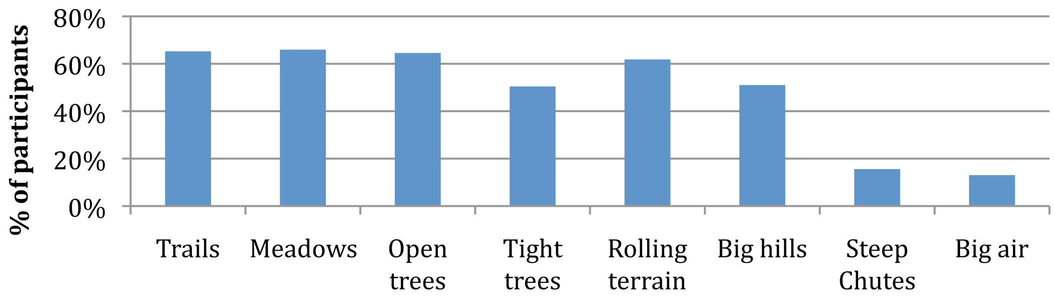


Figure 5.5. Terrain types accessed on the day of the intercept

While 67% (664 of 997) of participants reported to have checked the relevant CAC avalanche bulletin prior to their day of riding, only 71% (314 of 443) were able to correctly recall the alpine danger rating, 59% (226 of 385) were able to correctly recall the tree-line danger rating, and 59% (208 of 353) were able to correctly recall the below tree-line danger rating.[13]

The use of standard avalanche safety equipment was widespread among survey participants (Figure 5.6): 96% (974 of 1,019) carried shovels, 87% (890 of 1,019) avalanche transceivers and 86% (879 of 1,019) probes. Seventy-nine percent (804 of 1,019) of survey participants carried all three avalanche safety essentials on the day of the intercept survey. It is notable that 35% of survey participants were carrying an avalanche balloon pack.

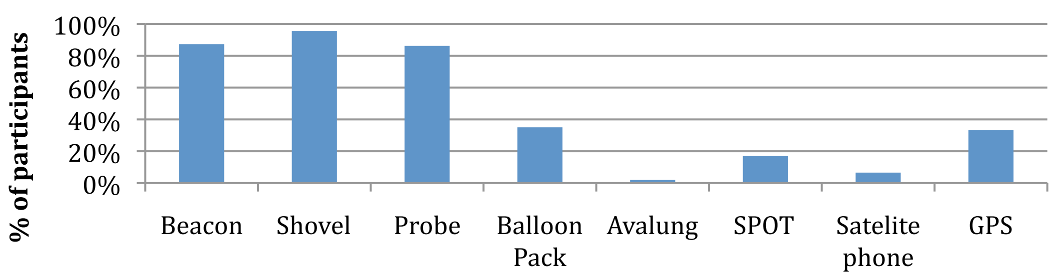


Figure 5.6. Avalanche equipment and safety gear [14]

[13] Participants often reported only one or two of the avalanche bulletin elevations.

[14] GPS was added to a later version of the intercept survey. Of those asked, 33% (237 of 710) carried GPS.

Seventy-six percent (775 of 1,019) of survey participants provided their email address and agreed to be contacted to participate in the online survey.

5.2. Online Survey Results

Of the 775 email addresses collected from the intercept survey, a survey was successfully delivered to 718, and of those 144 (20%) actually completed the online survey. Other participants were directed to the online survey by avalanche course providers, snowmobile manufacturers or dealerships, snowmobile movie companies (e.g., Thunderstruck, SledNecks), promotional postcard, website landing page, or from a friend. See Figure 5.7 for complete introduction source. Of the 662 completed online surveys that were included in this analysis, only 144 (22%) came from the recruited intercept sample.

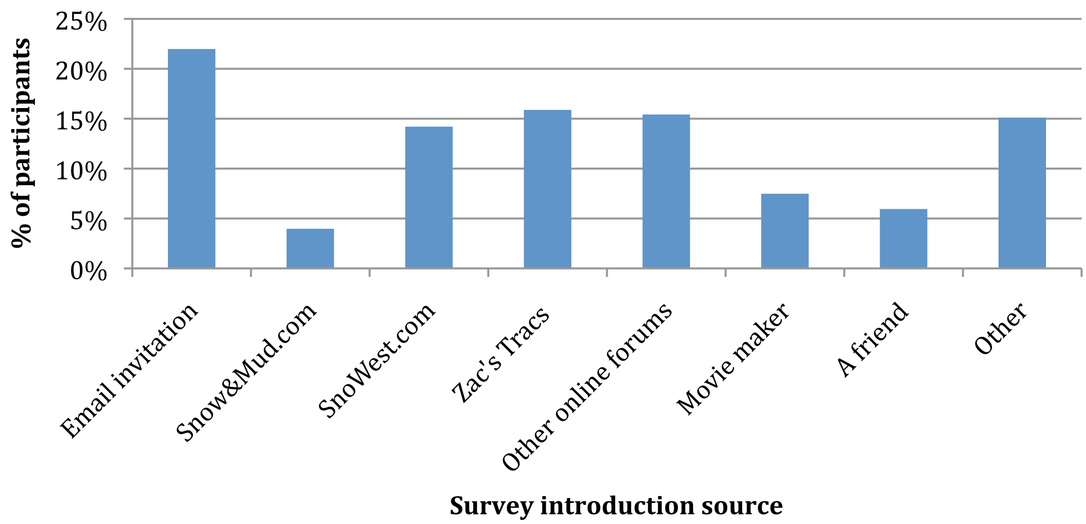


Figure 5.7. Online survey introduction source

5.2.1. Personal Background

Demographics

Ninety-three percent (608 of 657) of survey participants were male and their median age range was 35 to 44 (Figure 5.8). Questions about participants' personal status revealed that 64% (227 of 353) were married and 62% (223 of 357) had children.

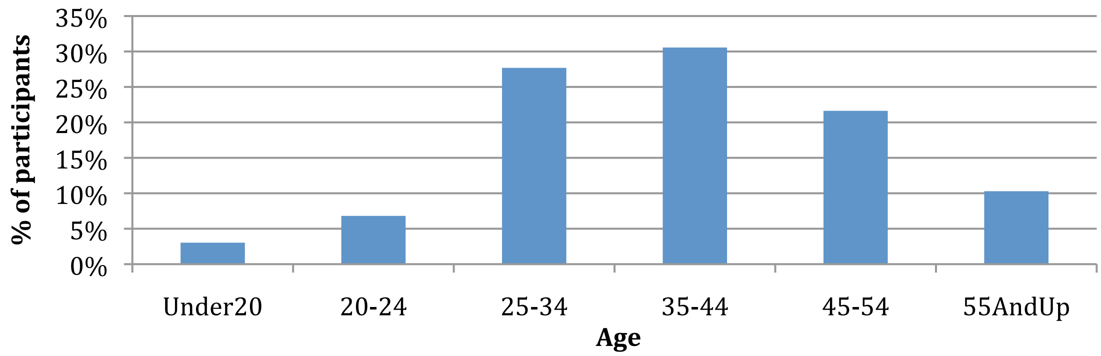


Figure 5.8. Age distribution of survey participants (n = 661)

All but three survey participants were Canadian (81%, 533 of 661) or American (19%, 125 of 661) with the majority coming from British Columbia or Alberta (Figure 5.9).

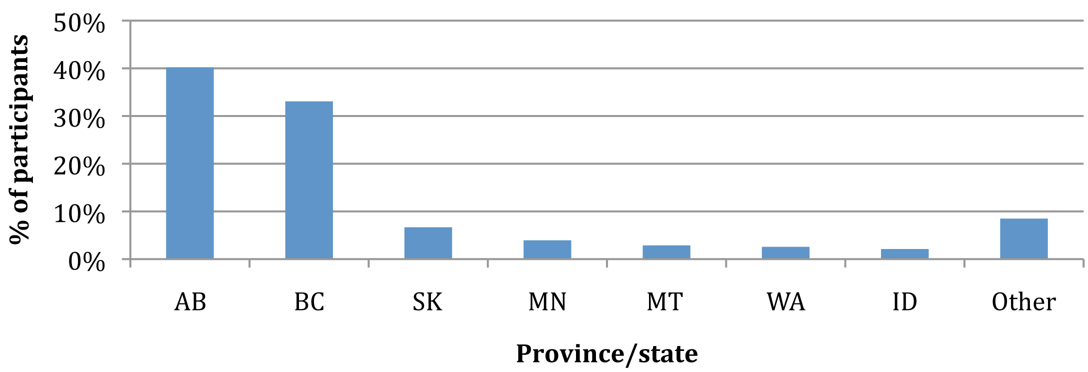


Figure 5.9. Province or state of residence (n = 659)

The median level of education was a trades or non-university certificate or diploma (45%, 293 of 659). Most common employment categories included oil and gas (18%, 117 of 661), construction (12%, 76 of 661), maintenance (9%, 58 of 661), sales (7%, 49 of 661) and business/finance (6%, 41 of 661). Appendix H for a complete list of education and employment results.

Snowmobile Type and Riding Experience

Survey participants were asked to provide detailed information about their current snowmobile. If they owned multiple snowmobiles, they were asked to describe the snowmobile they ride most often. Thirty-eight percent of survey participants rode Ski-doo/BRP (253 of 660), 26% Polaris (173, 660), 25% Arctic Cat (167 of 660) and 10%

Yamaha (63 of 660). Less than one percent (4 of 660) selected the “other” category. The most commonly reported snowmobile characteristics were two-stroke engines (88%, 569 of 652), 800 to 900 cc engine size (71%, 459 of 650) and a track-length of 153 to 162 inches (60%, 393 of 651). Fourteen percent (86 of 629) reported their snowmobile had a turbo and 29% (183 of 636) used other performance or engine modifications. Twenty-one percent of survey participants (135 of 659) reported to using race fuel instead of standard pump fuel in their snowmobiles. Table 5.3 lists the fifteen most common combinations of snowmobile characteristics, which represent 54% (357 of 662) of all snowmobiles described in this survey.

Table 5.3. Most popular snowmobile configuration

Make	Track Length	Engine Size	Engine Type	Fuel Type	Turbo	Engine Mod.	Count
BRP	153-162"	800-900cc	2-stroke	Pump fuel	No	Stock	84 (13%)
Arctic Cat	153-162"	800-900cc	2-stroke	Pump fuel	No	Stock	60 (9%)
BRP	143-152"	800-900cc	2-stroke	Pump fuel	No	Stock	42 (6%)
Polaris	153-162"	800-900cc	2-stroke	Pump fuel	No	Stock	35 (5%)
Polaris	163" +	800-900cc	2-stroke	Pump fuel	No	Stock	25 (4%)
BRP	153-162"	800-900cc	2-stroke	Pump fuel	No	Modified	19 (3%)
Polaris	153-162"	600-700cc	2-stroke	Pump fuel	No	Stock	16 (2%)
BRP	163" +	800-900cc	2-stroke	Pump fuel	No	Stock	15 (2%)
Arctic Cat	153-162"	800-900cc	2-stroke	Pump fuel	No	Modified	14 (2%)
BRP	153-162"	800-900cc	2-stroke	Race fuel	No	Modified	11 (2%)
Polaris	153-162"	800-900cc	2-stroke	Pump fuel	No	Modified	10 (2%)
BRP	163" +	800-900cc	2-stroke	Race fuel	No	Modified	9 (1%)
Yamaha	153-162"	1000cc +	4-stroke	Pump fuel	No	Stock	9 (1%)
Polaris	143-152"	800-900cc	2-stroke	Pump fuel	No	Stock	8 (1%)
						Sum	357 of 662 (54%)

Seventy-two percent (475 of 661) of survey participants performed their own non-warranty repair and maintenance. Median riding experience among survey participants was 6 to 9 years (20%, 129 of 662) and 16 to 20 days of riding per year (20%, 122 of 613). Self-reported riding ability ranged from novice (7%, 44 of 661), intermediate (35%, 234 of 661), advanced (45%, 294 of 661), to expert (14%, 89 of 661). A cross-tabulation of riding experience and risking ability clearly highlights the correlation between these two variables (Figure 5.10). Forty-five percent (294 of 661) of the participants were members of a snowmobile club.

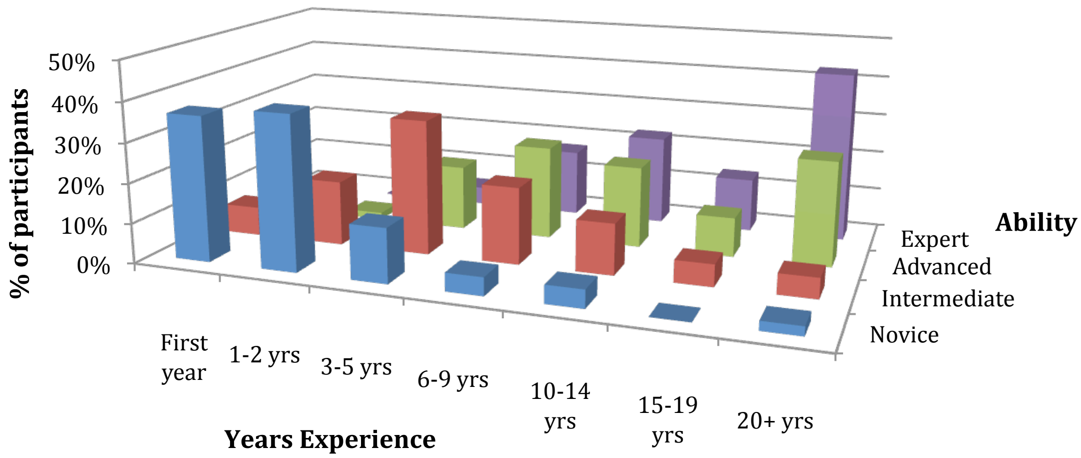


Figure 5.10. Experience and ability

Personal Avalanche Awareness Training

Similar to the intercept survey, participants were presented with all PAPM statements and asked to choose which one best describes their attitudes and actions about avalanche hazard (Table 5.4). According to participant's choices, 53% (352 of 662) of them indicated that they had formal avalanche training. However, responses to the detailed follow-up questions regarding their formal avalanche training indicate that 5% (19 of 352) of the participants claiming to have had formal avalanche training only attended a free avalanche awareness seminar and an additional 14% (50 of 352) only completed the classroom component of an introductory avalanche awareness course. Since free avalanche awareness seminars and the classroom component of an introductory avalanche awareness course alone are generally not considered as formal avalanche training by the CAC (2012, personal communication), these individuals were reclassified to the PAPM level 'Engaged' (4) for the present analysis.

Table 5.4. ***PAPM Statement progression and response***

Label	Characterization Statement	Original Count	Corrected Count	Formal training
Unaware (1)	I generally do not think about avalanches where I ride.	10 (2%)	10 (2%)	None 379 (57%)
Aware (2)	I know that avalanches can happen in some of the places I ride, but avalanche hazard generally does not affect the choices I make.	16 (2%)	16 (2%)	
Disengaged (3)	My personal experience in mountain snowmobiling has provided me with all the skills I need for managing avalanche hazard where I ride.	31 (5%)	31 (5%)	
Engaged (4)	I sometimes worry about being caught in an avalanche. I would like to learn more about avalanche safety, but have not taken a formal course with a field component (e.g.,AST1 or more advanced) yet.	253 (38%)	322 (49%)	
Non-emerging (5)	I have taken a formal avalanche course with a field component, but I don't regularly apply what I learned when riding.	33 (5%)	22 (3%)	Yes 283 (43%)
Emerging (6)	I have taken a formal avalanche course with a field component and I am practicing my skills whenever I can.	138 (21%)	111 (17%)	
Practicing (7)	I have taken a formal avalanche course and have several seasons of experience applying these skills when riding. Avalanche risk mitigation has become an integral part of my riding practice.	181 (27%)	150 (23%)	
	Total	662	662	662

Of the 283 individuals with formal avalanche training, 78% (222 of 283) reported completing an introductory avalanche awareness course with a field component (e.g. AST1), 7% (19 of 283) an advanced avalanche awareness course (e.g. AST2) with a field component, 10% (29 of 283) reported professional level avalanche training and 5% (13 of 283) reported to have completed another formal avalanche awareness course (e.g., European avalanche awareness training, military avalanche awareness training).

Personal Avalanche Safety Equipment

The vast majority of survey participants reported to carry standard personal avalanche safety equipment during their backcountry trips. Ninety-two percent (608 of 662) reported carrying an avalanche transceiver, 96% (631 of 662) a shovel, 91% (598 of 662) a collapsible probe, and 88% (585 of 662) reported carrying all three. Forty-two percent (278 of 662) reported carrying avalanche balloon packs (no specific brand).

General Personal Avalanche Safety Knowledge and Confidence

Participants self-assessed their current general avalanche safety knowledge and the perceived level of required knowledge for effectively managing avalanche danger using a scale from zero (know nothing at all) to 100 (know everything there is to know) with increments of 10. Participants who indicated that they had completed some formal training were also asked to assess the level of general avalanche safety knowledge they had prior to taking an avalanche skills course (Figure 5.11). Participants without training were only asked the later two.

For those with training, knowledge prior to taking their course was 20 (n = 279, IQR: 10, 40), current knowledge was 70 (n = 278, IQR: 60, 80) and the median level of knowledge they thought they needed was 80 (n = 276, IQR: 70, 90). For those without training current knowledge was 50 (n = 379, IQR: 40, 60) and the median level of knowledge they thought they needed was 80 (n = 377, IQR: 60, 90).

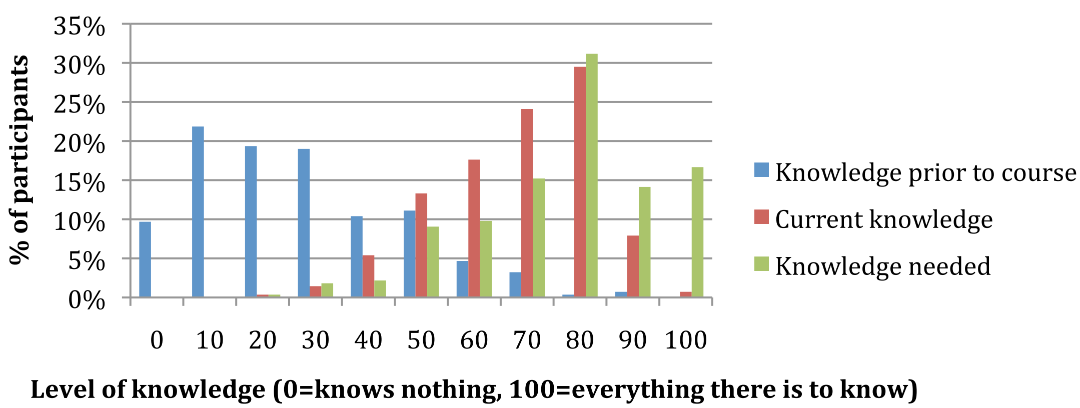


Figure 5.11. ***Knowledge prior to taking a course, perceived current, and knowledge needed (only participants with training)***

Similar to the intercept survey, participants were asked to describe their confidence in their ability to perform important preventative avalanche safety and rescue procedures. Using a scale from zero (Cannot do at all) to 100 (Highly certain can do), they assessed the following four individual skills (Figure 5.12):

- To recognize situations in which you are likely to trigger an avalanche (n = 662) Median: 70; IQR: 50, 80

- To identify locations to safely watch other snowmobilers ride (n = 661) Median: 80; IQR: 70, 90

- To locate and rescue a partner who is completely buried by an avalanche (n = 660) Median: 70; IQR: 50, 90

- To talk your partners out of riding a slope that you personally think is dangerous (n = 661) Median: 80; IQR: 70, 90

A pair-wise comparison of the different ratings indicates that the participant's confidence in their skills for identifying safe locations and talking their partners out of riding are significantly higher than for recognizing trigger locations or locating and rescuing a buried avalanche victim (Wilcoxon rank-sum tests: all p-values <0.001). No significant differences were identified between the respective pairs of skills.

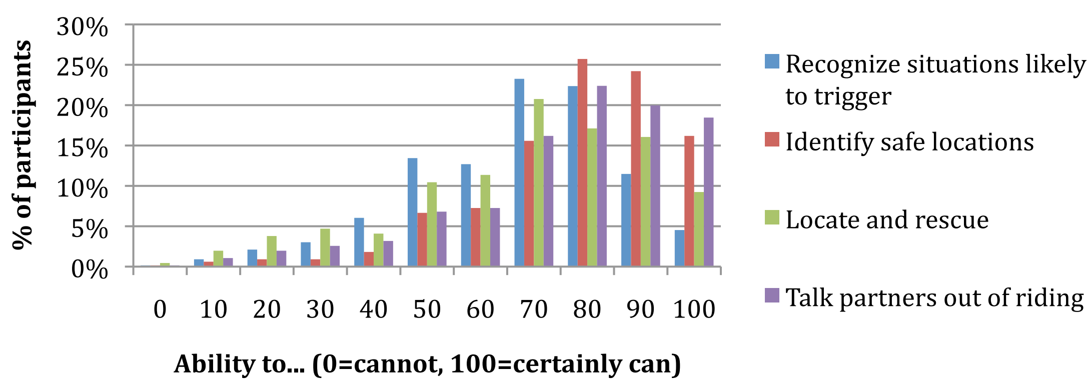


Figure 5.12. Ability to perform preventative measures and rescue

Overall, the consistency in these personal skill ratings was high as indicated by a Cronbach alpha value of 0.84.

Personal Avalanche Involvement Experience

Eighty-six percent (567 of 661) of participants have never personally been involved in a serious avalanche, 7% (44 of 661) had always managed to ride out of the avalanche before it came to a stop, and 8% (50 of 661) had been caught or buried at least once, of whom 20% (10 of 50) had experienced a full burial.

Survey participants were also asked if they had ever witnessed one of their riding partners involved in a serious avalanche. Eighty-one percent (533 of 655) had never seen their partners become involved, 8% (55 of 655) had witnessed one of their partners become involved but they managed to ride out of the avalanche before it came to a stop, and 10% (67 of 655) had witnessed a partner caught or buried at least once. Of these individuals, 58% (39 of 67) witnessed at least one full burial. Participants who had been caught in an avalanche themselves were much more likely to have witnessed a partner caught in an avalanche as well (Table 5.5), (Pearson's chi-squared test: p-value <0.001).

Table 5.5. Personal avalanche involvement and the involvements of riding partners

		Experienced the involvement of a riding partner			
		No	*Yes, but escaped*	*Caught or buried*	Total
Personal involvement experience	*No*	505	28	33	533 (81%)
	Yes, but escaped	14	20	9	55 (8%)
	Caught or buried	13	7	25	67 (10%)
	Total	567 (87%)	44(7%)	50 (8%)	654 (100%)

Overall, 77% (505 of 654) of survey participants had not had any personal avalanche involvement experiences. Among the participants who had been involved in avalanches, 13% (88 of 654) had personally experience, while 9% (61 of 654) only witnessed the experience of their riding partners being involved in an avalanche.

Participants from British Columbia had been caught in avalanches or witnessed riding partners caught significantly more than participants from other provinces (Figure 5.13). This held true in both the intercept (Pearson's chi-squared test: p-value <0.001) and the online survey (Pearson's chi-squared test: p-value <0.001).

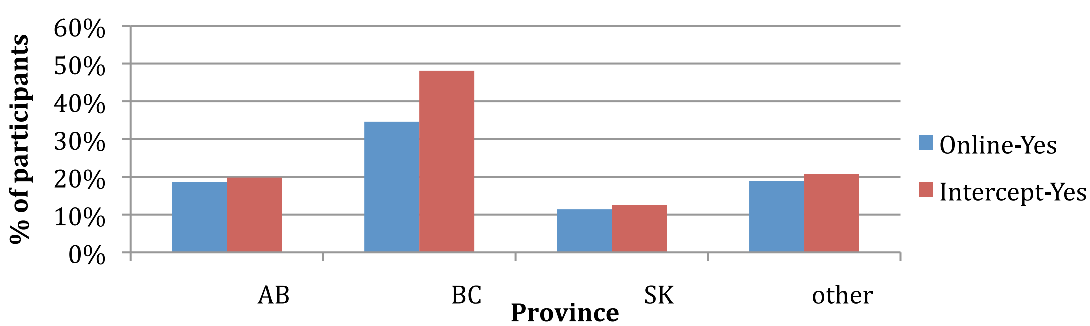


Figure 5.13. Relevant avalanche experience – Online and Intercept comparison

Health Motivations

To assess survey participants' general attitude towards health, they were asked to indicate how much they agreed or disagreed with the following two statements on a 7-point Likert scale (whereas 1-strongly disagree and 7-strongly agree):

- “Being healthy and fit is important to me”
- “I regularly work out to make sure I am in good shape for snowmobiling”

The scores for both of these questions were high. However, while the median score for the general health question was 6 (37% of sample; IQR: 5, 7), the median score for being in good shape for snowmobiling was significantly lower (5; 22% of sample; IQR: 3, 6) (Wilcoxon rank-sum test: p-value <0.001). Furthermore, there is only moderate consistency between the two ratings as indicated by a Cronbach alpha value of 0.72, which suggests participants viewed each item differently.

General Attitude towards Learning

Their general attitude towards learning has the potential to considerably affect snowmobile riders' willingness to take an avalanche course and to be informed about the current avalanche conditions. In the present survey, we asked participants to indicate their interest in learning with respect to three areas: new technology, snowmobiles and nature. In general, participants exhibited a high level of willingness to learn (Figure 5.14).

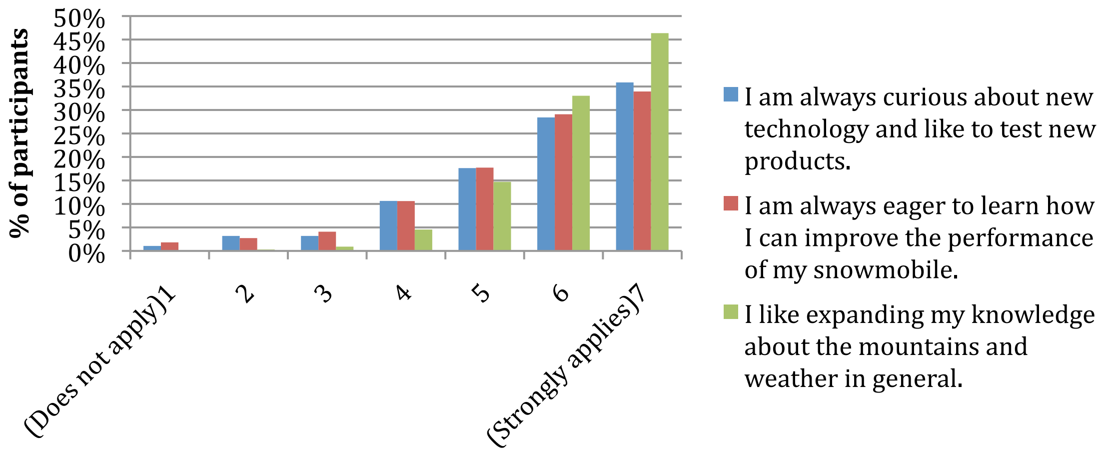


Figure 5.14. Agreement with statements about attitudes towards learning

While no significant differences between the ratings for learning about technology and snowmobiles were found (both medians: 6; IQR: 5,7), the ratings were significantly higher for learning about mountains and weather in general (median: 6; IQR: 7, 6). The p-values of pair-wise Wilcoxon rank-sum tests with Boniferroni corrections are <0.001 for both the comparison of learning about technology and snowmobiles. The moderate Cronbach alpha value (0.796) indicates that there are considerable differences in the learning attitudes of individual participants with respect to the different topics.

Sensation Seeking

To examine participants' general attitude towards risk taking, they were presented with the eight questions of the Brief Sensation Seeking Scale (BSSS-8). Similar to the health motivation questions, participants rated the eight statements on a 7-point Likert scale where a score of 1 represents strong disagreement and 7 indicates strong agreement with the statement. Table 5.6 presents mean scores and standard deviations with questions grouped by their underlying sensation seeking dimension: Experience Seeking, Boredom Susceptibility, Thrill and Adventure Seeking, and Disinhibition.

Table 5.6. Mean scores and standard deviation of BSSS-8 questions grouped by their sensation seeking dimension (Cronbach alpha value in brackets)

		Mean	SD
Experience Seeking (0.45)			
1.	I would like to explore strange places.	5.79	1.14
5.	I would like to take off on a trip with no pre-planned routes or timetables.	4.23	1.99
Boredom Susceptibility (0.40)			
2.	I get restless when I spend too much time at home	5.55	1.4
6.	I prefer friends who are excitingly unpredictable.	3.19	1.67
Thrill and Adventure Seeking (0.66)			
3.	I like to do frightening things.	4.21	1.71
7.	I would like to do bungee jumping.	3.52	2.21
Disinhibition (0.72)			
4.	I like wild parties	3.19	1.84
8.	I would love to have new and exciting experiences, even if they are illegal.	2.78	1.84

The Cronbach alphas in the present study are slightly higher than those of the out-of-bounds skiers in Haegeli et al. (2012), indicating marginally more consistent response patterns for the different dimensions of sensation seeking.

5.2.2. Characteristics of Typical Riding Group

To get a better understanding of the characteristics of snowmobile groups, survey participants were asked to describe their typical riding partners with respect to riding experience and ability, avalanche awareness training and safety equipment typically carried and their approach to decision-making.

Group Size

Participants were asked questions about their typical riding group. The median group size was four people (n = 660, IQR: 4, 6, mean: 4.7, SD: 1.68) with a total 3,055 riding partners reported.

5.2.3. Riding Experience and Ability

Approximately two-thirds of participants indicated having riding partners with similar levels of experience as themselves (64%; 424 of 660), 33% (221 of 660) also had partners that are less experienced and 36% (240 of 660) had partners that are more experienced riders[15]. The most commonly reported patterns of riding experience indicate that riders generally ride with partners that have the same level of riding experience (Table 5.7).

Table 5.7. Riding experience within snowmobile groups

Respondent's years of riding	Group's experience	Count
20+ yrs	Same	58 (9%)
6-9 yrs	Same	58 (9%)
3-5 yrs	Same	51 (8%)
20+ yrs	Less	47 (7%)
10-14 yrs	Same and More	45 (7%)
3-5 yrs	More	35 (5%)
15-19 yrs	Same	29 (4%)
1-2 yrs	More	29 (4%)
6-9 yrs	More	22 (3%)
10-14 yrs	Less	22 (3%)
	Sum	396 of 660 (60%)

Overall, 21% (140 of 660) reported that their typical the group included novice riders, 60% (396 of 660) intermediate riders, 73% (480 of 660) advanced riders and 25% (164 of 660) expert riders[16]. Similar to the pattern observed with respect to riding experience, most participants are typically riding with people of the same riding ability (Table 5.8).

Table 5.8. Riding ability within snowmobile groups

Respondent's ability	Riding ability within group		Count
Advanced	Advanced		112 (17%)
Intermediate	Intermediate		66 (10%)
Advanced	Intermediate to Advanced		49 (7%)
Intermediate	Intermediate to Advanced		44 (7%)
Intermediate	Advanced		40 (6%)
Advanced	Intermediate		39 (6%)
Advanced	Novice to Advanced		33 (5%)
Intermediate	Novice to Advanced		29 (4%)
Advanced	Intermediate to Expert		25 (4%)
Expert	Expert		24 (4%)
		Sum	483 of 660 (70%)

[15] Participants were allowed to select multiple levels of experience present in their group.
[16] Participants were allowed to select multiple levels of ability present in their group.

Group Avalanche Training

Overall, 649 participants reported on the levels of training their group members had received. Within the typical group, 49% (319 of 649) of the participants reported having partners without any avalanche awareness training, 36% (231 of 649) had partners that attended a free avalanche seminar, 28% (181 of 649) took the classroom component of an AST1 course and 49% (321 of 649) also completed the field component of their AST1 course. Of those groups with more advanced training present, 10% (67 of 649) had partners who completed an AST-2 course and 7% (48 or 649) had professional level avalanche training. In addition, 3% (17 of 649) had completed other types of avalanche awareness training and 6% (40 of 649) of their partners' avalanche awareness training levels was unknown[17]. Similar levels of training were present in most groups. The most commonly reported patterns of avalanche awareness training within the typical riding groups were either no training at all (11%; 74 of 649), all AST1 graduates (11%; 71 of 649) or a mixture of AST1 graduates and riders without formal training (11%, 69 of 649), (Table 5.9).

Table 5.9. Avalanche awareness - 15 most common avalanche training compositions

Respondent's level of training	Training levels within group		Count
None	None		74 (11%)
AST1	AST1		71 (11%)
AST1	None to AST1		69 (11%)
None	None to Free seminar		48 (7%)
None	None to AST 1		48 (6%)
None	Unknown		33 (5%)
None	Free seminar		48 (4%)
AST1	Free seminar to AST 1		24 (4%)
None	None to AST 1 Classroom only		22 (3%)
None	Free seminar to AST 1		17 (3%)
AST1	AST1 Classroom only to AST 1		16 (2%)
AST1 Classroom only	None to AST 1 Classroom only		15 (2%)
AST1 Classroom only	AST 1 Classroom only		12 (2%)
Professional	AST1 to Professional		12 (2%)
None	Free seminar to AST1 Classroom only		9 (1%)
		Sum	485 of 649 (75%)

Avalanche Safety Gear in Group

Use of safety gear was high in the group as well, 79% (511 of 646) of survey participants reported that all of their riding partners typically carry standard avalanche safety equipment—transceiver, shovel and probe (Figure 5.15). While 76% (410 of 539) reported that at least one member of their group uses an avalanche balloon pack, it was only in 17% (93 or 539) of the reported groups were everybody was equipped with this additional avalanche safety device.

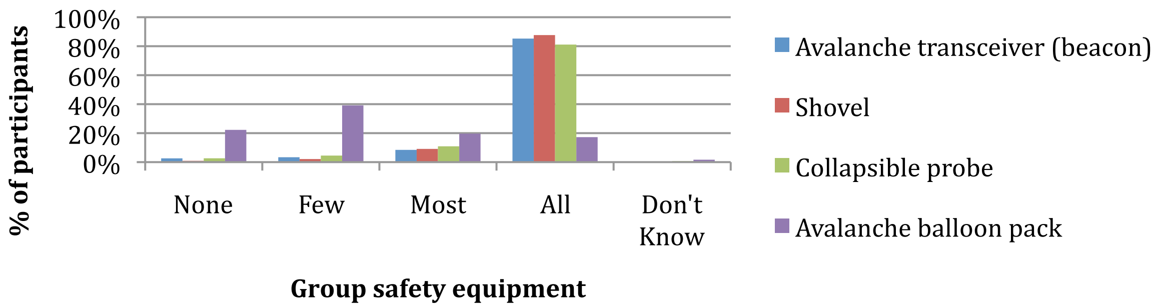


Figure 5.15. Prevalence of avalanche safety gear in typical riding groups

Participants also reported on the additional group emergency gear typically carried by their group, 48% (319 of 662) reported to typically carry a SPOT personal location transmitter, 88% (580 of 662) bring a first aid kid on their snowmobile trips, 17% (110 of 662) carry a satellite phone and 73% (481 of 662) bring emergency overnight supplies.

Group Decision-Making

Collective decision making was the norm, 68% (452 of 658) of survey participants reported that they typically ride in groups where "we all contribute to the decision process and we decide together where we ride", compared to the 12% (77 of 658) with a single designated leader and 13% (83 of 658) that had a small group of designated leaders that decide where the group rides. The most common characteristics of the leaders is that they are most familiar with the riding area, followed by the most experienced or most skilful rider and the individual with the highest level of avalanche

[17] Participants were allowed to select multiple levels of training in their group.

awareness training (Figure 5.16). Only 3% (22 of 658) of survey participants reported that “we all make our own decisions about where we ride” and 4% (24 of 658) indicated that they typically ride in groups where “whoever is at the front of our group decides where we ride”.

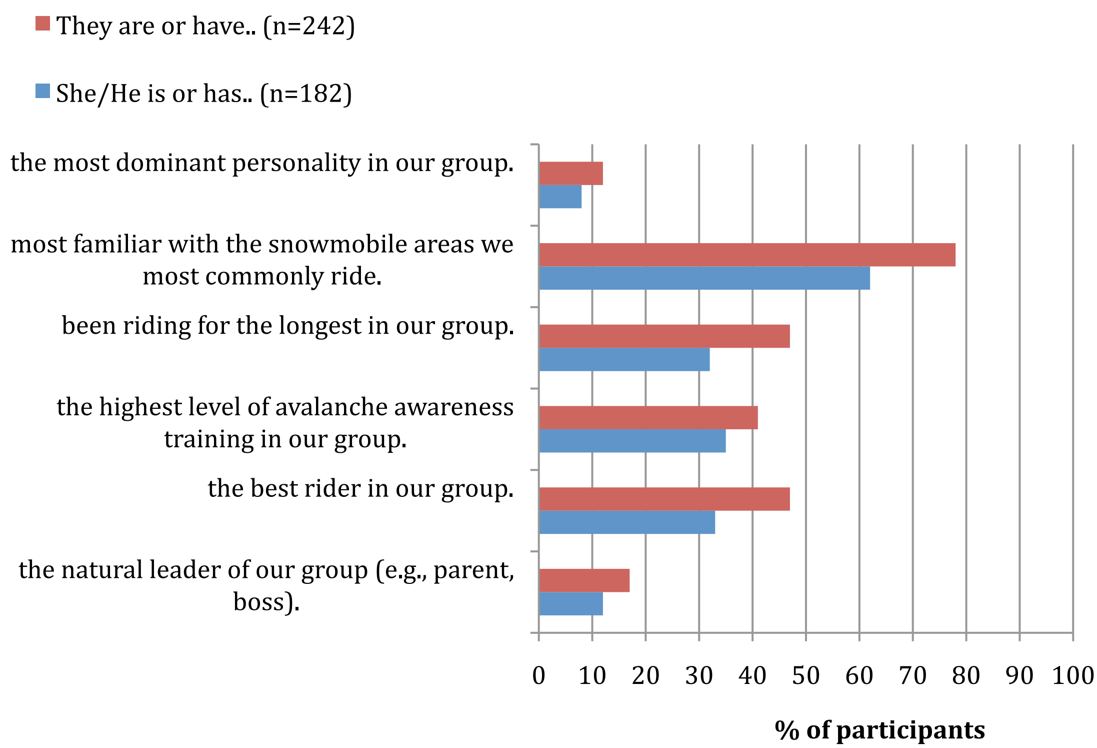


Figure 5.16. ***Characteristics of single designated leader (blue bars) or group of leaders (red bars)***

Role of Survey Participant Within the Group

The majority of survey participants (65%; 427 of 659) reported that “I am one of the decision-makers of my group”, while 11% (72 of 659) indicated that they are the primary decision maker of the group. Roughly one quarter (24%; 155 of 659) said that “I speak up if I have any concerns, but I am generally not part of the decision process”, and less than one percent (5 of 659) reported that “I completely leave the decision process up to other riders in my group”.

5.2.4. Character of Typical Snowmobile Trips

Favourite Snowmobile Destinations

When asked about their favourite snowmobile destinations, 67% (441 of 662) of survey participants indicated that some of their favourite riding areas are far enough away that at least a day of travel is needed before riding. Survey participants provided the names of their favourite riding areas (up to three locations) as well as the number of visits per winter to each destination. Participants' home towns and their favourite riding areas were used to create and origin-destination map showing travel patterns (Figure 5.17) which indicated a considerable volume of travel requiring more than five hours on the road. Only locations reporting more than six reported riding days per year were included in the map shown in Figure 5.17 and thicker lines denote more travel.

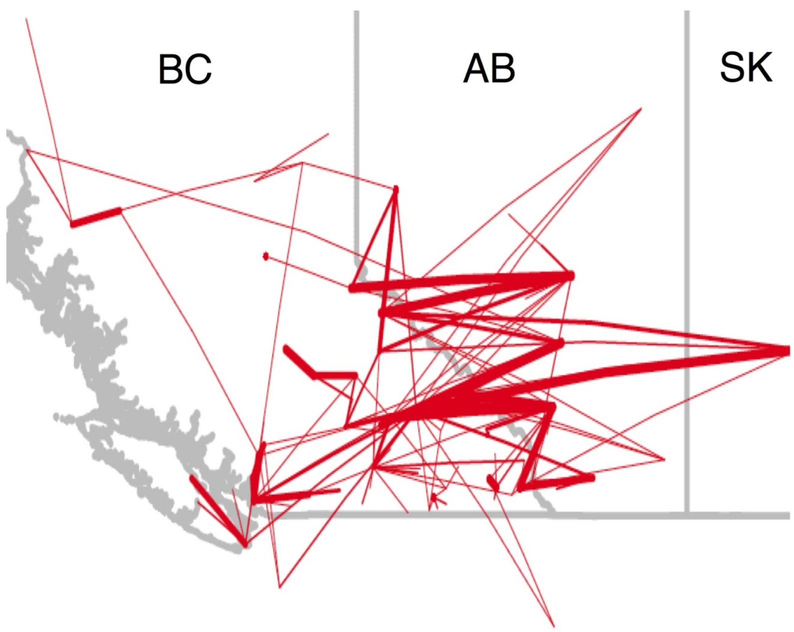


Figure 5.17. Map of travel to the most popular snowmobile destinations (days reported >6), line thickness delineates flow volume

Survey participants seemingly chose their riding destinations based on some combination of terrain quality and proximity. Intercept and online survey participants showed very similar travel patterns to Revelstoke, the most popular self-reported snowmobile destination with the maximum number of days per year reported in the online survey (Table 5.10).

Table 5.10. 25 most popular snowmobile destinations (percent of total travel days)

Popularity	Destination	Count of days
1	Revelstoke	288 (11%)
2	Sicamous	178 (7%)
3	Fernie	136 (5%)
4	Golden	116 (4%)
5	Valemount	97 (4%)
6	Blue River	92 (3%)
7	Whistler	74 (3%)
8	McBride	72 (3%)
9	Pemberton	71 (3%)
10	Kimberley	71 (3%)
11	Clearwater	64 (2%)
12	Cranbrook	64 (2%)
13	Squamish	58 (2%)
14	Castlegar	57 (2%)
15	Crowsnest Pass	47 (2%)
16	Chetwynd	46 (2%)
17	Trout Lake	44 (2%)
18	Radium	41 (2%)
19	Smithers	40 (2%)
20	Hope	38 (1%)
21	Enderby	37 (1%)
22	Kamloops	35 (1%)
23	Nelson	33 (1%)
24	Barriere	32 (1%)
25	Grand Prairie	31 (1%)
	Sum	1862 of 2636 (71%)

The vast majority of survey participants reported that avalanche bulletins are available for all (70%; 460 of 662) or at least some (17%; 113 of 662) of their favourite riding areas, and 7% (49 of 662) of participants reported that while bulletins are not available for their destinations, there are bulletin regions they use close by. Only 3% (18 of 662) indicated that there are no relevant bulletins available for any of their favourite destinations and another 3% (22 of 662) did not know about the availability of bulletins for their riding areas.

Type of Snowmobile Trips

The vast majority of survey participants (75%; 497 of 661) never use their snowmobile to access ski/snowboard terrain. Nineteen percent (128 of 661) sometimes use their snowmobile to accessed ski terrain, and 5% (36 of 661) regularly use their snowmobile for accessing ski and snowboarding terrain.

Type of Snowmobile Riding

To get a better understanding of their riding preferences, survey participants were asked to describe the type of riding (as many as apply) their group typically pursues when visiting a favourite riding area. The most commonly reported type of snowmobile riding were moderately technical exploring and touring (67%; 442 of 662), highly technical exploring and touring (53%; 384 of 662) and hill climbing (45%; 300 of 662) (Table 5.11).

Table 5.11. Types of riding typically pursued

Riding type	Number
Socializing and watching other riders	116 (18%)
Non-technical exploring and touring	127 (19%)
Moderately technical exploring and touring	442 (67%)
Highly technical exploring and touring	348 (53%)
Hill climbing	300 (45%)
Big air	88 (13%)

Trip Planning and Use of Avalanche Bulletin from Home

Consistent with the considerable amount of travelling required to their favourite snowmobile destinations, a considerable portion of the participants plans their snowmobile trip well in advance: 12 % (78 of 659) typically plan their trips months in advance and 33% (219 of 659) do their planning weeks ahead of the trip. Thirty-seven percent (241 of 659) typically plan days in advance, 14% (91 of 659) normally plan the evening before the trip, and 5% (30 of 659) decide on their destination in the morning of their outing.

Of the 87% of survey participants that visit snowmobile destinations where avalanche bulletins are available, 59% (338 of 573) always check the relevant bulletins from home and 27% (152 of 573) check them frequently (Figure 5.18). The bulletin checking frequency is considerably lower but still fairly regular among riders who visit riding areas that only have bulletins available for close-by areas. The same can be said for checking some of the other sources, 24% percent (156 of 645) and 40% (260 of 645) of survey participants reported to always or frequently consult other information sources about the local avalanche conditions (e.g., locals, clubs, forums). The information gathering reported for riding partners (Figure 5.19) exhibit similar patterns.

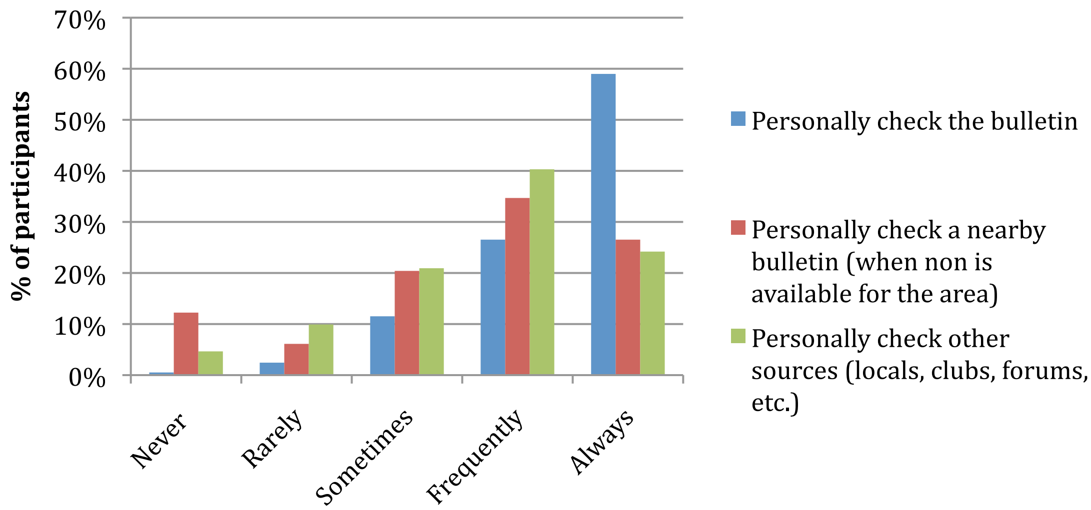


Figure 5.18. Frequency of personally checking avalanche information from home

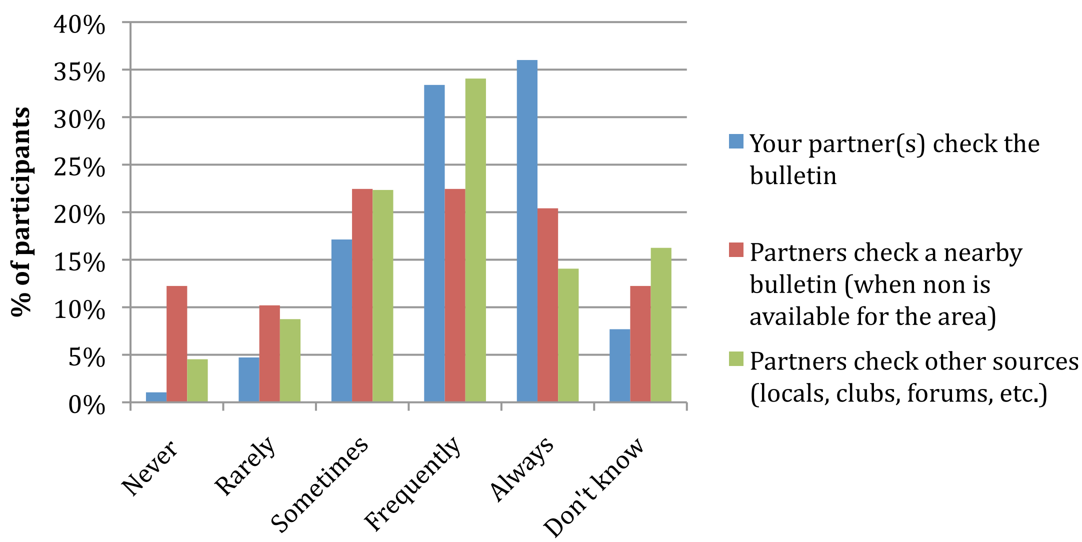


Figure 5.19. Frequency of group members checking avalanche information from home

Before leaving on a trip, 44% (289 of 662) of survey participants always discuss avalanche conditions with their riding partners and 40% (267 of 662) do so frequently. Only 13% (84 of 662) reported that they only talk about avalanche conditions sometimes, 3% (18 of 662) rarely do and less than one percent (4 of 662) reported never discussing avalanche conditions.

Due to concerns about avalanches, 62% (408 of 661) reported that they had cancelled a trip or changed their trip destination before leaving home.

Use of Avalanche Bulletin On the Road

Once on the road, 41% (158 of 390) always check the online avalanche bulletins and 27% (107 of 390) do so frequently. Also, 34% (131 of 387) always check posted avalanche bulletins at staging areas or hotels and 35% (136 of 387) do so frequently (Figure 5.20). The reported bulletin checking patterns for riding partners exhibit similar patterns (Figure 5.21).

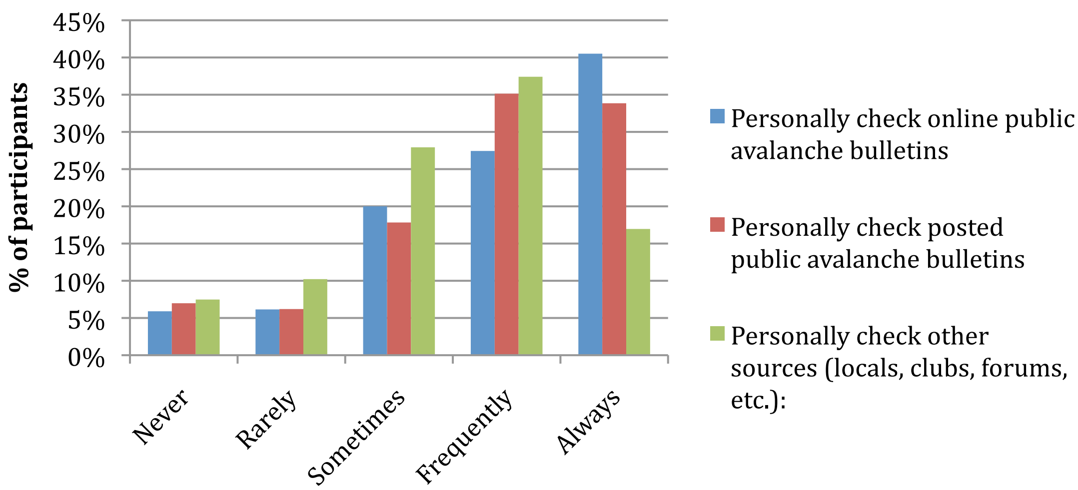


Figure 5.20. Frequency of personally checking avalanche information sources between home and leaving the staging area

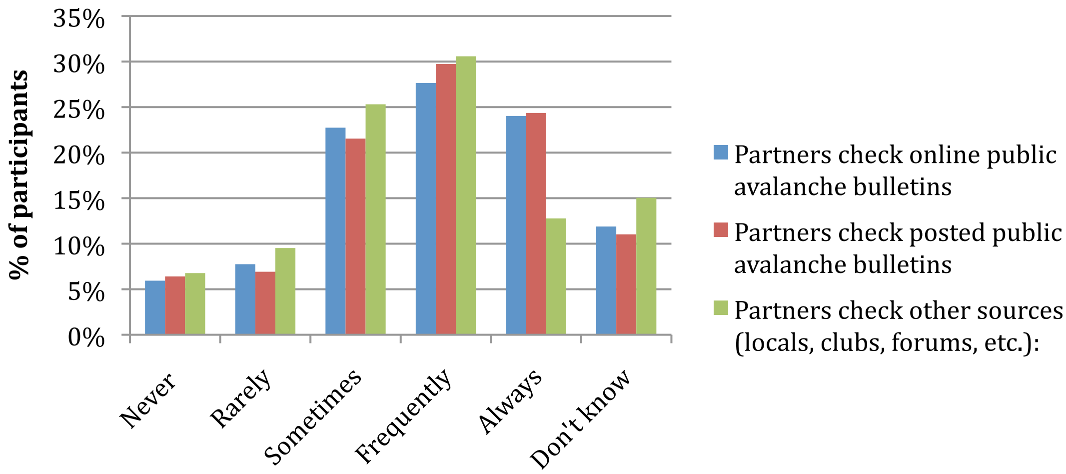


Figure 5.21. ***Frequency of group members checking avalanche information sources between home and leaving the staging area***

Before leaving the staging area, 32% (209 of 661) always discussed avalanche conditions and 37% (244 of 661) do so frequently. While 25% (168 of 661) sometimes speak about avalanche conditions within their group, 5% (31 of 661) rarely do so and 1% (9 of 661) reported never discussing avalanche conditions.

Fifty percent (331 of 661) of survey participants reported to have cancelled a trip or changed their trip destination due to avalanche concerns between leaving home and leaving the staging area.

Knowledge about Current Avalanche Conditions from the Bulletin

To assess the perceived value of avalanche bulletins for the decision process of snowmobilers, survey participants were asked to rate their knowledge about current avalanche conditions before checking the bulletin and when leaving the stating area on a scale from 0 (knowing absolutely nothing) to 100 (knowing absolutely everything). As a reference, participants were also asked to indicate the level of knowledge they believe is required for effectively managing avalanche danger when travelling in the backcountry. The median level of knowledge held before checking the avalanche bulletin was 60 (94 of 585, IQR: 50, 70) and 70 (92 of 662, IQR: 60, 80) for the knowledge when leaving the staging area (Figure 5.22). The median level of perceived knowledge needed to effectively manage avalanche danger while riding was 80 (211 of 660, IQR: 70, 90).

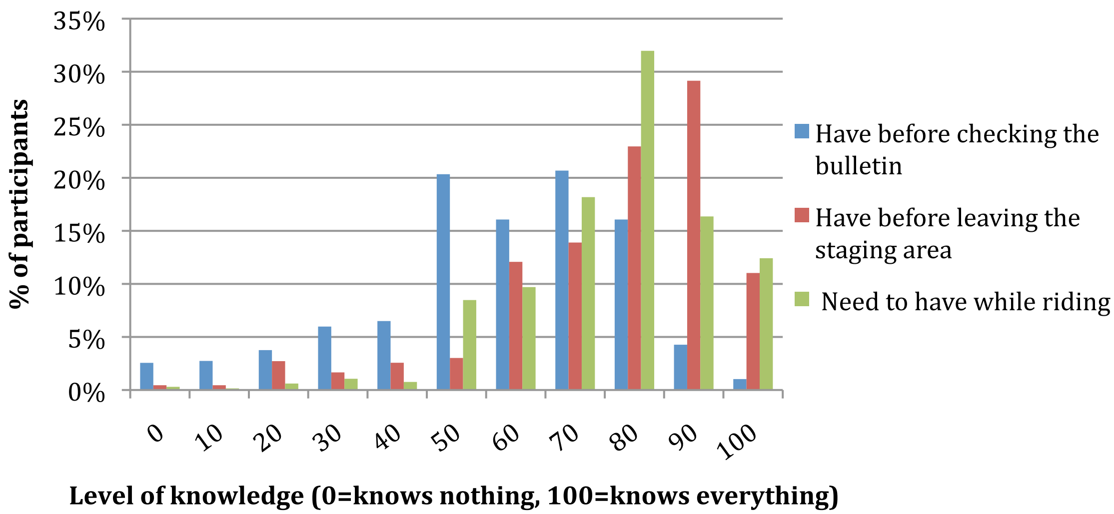


Figure 5.22. Comparison perceived knowledge of current avalanche conditions prior to checking avalanche bulletins, before leaving the staging area and required to safely riding in avalanche terrain.

5.2.5. Avalanche Risk Perception

To assess participants' perception of their personal avalanche risk, the survey included questions that asked participants to assess their personal likelihood of being involved in an avalanches, their personal ability and their group's ability to respond to an involvement, and indicate how much control they perceive to have to avoid an avalanche involvement (i.e., locus of control).

Probability of Avalanche Involvement

Participants were asked to assess their personal likelihood of being involved in avalanche incidents of different severity:

- Being caught or buried in an avalanche (least severe)
- Having your snowmobile damaged in an avalanche
- Getting seriously injured in an avalanche
- Getting killed in an avalanche

While the median of survey participants' rating for their likelihood of being caught of buried in an avalanche or having their snowmobile damaged was 1 in 10 years of riding, the median likelihood of getting seriously injured or dying was assessed slightly lower at

1 in 100 years of riding (Figure 5.23)[18]. Despite the same median values, a comparison distribution of ratings indicates that likelihood for dying is assessed significantly lower than for getting seriously injured (Wilcoxon rank-sum test: p-value <0.001).

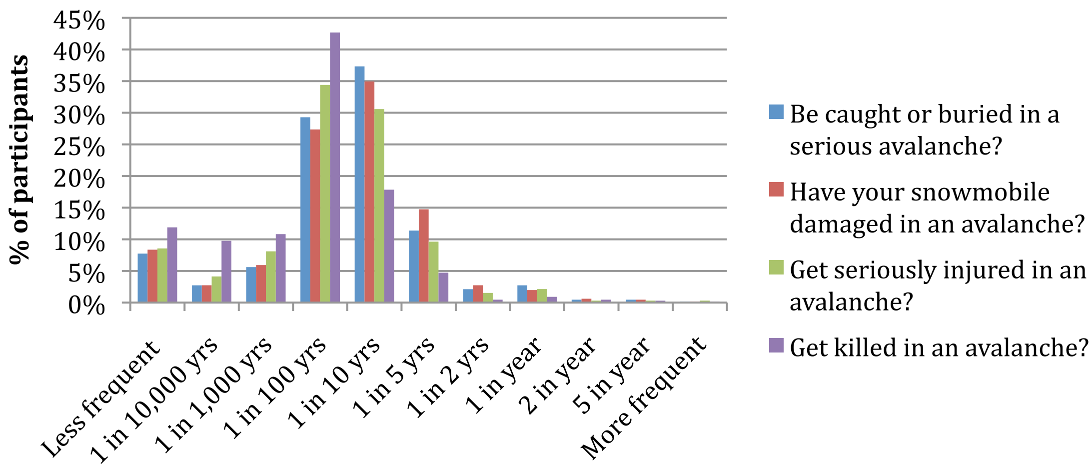


Figure 5.23. Perceived likelihood of being involved in avalanches of different severity

The internal consistency of participants' assessments of all four likelihoods is very high with a Cronbach alpha of 0.92.

Participants with relevant avalanche experience[19] viewed being caught and buried by an avalanche as more likely (Wilcoxon rank-sum test: p-value <0.001). They also viewed damaging their snowmobile in an avalanche more likely (Wilcoxon rank-sum test: p-value <0.001) and getting injured in an avalanche more likely (Wilcoxon rank-sum test: p-value = 0.001). There was no significant difference in their perceived likelihood of dying.

[18] As a reference, the likelihood of an average driver in British Columbia to get injured or killed is approximately 1 in 100 years and 1 in 10,000 years respectively (ICBC, 2009)

[19] Relevant avalanche experience includes those who have been caught in an avalanche or witnessed a riding partner(s) caught.

Self-Efficacy to Avoid Burial in an Avalanche Involvement

Using a scale from zero (cannot do at all) to 100 (highly certain can do), survey participants rated their confidence in their personal ability to avoid burial once caught in an avalanche. While participants rated their personal ability to escape the avalanche by riding out in the middle of the scale (median: 50; IQR: 40,70), participants who regularly use avalanche balloon packs reported a significantly higher confidence in the ability of their safety devices to prevent their burial (n = 275; median: 80; IQR: 60, 80) (Figure 5.24).

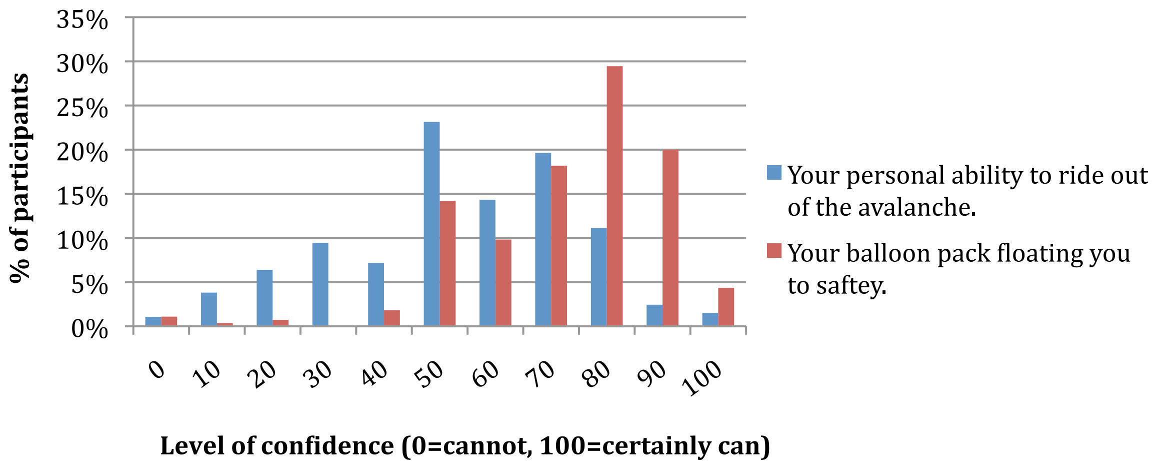


Figure 5.24. Confidence in personal ability to avoid burial

Locus of Control

To assess the snowmobilers' perception on personal control in avalanche involvements or the notion of avalanches as 'acts of God', survey participants were asked to assess the influence of luck on different levels of avalanche involvements “Even with the highest level of avalanche training, extensive experience and up-to-date information on current conditions, how much luck do you think is still involved in avoiding avalanches when riding in the mountains?”. Perceptions were assessed on a scale from zero, a situation where no luck is involved at all, to 100, where the outcome is all determined by luck. While survey participants perceived avoiding serious avalanches to be more skill-based (median: 40, 37 of 656; IQR: 20, 50), they view luck to play a much bigger role in riding out of a serious avalanche (median: 70, 94 of 657; IQR: 50, 80) or for surviving a serious avalanche after being caught (median: 70, 86 of 655; IQR: 50, 80) (Figure 5.25). Pair-wise comparisons of the distributions of the three ratings confirms that there is no significant difference between the ratings for escaping and surviving an avalanche (Wilcoxon rank-sum test with Boniferroni correction: p-value = 0.13). The high consistency of these two ratings is further confirmed by the high value of Cronbach alpha (0.89).

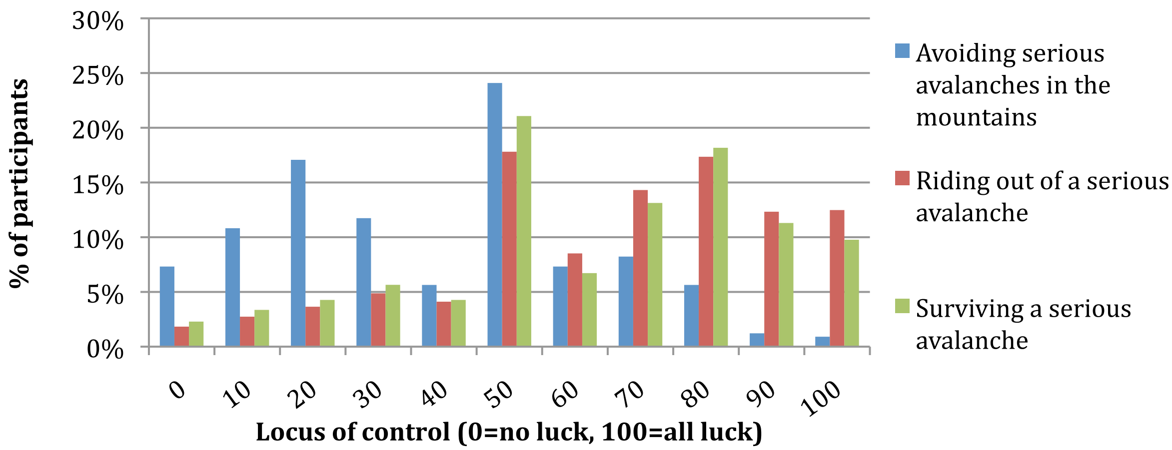


Figure 5.25. ***Influence of luck in avalanche involvements***

Group Efficacy for Preventing an Avalanche Involvement

To assess survey participants' confidence in their riding group to prevent a serious avalanche involvement, they were asked to rate their partners' efficacy to select riding terrain appropriate for the conditions and their efficacy to locate and rescue a fully buried avalanche victims on a scale from zero (cannot do at all) to 100 (highly certain that can do). Overall, survey participants exhibited a high level of confidence in the skills of their partners with a median rating of 80 (202 of 657 IQR: 70, 90) for selecting appropriate terrain and 70 (125 of 659, IQR: 60, 90) for locating and rescuing a completely buried victim (but the rating for selecting appropriate terrain was significantly higher (Wilcoxon rank-sum test: p-value = 0.005). The internal consistency between these two measures is good with a Cronbach alpha of 0.81.

Worry

To assess participants' overall concern about avalanches, the survey included a series of questions that asked them to rate their personal worry about the following levels of avalanche involvements on a scale from zero (not afraid at all) to 100 (extremely afraid):

- Being caught in a serious avalanche (median: 70, IQR: 40, 90)
- Getting completely buried (median: 80, IQR: 50, 100)
- Getting seriously injured (median: 70, IQR: 50,90)
- Dying in an avalanche (median: 80, IQR: 50-100)

A pair-wise comparison of the distributions (Figure 5.26) indicates that overall participants' worry to get caught in an avalanche is significantly lower than for being completely buried (Wilcoxon rank-sum test with Boniferroni correction: p-value = 0.001) and getting killed (Wilcoxon rank-sum test with Boniferroni correction: p-value <0.001). No significant differences were identified for the other pairs.

The consistency of participants' rating their worries is highlighted by the high Cronbach alpha value of 0.975.

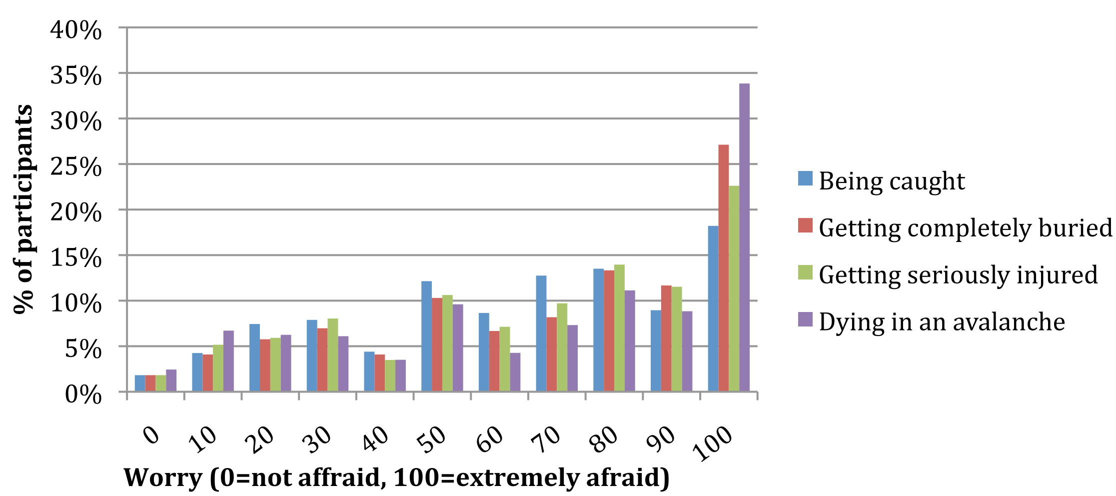


Figure 5.26. Participants' worry of various levels of avalanche involvement

5.2.6. Barriers for Becoming Avalanche Trained

To gain insight into the possible reasons for snowmobile riders not to become avalanche trained, the survey included a number of questions examining potential motivational factors and barriers.

Subjective Norms of Close Family Members and Riding Partners

To assess the support that survey participants receive from their social environment to become avalanche trained, the survey included questions on subjective norms of participants' families and riding partners as the two most important groups of influence. Normative beliefs of family members and riding partners were assessed by asking survey participants to rate the supportiveness of these groups on a scale from -3 (not supportive) to 3 (very supportive) for becoming avalanche trained and for keeping themselves informed about the current avalanche conditions (Table 5.12).

Table 5.12. Ratings for normative beliefs (Cronbach alpha values in brackets)

Question	Median	IQR
Family (0.79)		
Close family members would not be/be supportive of me taking a formal avalanche safety course	3	3, 3
It is not/very important to my family that I keep myself informed about current avalanche conditions	3	2, 3
Riding Partners (0.80)		
My riding partners would not be/be supportive of me taking a formal avalanche safety course	3	2, 3
It is not/very important to my riding partners that I keep myself informed on avalanche conditions	3	2, 3

-3 (not supportive), 3 (very supportive)

Despite the fact that the median rating for all questions was three, a pair-wise comparison with the Wilcoxon rank-sum test indicates that there are significant differences between these ratings. For both family and riding partners, the perceived support for taking a course is significantly higher than for being informed about the current conditions (p-values = 0.034 and <0.001). The family support is significantly higher than the partner support for both taking a course and being informed (p-values = 0.016 and <0.001), (Figure 5.27). The consistency in ratings of the support from family and riding partners are moderately high with Cronbach alpha values of 0.79 and 0.80 respectively.

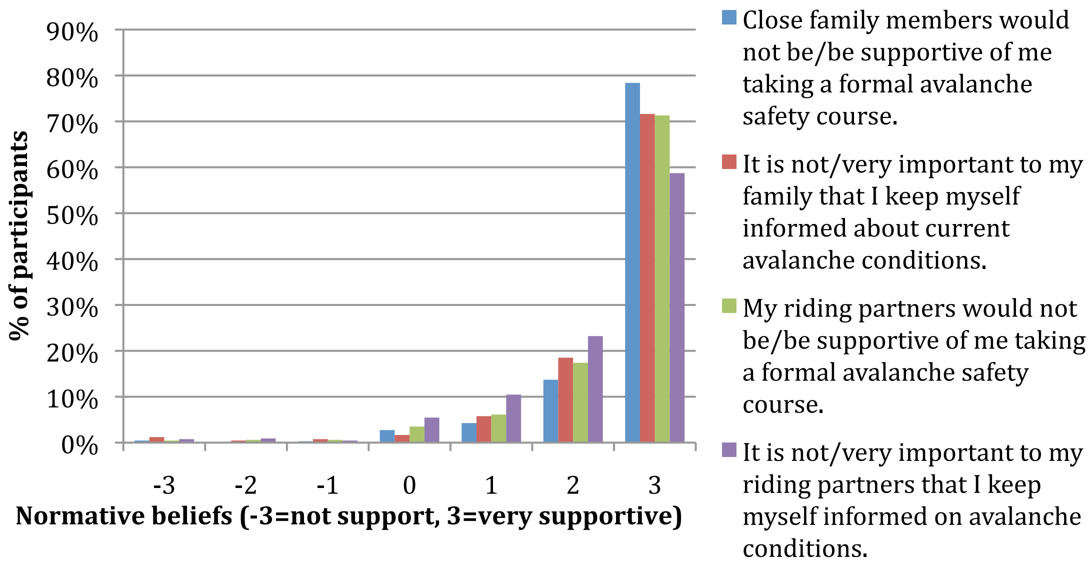


Figure 5.27.   Beliefs of family members and riding partners

Participants' motivation to comply with their families' and riding partners' wishes regarding avalanche safety was also high with median values of 6 on a scale from 1 (not important at all) to 7 (extremely important). The IQR for both questions is 5,7 and a Wilcoxon rank-sum test does not indicate any significant differences between the two distributions (p-value = 0.059). However, the consistency in the two ratings is relatively low (Cronbach alpha = 0.622) indicating the survey participants weigh the opinions of family and riding partners differently (Figure 5.28).

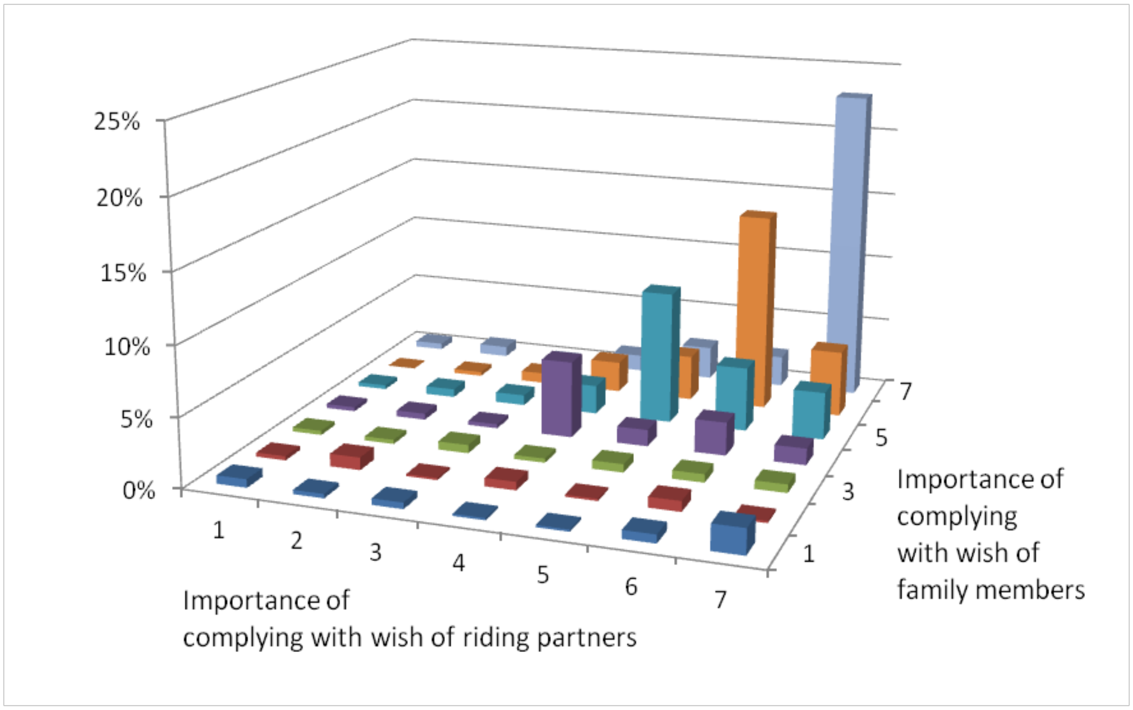


Figure 5.28. ***Distribution of ratings for importance comply with wishes of riding partners and close family members***

Potential Barriers to Taking a Formal Avalanche Awareness Courses

To assess snowmobile riders' potential barriers for taking formal avalanche training, a subsample of survey participants (n = 212) was presented with a series of questions about avalanche safety courses. To assess their general perception of their need to take a course, participants were asked to indicate their agreement with the statement “I generally do not ride in avalanche terrain, so I do not need an avalanche course.” using a scale from 1 (strongly disagree) to 7 (strongly agree). While the vast majority of participants presented with this question strongly disagreed with this statement (62%, 129 of 209), 24% (51 of 209) disagreed, and 14% (29 of 209) were either neutral or agreed with the statement.

Cost and Time

Anecdotally, the high cost of avalanche awareness courses and the limited amount of spare time are commonly used reasons for not becoming avalanche trained. In the present survey, participants were asked how much they agree with these two reasons on the same scale as for the previous question. While the median ratings to both questions was roughly in the middle of the scale, participants agreed more with the concern about time (median 4, 50 of 211, IQR: 2, 5) than cost (median 3, 18 of 211, IQR: 1, 4) (Figure 5.29). This difference was further confirmed with a Wilcoxon rank-sum test that showed that the two distributions differ significantly from each other (p-value = 0.001).

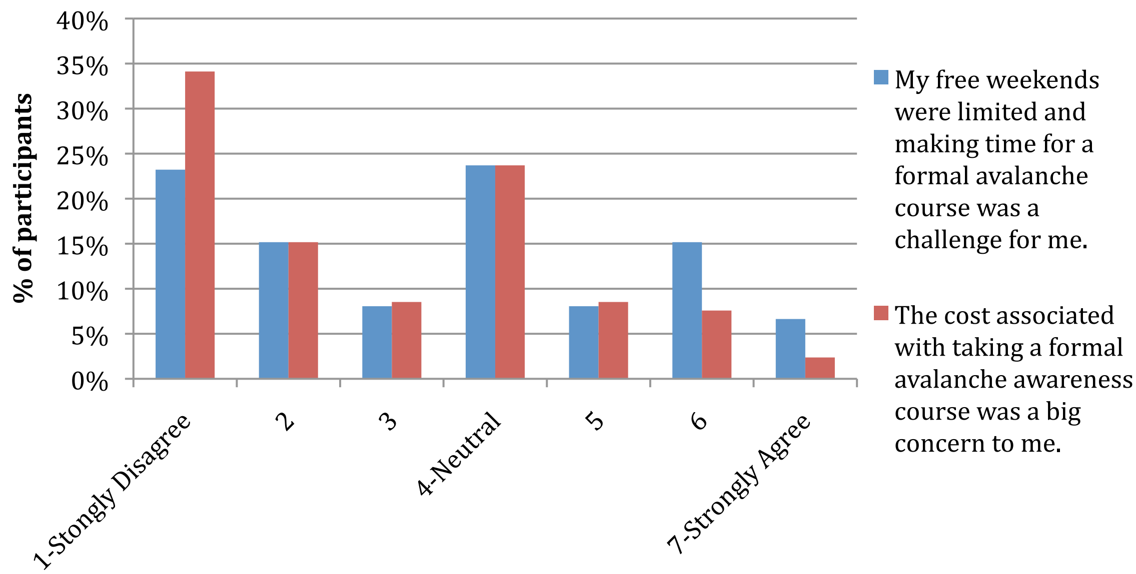


Figure 5.29. Cost and time as a barrier for taking a formal avalanche awareness course

Attitudes Towards Course Content and Provider

Using the same seven-point scale, participants were also asked to rate how much they personally agreed or disagreed with possible preconceived notions about avalanche course contents and course providers (Table 5.13). All negative question statements were reverse coded (indicated in table with R) so that higher values consistently indicate more positive attitudes towards course content and providers.

Table 5.13. ***Assessment of preconceived notions about avalanche course content and course providers (Cronbach alpha values in brackets)***

Survey statement	n	Median	IQR
Course content (0.463)			
1. The skills taught in avalanche courses allow me to go farther and more fully experience the mountains.	210	5	4, 6
2. Taking an avalanche course only teaches me that I should not ride in my favourite places anymore. (R)	209	6	5, 7
3. Avalanche courses teach me the necessary skills to safely explore the mountains under all conditions.	210	5	4, 6
Course providers (0.903)			
1. Avalanche course providers are safety geeks who simply don't have the balls to ride the stuff I do. (R)	210	7	7, 7
2. Avalanche course providers are as committed to the sport of mountain snowmobiling as I am.	210	6	5, 7
3. Avalanche course providers just want to scare us to keep us out of the backcountry. (R)	207	7	6, 7
4. Avalanche courses have been developed by skiers for skiers and don't apply to snowmobilers. (R)	209	7	6, 7

1 (strongly disagree), 7 (strongly agree)

While the overall attitude of the survey participants towards avalanche awareness courses and course providers is very positive, a more detailed analysis reveals a number of nuances. Whereas there was no significant difference between the first and the third questions regarding the course content (Pair-wise Wilcoxon rank-sum test with Boniferroni correction: p-value = 0.76), survey participants more strongly disagreed with the statement that avalanche course would only teach them that they could not ride in the favourite areas anymore (Pair-wise Wilcoxon rank-sum test with Boniferroni correction: p-value <0.001 for both comparisons). The small Cronbach alpha value (0.463) further indicates that there is limited consistency among the ratings for the three questions regarding the course content.

Survey participants had the least positive opinion of the commitment of the course provider towards their sport. Pair-wise comparisons with the Wilcoxon rank-sum test with Boniferroni corrections showed significant differences with respect to the ratings of all other questions (p-value for Question 2 vs. Question 4 = 0.044, both 2 vs. 1 and 2 vs. 3 p-value <0.001). Furthermore, the ratings with respect to the course provider being a safety geek were significantly more positive than the course been developed by skiers (p-value = 0.005). The high value of the Cronbach alpha (0.903) indicates that participants rated all of the questions regarding the course providers consistently.

5.2.7. Potential Barriers for Consulting Avalanche Bulletins

A subsample of participants (n = 220) who indicated that avalanche bulletins were available for their favourite snowmobile areas were asked a series of questions regarding potential barriers that could affect their use of the avalanche bulletin. This information can provide useful insights about how the content and delivery of avalanche bulletins might be improved for snowmobile riders.

Internet Access

With avalanche bulletin information being primarily distributed via the Internet, Internet access has the potential to be a considerable stumbling block for riders to get up-to-date avalanche safety information. Participants were therefore presented with three statements regarding their ease of Internet access and asked to rate how much they apply to them personally on a scale from 1 (does not apply at all) to 7 (strongly applies), (Table 5.14).

Table 5.14. Ease of access to Internet (Cronbach alpha value in brackets)

Statement	n	Median	IQR
Ease of access in general (0.97)			
1. Accessing the Internet is easy for me	220	7	7, 7
2. 'I am comfortable navigating in the Internet	219	7	7, 7
Ease of remote access			
I frequently connect to the Internet on the road via my smart phone	220	7	5, 7

1 (does not apply at all), 7 (strongly applies)

The vast majority of survey participants stated that both Internet access and navigation comes easy to them (i.e., 80% (177 of 220) and 82% (179 of 219) respectively selected 'strongly applies'). The consistency between the two ratings is extremely high (Cronbach alpha: 0.97), which indicates that the two questions can be collapsed into a single measure for ease of general Internet access.

However, the percentage of participants indicating that they frequently access the Internet on a mobile device was significantly lower (59%; 130 of 220). Pair-wise comparison using Wilcoxon rank-sum tests with Boniferroni corrections confirm this difference with p-values <0.001 for the comparisons between ratings for the remote access and the two general statements respectively. Low correlations between the ratings for general and mobile Internet access indicate that the latter is a distinctly different matter.

Use of Avalanche Bulletin

To evaluate participants' use of the avalanche bulletin, the present survey included a series of questions that asked them to indicate how frequently they study the different parts of the avalanche bulletins (Figure 5.30).

The avalanche danger rating is the part of the bulletin that is consulted the most by far; 73% (160 of 219) check the danger ratings always and 18% (40 of 219) do it frequently. The frequency of participants studying the graphics and reading the additional paragraphs contained in the bulletin on weather, snowpack and avalanches was significnatly lower, as was their frequency of applying bulletin information to the current conditions. (Pair-wise Wilcoxon rank-sum tests: all p-values <0.001). However, the high Cronbach alpha value (0.945) indicates that there is considerable consistency between all of the ratings.

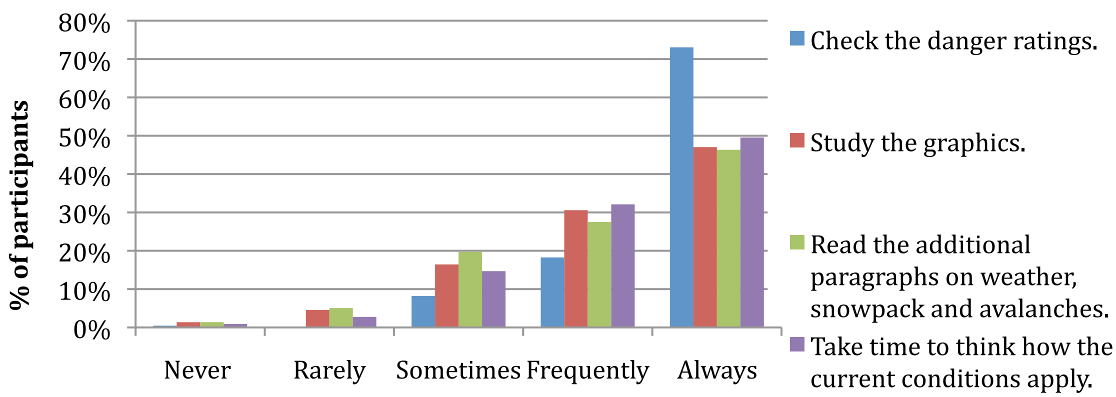


Figure 5.30. Frequency of use of different bulletin parts (n = 220)

Application of bulletin information

Survey participants were also asked to rate their confidence in their ability to apply the information provided in avalanche bulletins to their riding plans on a scale from zero (cannot do at all) to 100 (highly confident can do) (Table 5.15 and Figure 5.31). While the median was 80 for all three questions, the confidence rating for the application of the danger rating information was significantly higher than for identifying and applying relevant additional information (Pair-wise Wilcoxon rank-sum test comparisons with Boniferroni correction: p-values = 0.043 and 0.018). However, the high overall consistency of the confidence ratings (Cronbach alpha: 0.957) indicates that these ratings can be combined into a single measure for the perceived confidence of applying bulletin information.

Table 5.15. Confidence in ability to apply bulletin information to riding plans

Statement	n	Median	IQR
To adjust your riding plans according to the avalanche danger rating posted in the bulletin	220	80	70, 100
To identify information in the additional content of the bulletin (graphics, additional paragraphs) that applies to your riding plans	218	80	70, 90
To understand the meaning of this additional information for managing the avalanche conditions during your ride	217	80	70, 90

0 (Cannot do at all) to 100 (Highly confident can do)

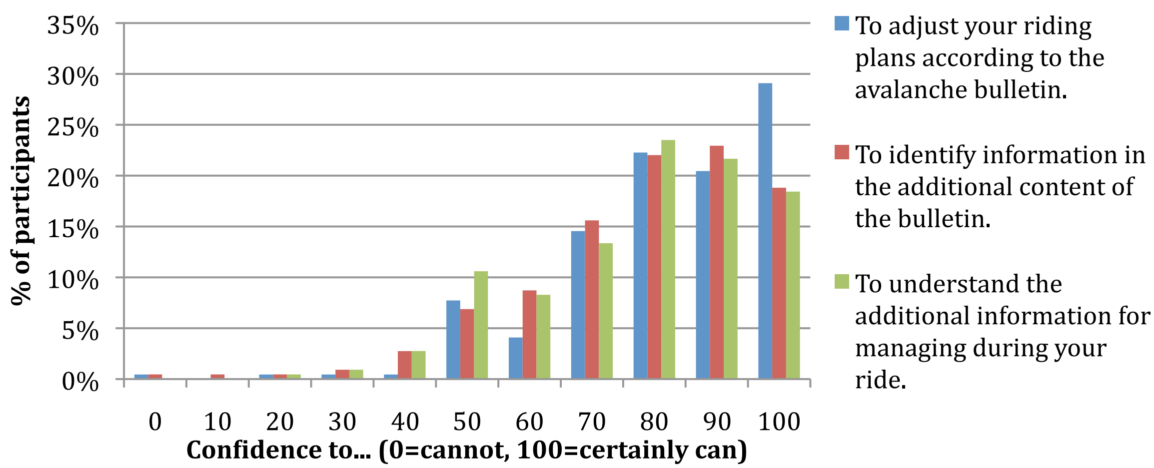


Figure 5.31. Confidence in ability to apply bulletin information

Attitudes towards avalanche bulletin and Canadian Avalanche Center

To assess attitudes toward the bulletin and the Canadian Avalanche Centre, participants were presented with a series of statements where their needed to indicate how much they agreed on a scale from 1 (strongly disagree) to 7 (strongly agree), (Table 5.16). The ratings of the negative statement have been reverse coded (indicated with R) so that higher ratings consistently represent more favourable attitudes.

Table 5.16. Assessment of preconceived notions about avalanche bulletin content and the Canadian Avalanche Centre (Cronbach alpha values in brackets)

Survey statement	n	Median	IQR
Bulletin content (0.272)			
1. Avalanche bulletins often exaggerate the seriousness of avalanche conditions (R)	219	6	4, 7
2. Avalanche bulletins are a useful source of information on avalanche conditions for the areas I ride	220	6	6, 7
3. Avalanche bulletins need to err on the side of caution	218	5	4, 6.75
Canadian Avalanche Centre (0.749)			
1. Keeping snowmobilers safe is a priority of the Canadian Avalanche Centre	218	7	6, 7
2. The CAC is just another government organization that tries to shut mountain snowmobiling down (R)	218	7	6, 7

1 (strongly disagree), 7 (strongly agree)

Avalanche bulletins received the highest ratings for being a useful source of information. Both the ratings for exaggerating conditions (R) and the understanding that bulletins need to err on the side of caution received significantly lower later ratings (Pair-wise Wilcoxon rank-sum test comparisons with Boniferroni correction: p-value <0.001 for both comparisons). Furthermore, the extremely low Cronbach alpha value (0.272) shows that participants responded to these three questions distinctly differently indicating that they cover very different attitudes towards avalanche bulletins.

Overall, the ratings for the Canadian Avalanche Centre are very favourable with the median of both statement being 'Strongly agree' (7) and only small IQRs. A Wilcoxon rank-sum test did not reveal any significant difference between the ratings to the two different questions. However, the only moderately high Cronbach alpha value (0.749) indicates the participants did not rate the two statements exactly the same way.

5.2.8. Information Seeking and Processing in the Field

A subsample of survey participants (n = 230) was also asked a series of questions regarding their information gathering and processing practices in the field when riding.

Frequency of Procedures

To assess participants' information gathering habits, they were asked to indicate how often they perform a number of standard information seeking procedures (Table 5.17 and Figure 5.32).

Table 5.17. ***Frequency of information gathering and processing procedures (Cronbach alpha values in brackets)***

Activity	n	Median*	IQR
Information Seeking (0.725)			
1. Scan the landscape for signs of avalanches	230	4	4, 5
2. Test the stability of small slopes with your sled before moving into larger terrain	229	4	3, 4
3. Examine terrain with respect to its exposure to avalanche danger	229	4	4, 5
4. Talk to riders outside of my group about avalanche conditions	230	3	3, 4
Information Processing			
5. Combine your observations into a mental picture of the current avalanche conditions	230	4	4, 5

*Never (1), Rarely (2), Sometimes (3), Frequently (4), Always (5)

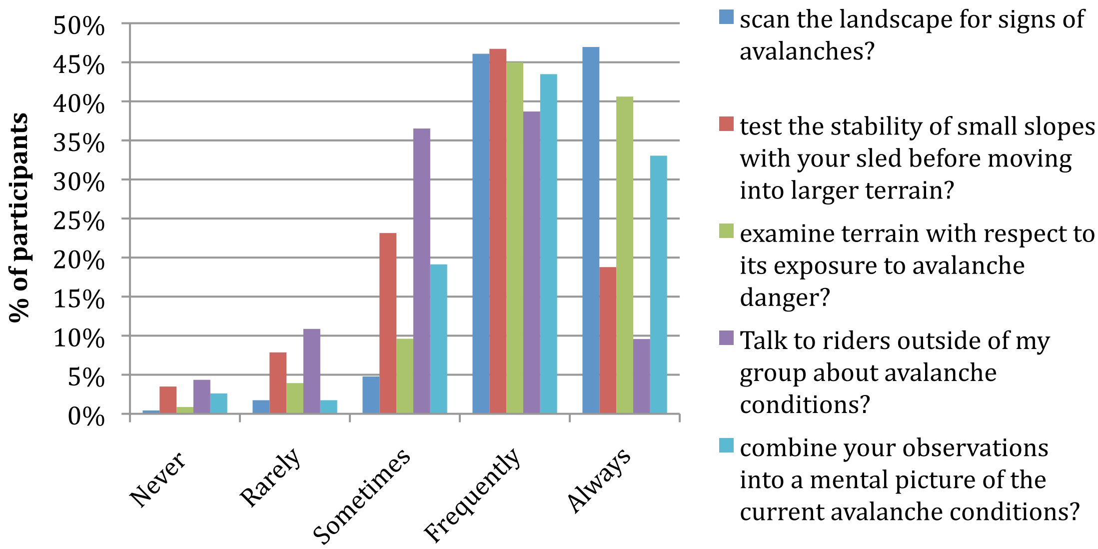


Figure 5.32. ***Frequency of information seeking and processing procedures in the field***

The most commonly reported information gathering practice is scanning the landscape for avalanches followed by examining the terrain with respect to its exposure to avalanche hazard. A Wilcoxon rank-sum test did not detect any significant difference in the reported frequency of these two practises. The moderately high Cronbach alpha value (0.820) indicates considerable consistency between these two ratings. The frequency of testing small slopes was significantly lower (pair-wise Wilcoxon rank-sum test with Boniferroni correction: p-value <0.001) and the reported frequency of talking to riders outside your group was significantly lower again (pair-wise Wilcoxon rank-sum test with Boniferroni correction: p-value = 0.001). An examination of the most common response patterns and the moderately low overall Cronbach alpha value (0.725) indicates that while scanning for avalanches and assessing the terrain for exposure to avalanche hazard often go hand in hand, testing small slopes and talking to others are more distinct avalanche safety practices (Table 5.18).

Table 5.18. Five most common patters for information seeking and processing

	Scan for avalanches	Test small slopes	Assess Terrain	Talk to others	Mental picture	Count
1.	Freq/Always	Freq/Always	Freq/Always	Freq/Always	Freq/Always	68 (30%)
2.	Freq/Always	Freq/Always	Freq/Always	Sometimes	Freq/Always	40 (18%)
3.	Freq/Always	Sometimes	Freq/Always	Freq/Always	Freq/Always	20 (8%)
4.	Freq/Always	Freq/Always	Freq/Always	Never/Rarely	Freq/Always	13 (6%)
5.	Freq/Always	Sometimes	Freq/Always	Sometimes	Freq/Always	12 (5%)
					Sum	149 of 228 (65%)

The reported frequency of assimilating the collected avalanche safety information into a mental picture of the current conditions was in the same range as scanning the terrain signs of avalanches and examining the terrain for exposure to avalanche hazard.

Personal Confidence in Procedures

Participants were also asked to rate their confidence in different aspects of their personal field observation seeking and processing skills on a scale from zero (cannot do at all) to 100 (highly confident can do), (Table 5.19).

Table 5.19. Confidence in field observation seeking and processing skills

Statement	n	Median	IQR
Making field observations for accurately assessing local avalanche conditions	227	70	50, 80
Asking the right questions when talking about local avalanche conditions	228	70	60, 80
Creating an accurate mental picture of the local avalanche conditions	225	70	60, 80

There are no significant difference in the distributions of these three ratings and an exceptionally high Cronbach alpha value (0.99) indicates very high consistency between the three ratings. As a consequence, the average rating of these three questions provides a meaningful single measure of their overall confidence in their field skills.

Susceptibility for Heuristic Traps

To assess their susceptibility for heuristic traps, survey participants were presented with statements about personal decision-making that reflect situations associated with five of the heuristic traps described by McCammon (2002). Participants were asked to indicate how much these statements reflect their personal approach to travelling in avalanche terrain on a scale from 1 (strongly disagree) to 7 (strongly agree), (Table 5.20).

Table 5.20. Assessment of personal susceptibility to heuristic traps

	Statement	n	median	IQR
1.	Scarcity: I need to go further to find fresh powder when an area is tracked out.	230	5	4, 6
2.	Expert Halo: I sometimes overly trust the safety judgment of better riders and tend to interpret their riding skills as avalanche skills.	230	4	2, 5
3.	Familiarity: I have noticed myself being less cautious when riding in areas I am very familiar with.	230	5	3, 5.75
4.	Social Facilitation: Having other riders watch or a camera running really motivates me to push my riding further.	230	4	2, 5
5.	Commitment: I am pretty committed when riding and I rarely deviate from my original plans.	229	4	2, 5

1 (strongly disagree), 7 (strongly agree)

Pair-wise comparisons indicate that participants agreed significantly more with the scarcity statement than any other statement (Wilcoxon rank-sum test with Boniferroni corrections: p-values <0.001 for all comparisons). They agreed second most with the familiarity statement, which exhibits a rating that is significantly higher than the remaining three statements (Wilcoxon rank-sum test with Boniferroni corrections: p-values <0.001 for all comparisons). No significant differences were observed in the ratings for expert halo, social facilitation and commitment.

A low Cronbach alpha value (0.587) and low correlations among the ratings indicate that the five different statements clearly represent different dimensions of heuristic traps and that participants responded to them in distinct fashions.

5.3. Non-response analysis results

First, a comparison of intercept responses by those who completed both the intercept and the online surveys (n = 158) and those who completed only the intercept survey (n = 861) was done for the entire intercept survey. This analysis offers first insights about the response bias in our online survey sample. Participants recruited from the intercept who completed both surveys were older than those who completed only the intercept

(Wilcoxon rank-sum test: p-value <0.001). Their snowmobile engine size was larger (Wilcoxon rank-sum test: p-value = 0.049). Their ability to talk a partner out of riding a slope they thought to be dangerous was higher (Wilcoxon rank-sum test: p-value = 0.011). They reported significantly higher levels of awareness and training through the PAPM statements (Wilcoxon rank-sum test: p-value = 0.002). Last, participants who completed both surveys were significantly more accurate in their recollection of the avalanche danger rating below the tree line (Wilcoxon rank-sum test: p-value = 0.014). All other comparisons did not reveal any significant differences between the two groups.

Next, a comparison of responses by intercept (n = 1,019) and online survey (n = 662) responses was done using items that were included in both surveys to offer an overall perspective on the differences between the intercept and online samples. The percentage of males responding to the online survey was significantly higher than in the intercept (Pearson's Chi-squared test: p-value = 0.003). Online survey participants were older (Wilcoxon rank-sum test: p-value <0.001) had more years of riding experience (Wilcoxon rank-sum test: p-value = 0.001), more days riding per year (Wilcoxon rank-sum test: p-value <0.001), higher levels of riding ability (Wilcoxon rank-sum test: p-value <0.001) and were more likely to be a snowmobile club member (Pearson's Chi-squared test: p-value <0.001). Online survey participants were less likely to ride Skidoo BRP snowmobiles (Pearson's Chi-squared test: p-value = 0.039) and had shorter track lengths (Wilcoxon rank-sum test: p-value = 0.006). They reported being more able to talk a partner out of riding a slope (Wilcoxon rank-sum test: p-value = 0.0234) and higher levels of awareness and training through the PAPM statements (Wilcoxon rank-sum test: p-value <0.001).

Last, a comparison of online responses by those recruited from the intercept (n = 144) and those coming from the other sources (n = 510) was done for key characteristics and demographics to better understand the differences in the participants from the different recruiting sources. Online survey participants recruited from the intercept were younger (Wilcoxon rank-sum test: p-value = 0.005), and more likely to be from Alberta or Saskatchewan (Pearson's Chi Square <0.001). The sample recruited from the intercept also had less years of riding experience (Wilcoxon rank-sum test: p-value <0.001), rode fewer days per year (Wilcoxon rank-sum test: p-value <0.001), reported lower ability levels (Wilcoxon rank-sum test: p-value <0.001), had less training (Wilcoxon rank-sum test: p-value = 0.033) and were less likely members of a snowmobile club (Pearson's Chi Square = 0.010).

Detailed results from the response bias analysis are presented in Appendix F

5.4. Comparing Participants With Training to Those Without

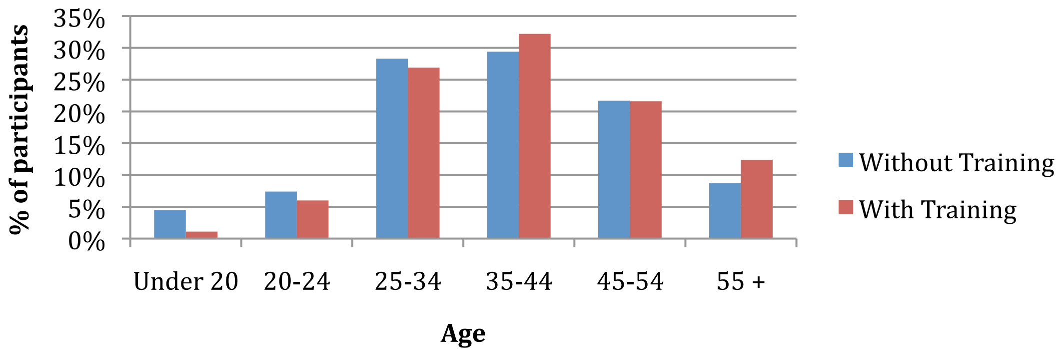
Avalanche Training

Forty-three percent (283 of 662) of online survey participants had formal avalanche training[20] and 40% (404 of 1,005) of intercept participants indicated they were trained through their chosen PAPM statement. The following comparison of response patterns based on participants' training addresses several of the identified research objectives.

Demographics and Avalanche Training

Online survey participants with and without formal training both reported a median age of 35 to 44 years old (IQR: 25-34 years, 45-54 years). Despite the same median and IQR values, a Wilcoxon rank-sum test indicates that online participants without training were significantly younger than those with training (p-value = 0.0491) (Figure 5.33). Similarly, intercept participants without training were also significantly younger than those with training (Mean = 32, SD = 9.97 versus Mean = 36, SD = 10.56; $t(824) = -4.76$, p-value <0.001). There was no significant difference between the two groups with respect to genders, marital status, or having children.

[20] Formal avalanche training includes AST 1, AST 2, CAA professional and other courses with a field component.



Participants without training had significantly lower levels education (n = 378, Median: Trades, IQR: High school, Trades) than those with training (n = 281, median: Trades, IQR: Some post secondary, Trades), (Wilcoxon rank-sum test: p-value <0.001), (Figure 5.34).

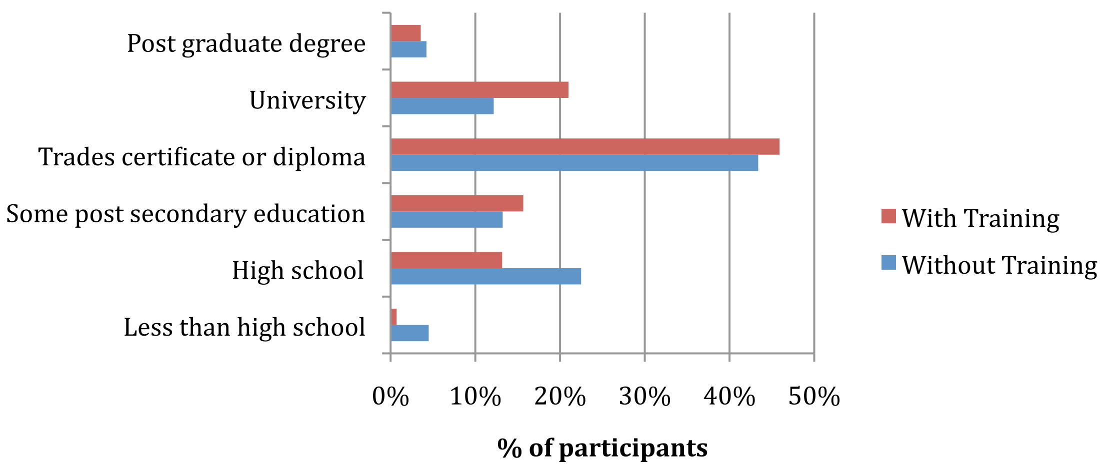


***Figure 5.34.	Education and training – Online***

The relationship between participant's home province and formal training was significant in both surveys. Online participants without formal training were more likely live outside of British Columbia, (n = 659, Pearson's chi-squared test: p-value <0.001), (Figure 5.35). Intercept participants without formal training were also more likely live outside of British Columbia (n = 993, Pearson's chi-squared test: p-value <0.001), (Figure 5.36).

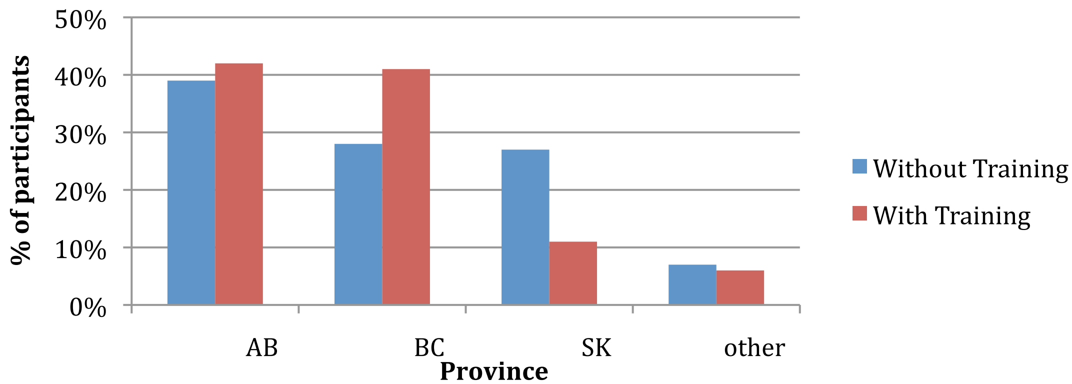


Figure 5.35. Avalanche training by province – Online

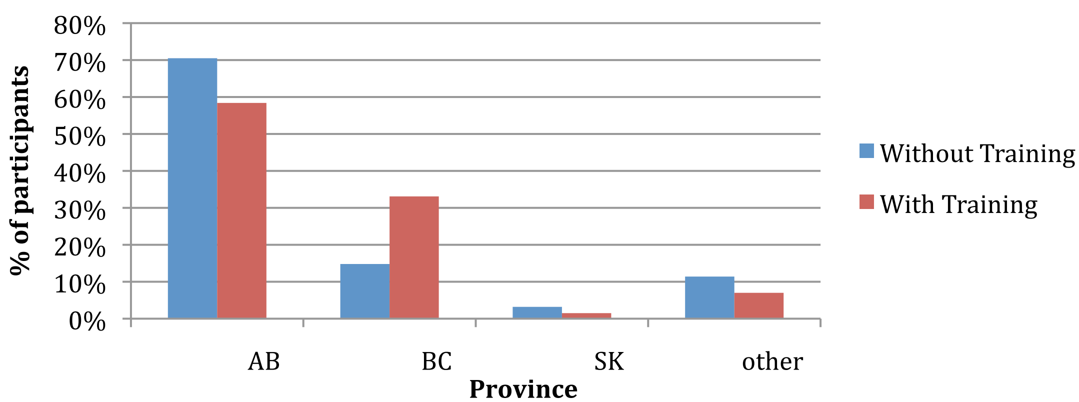


Figure 5.36. Avalanche training by province – Intercept

Riding Experience and Avalanche Training

Online participants without training reported fewer riding days per year (n = 350, Median: 16 to 20, IQR: 10-15 days, 21-30 days) than those with training (n = 263, Median: 16 to 20 riding, IQR: 10-15 days, 31-60 days) (Figure 5.37). Despite both groups having the same median values, a Wilcoxon rank-sum test indicates the two samples are significantly different (p-value <0.001). Similarly, intercept participants without training reported fewer riding days per year (n = 581, Median: 5 to 15 day, IQR: 1 to 4 days, 16 to 30 days) than those with training (n = 398, Median: 16 to 30 days, IQR: 5 to 15 day, 31 to 60 days) (Wilcoxon rank-sum test: p-value <0.001) (Figure 5.38).

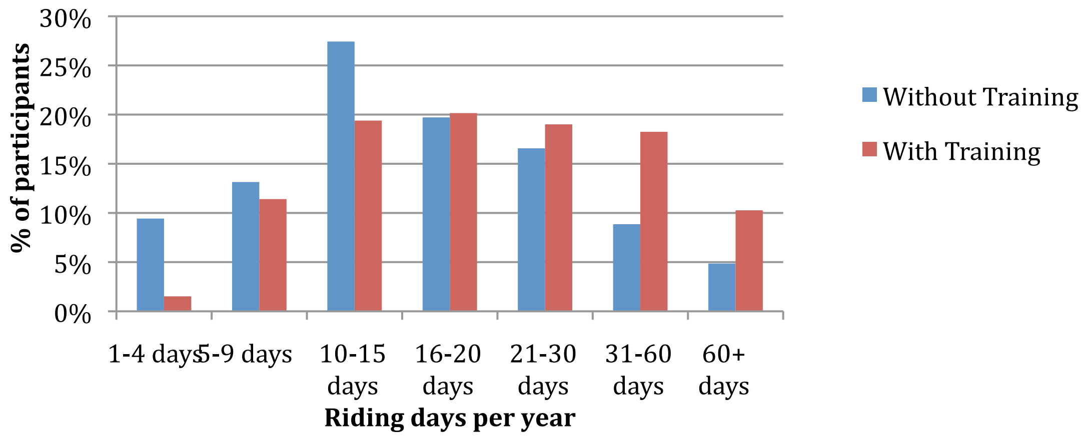


Figure 5.37. Days of riding per year – Online

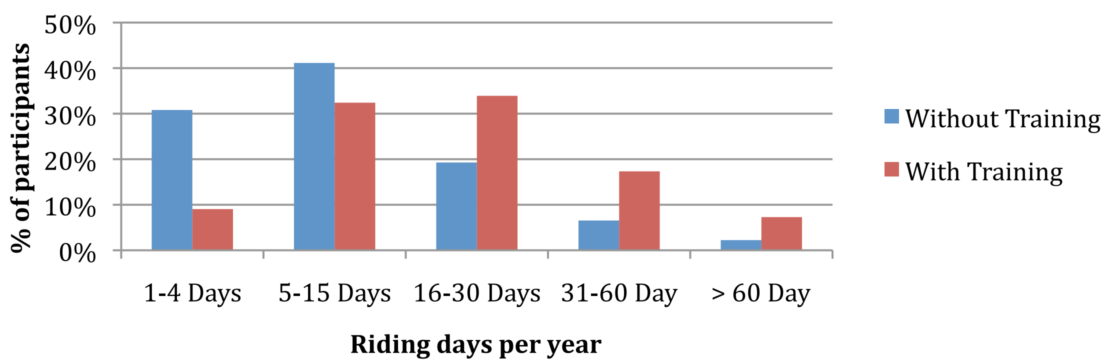


Figure 5.38. Days of riding per year – Intercept

Online participants without training reported fewer years of riding experience (n = 379, Median: 6 to 9 years, IQR: 3-5 years, 15-19 years) than those with training (n = 283, Median: 6 to 9 years, IQR: 3-5 years, 15-19 years) (Figure 5.39). Despite both groups having the same median values and interquartile ranges, a Wilcoxon rank-sum test indicates that the two samples are significantly different (p-value <0.001). Similarly, intercept participants without training reported fewer years of riding experience (n = 595, Median: 3-5 years, IQR: 1-2 years, 6-9 years) than those with training (n = 400, Median: 6-9 years, IQR: 3-5 years, >10 years) (Wilcoxon rank-sum test p-value: <0.001) (Figure 5.40).

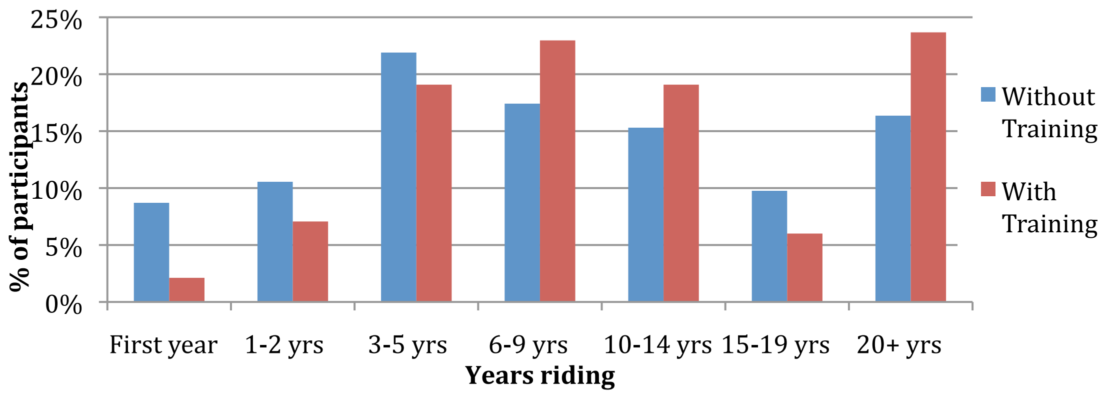


Figure 5.39. Years of experience – Online

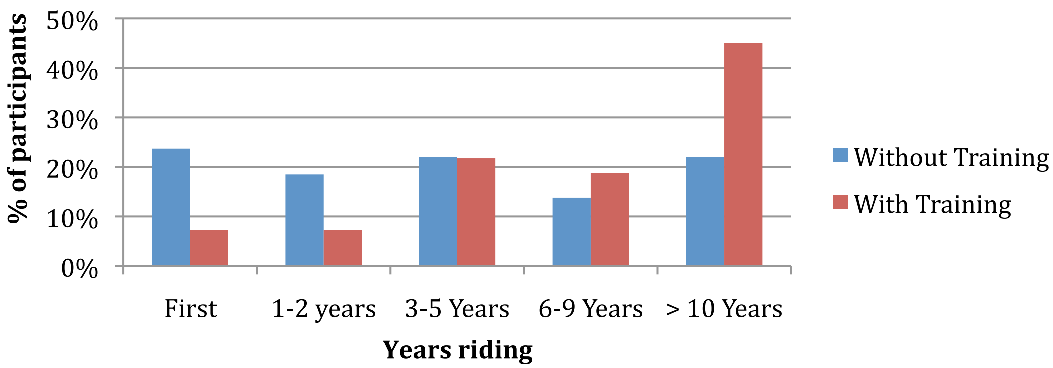


Figure 5.40. Years of experience – Intercept

Avalanche Involvement and Avalanche Training

Participants without training from both surveys were less likely to have been involved in an avalanche[21], (Table 5.21).

[21] personally caught or witnessed a partner caught

Table 5.21. Prior avalanche involvement – Intercept and Online

Variable	Test	Level	Without Training	With Training	P-Value
Personally caught or witnessed a partner caught in an avalanche	Chi Sqrd		n = 379	n = 281	
Online participants		Yes	61 (16%)	94 (33%)	<0.001
	Chi Sqrd		n = 569	n = 385	
Intercept participants		Yes	86 (15%)	154 (40%)	<0.001

Sensation Seeking and Avalanche Training

Of the BSSS-8 questions, online participants without formal training were significantly less likely to agree with the statement, ‘I would like to explore strange places’ (n = 378, median: 6, IQR: 5, 7) than those with training (n = 283, median: 6, IQR: 5, 7), (Wilcoxon rank-sum test: p-value = 0.012). This particular question relates to the experience seeking dimension of sensation seeking and was the only item from the BSSS-8 where a significant difference was found.

Safety Equipment and Avalanche Training

Online participants without training were less likely to carry an avalanche beacon (88%, 333 of 379) than those with training (97%, 273 of 283), (n = 662, Pearson's chi-squared test: p-value <0.001). They are also less likely to carry a probe (86%, 326 of 379 versus 96%, 272 of 283) and balloon pack (35%, 131 of 379 versus 51%, 145 of 283) (n = 662, Pearson's chi-squared tests: p-value <0.001 for both comparisons). No significant difference was found for the use of shovels between groups (Figure 5.41).

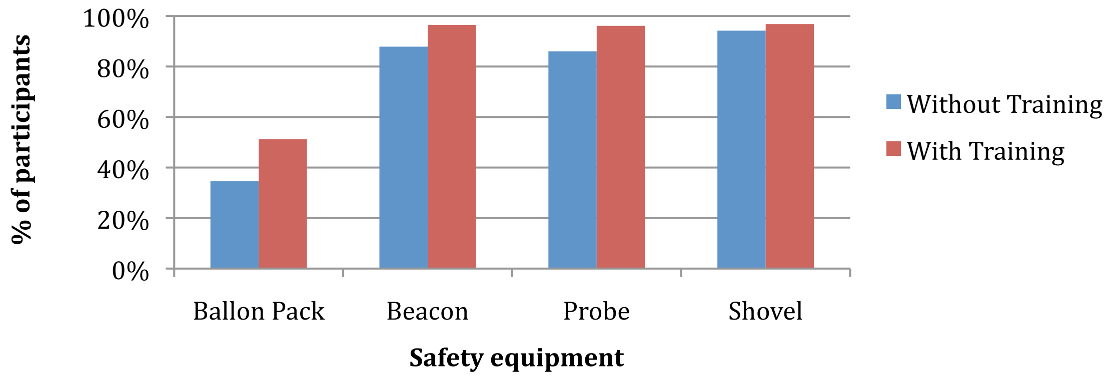


Figure 5.41. Avalanche safety equipment use and training – Online

Intercept participants without training were significantly less likely to carry all types of avalanche safety equipment (Table 5.22).

Table 5.22. Avalanche safety equipment use – Intercept

Variable	Test	Level	Without Training	With Training	P-Value
Avalanche safety equipment carried on day of intercept	Chi Sqrd	Carrying:	n = 601	n = 404	
		Beacon	503 (84%)	376 (93%)	<0.001
		Shovel	567 (94%)	395 (98%)	<0.001
		Probe	486 (81%)	384 (95%)	<0.001
		Balloon pack	174 (29%)	181 (45%)	<0.001

General Personal Avalanche Safety Knowledge/Confidence and Avalanche Training

Participants of the online survey without training had significantly lower levels of current avalanche knowledge (n = 379, Median: 50, IQR: 40, 60) than those with training (n = 278, Median: 70, IQR: 60, 80) (Wilcoxon rank-sum test: p-value <0.001). However, the perceived knowledge needed to effectively manage avalanche hazard was not significantly different between groups (Figure 5.42).

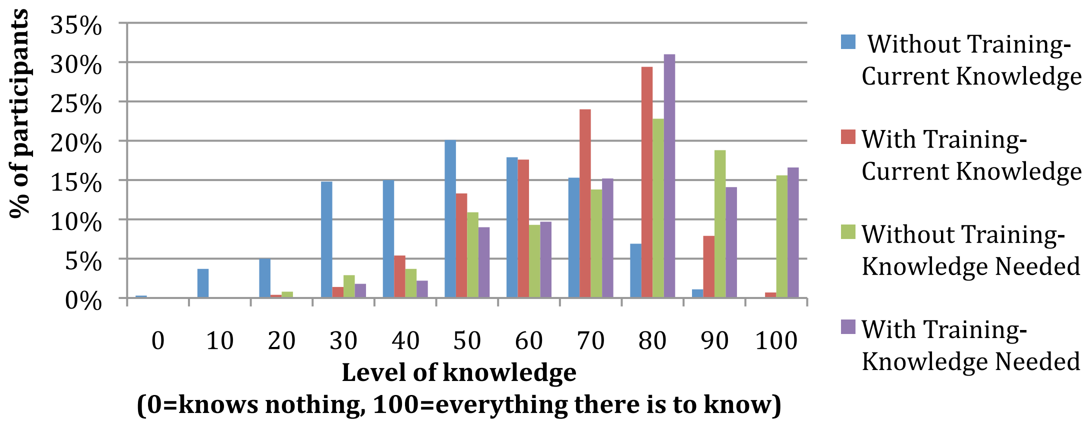


Figure 5.42. ***Perceived current knowledge and knowledge needed – Online***

However, the current level of knowledge for those without training (n = 378, Median: 50, IQR: 40, 60) was significantly higher than the level of knowledge those with training had prior to taking an avalanche course (n = 378, Median: 20, IQR: 10, 40) (Wilcoxon rank-sum test: p-value <0.001). This suggests those without training may over estimate their current level of knowledge, possibly because they don't yet recognize the amount of knowledge that exists (Figure 5.43).

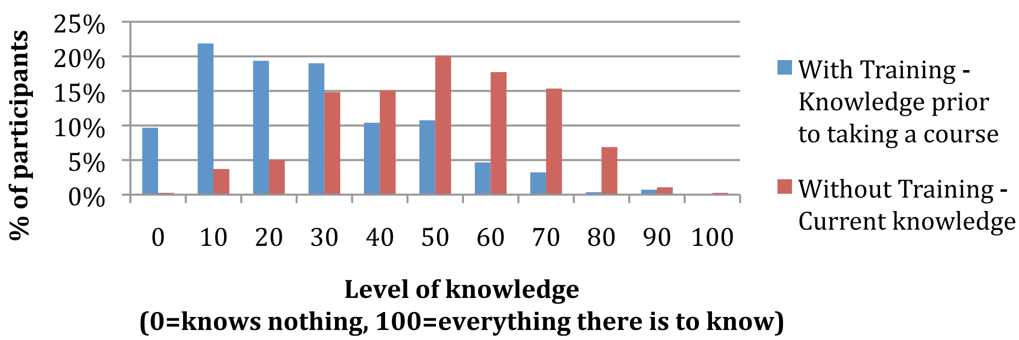


Figure 5.43 ***Knowledge prior to taking a course (with training) and current knowledge (without training) – Online***

Not surprisingly, participants without training still had significantly higher levels information insufficiency[22] (n = 377, Median: 30, IQR: 0, 40) than those with training (n = 276, Median: 1, IQR: 0, 20) (Wilcoxon rank-sum test: p-value <0.001) (Figure 5.44).

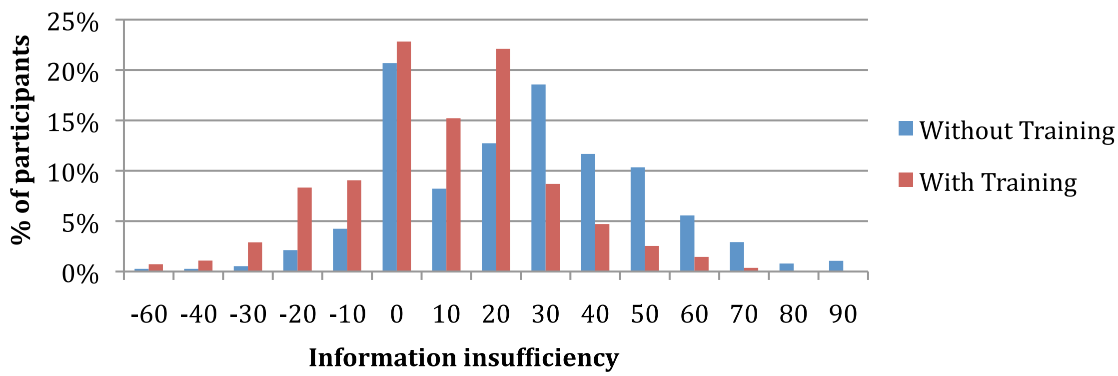


Figure 5.44. Information insufficiency and training

Participants without formal training had significantly lower levels of confidence in all of their avalanche safety skills (Wilcoxon rank-sum tests: all p-values <0.001):

- Recognize situations in which they are likely to trigger an avalanche: without training (n = 379, Median: 70, IQR: 50, 80), with training (n = 283, Median: 70, IQR: 60, 85)
- Identify locations to safely watch other snowmobilers ride: without training (n = 378, Median: 80, IQR: 60, 90), with training (n = 283, Median: 90, IQR: 80, 90)
- Locate and rescue a partner who is completely buried by an avalanche: without training (n = 378, Median: 60, IQR: 50, 70), with training (n = 282, Median: 80, IQR: 70, 90)
- Talk their partners out of riding a slope that they personally think is dangerous: without training (n = 378, Median: 80, IQR: 60, 90), with training (n = 283, Median: 80, IQR: 70, 90)

[22] Information insufficiency = perceived knowledge needed - perceived current knowledge

Group Dynamics and Avalanche Training

Participants without training were more likely to "not be part of the decision process, but would speak up if they had any concerns" and less likely to "be one of the decision-makers of their group". Surprisingly, the likelihood of being the primary decision maker was unaffected by training (Table 5.23).

Table 5.23. Group roles and training – Online

Role within group	Test	No Training	Trained	P-Value
	Chi-Sqrd	n = 375	n = 279	0.0287
I am the primary decision-maker of my group		41 (11%)	31 (11%)	
I am one of the decision-makers of my group		231 (62%)	196 (70%)	
I speak up if I have any concerns, but I am generally not part of the decision process		103 (27%)	52 (19%)	

Online participants without training were significantly less likely to use their snowmobile for ski or snowboard access[23] (19%, 73 of 378) than those with training (32%, 91 of 283), (Chi-Squared test: p-value: <0.001), (Figure 5.45). There was no significant difference in the intercept response between participants' use of their snowmobile for ski/snowboard access and training.

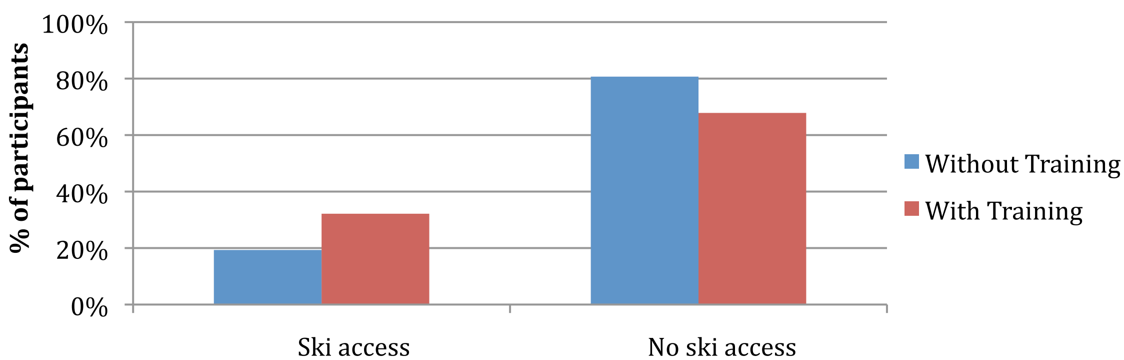


Figure 5.45. Snowmobile used for ski/snowboard access and training – Online

Avalanche Bulletin Use and Training

Participants of the online survey without training checked the online avalanche bulletin from home significantly less frequently (n = 321, Median: Frequently, IQR: Frequently,

[23] Participants who selected *'sometimes', 'most of the time',* and *'always'* use their snowmobile for backcountry ski/snowboard access were grouped as using their snowmobile for ski access.

Always) than those with training (n = 321, Median: Always, IQR: Frequently, Always) (Wilcoxon rank-sum test: p-value <0.001) (Figure 5.46). There was no significant difference for checking on the road between groups (many participants opted not to answer the "on the road" questions).

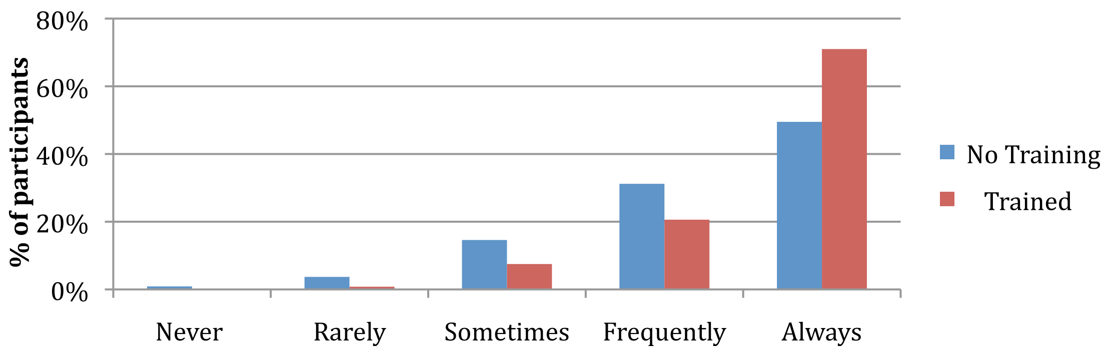


Figure 5.46. Checking the bulletin prior to leaving home and training – Online

When participants without training had a bulletin available and did access the online avalanche bulletin, they reported to:

- Check the danger ratings significantly less frequently (n = 128, median: 5, IQR: 4, 5) than those with training (n = 91, median: 5, IQR: 5, 5) (Wilcoxon rank-sum test: p-value=0.0194)

- Study the graphics that described the current avalanche problems significantly less frequently (n = 128, median: 4, IQR: 3, 5) than those with training (n = 91, median: 5, IQR: 4, 5), (Wilcoxon rank-sum test: p-value 0.011).

- Read the additional paragraphs on weather, snowpack and avalanches significantly less frequently (n = 128, median: 4, IQR: 3, 5) than those with training (n = 90, median: 5, IQR: 4, 5), (Wilcoxon rank-sum test: p-value 0.007)

- Take the time to think in detail how the current conditions applied to their intended riding area significantly less frequently (n = 128, median: 4, IQR: 4, 5) than those with training (n = 90, median: 5, IQR: 4, 5), (Wilcoxon rank-sum test: p-value <0.001).

Online participants without training were also less likely to have changed plans or cancelled a trip from both before leaving home and leaving the staging area due to due to avalanche conditions (Table 5.24)

Table 5.24. *Cancelled trips due to avalanche concern and training – Online*

Variable	Test	Level	Without Training	With Training	p-value
	Chi-Sqrd		n = 378	n = 283	
Have cancelled a trip at the staging		Yes	163 (43%)	168 (59%)	<0.001
			n = 379	n = 282	
Have cancelled a trip from home		Yes	192 (51%)	216 (77%)	<0.001

Information Seeking and Processing in the Field and Training

While riding, online participants without formal training seek out and process observational avalanche information less frequently and in less depth than those with training. Despite similar median and interquartile range values, a series of Wilcoxon rank-sum tests indicates that the differences are significant, except in the case of 'talking to riders outside of the group about avalanche conditions', which shows considerably lower ratings from both groups (Table 5.25).

Table 5.25. Information seeking/processing the field and training – Online

Variable	Level	n	Median*	IQR	p-value
Information Seeking:					Wilcoxon
Scan the landscape for signs of avalanches	Without training	131	4	4, 5	
	With training	99	5	4, 5	0.009
Test the stability of small slopes with your sled	Without training	131	4	3, 4	
before moving into larger terrain	With Training	98	4	3, 4	0.023
Examine terrain with respect to its exposure to	Without training	130	4	4, 5	
avalanche danger	With Training	99	4	4, 5	0.002
Talk to riders outside of my group about	Without training	131	3	3, 4	
avalanche conditions	With Training	99	3	3, 4	0.725
Information Processing:					
Combine your observations into a mental picture	Without training	131	4	4, 5	
of the current avalanche conditions	With Training	99	4	4, 5	0.002

*Never (1), Rarely (2), Sometimes (3), Frequently (4), Always (5)

Wilcoxon rank-sum tests indicate that online participants without training are also significantly less confident in their ability to accurately assess local avalanche conditions, ask the right questions when talking about local avalanche conditions, and to create an accurate mental picture of the local avalanche conditions as they would apply (Table 5.26).

Table 5.26. Information gathering and training – Online

Variable	Level	n	Median*	IQR	p-value
					Wilcoxon
Accurately assess local avalanche conditions	Without training	131	60	50, 70	
	With Training	99	75	50, 80	<0.001
Ask the right questions when talking about local avalanche conditions	Without training	129	60	50, 80	
	With Training	98	80	70, 90	<0.001
Create an accurate mental picture of the local avalanche conditions	Without training	127	60	50, 70	
	With Training	98	80	70, 90	<0.001

*Cannot do so at all(0), (100) Highly confident can do

Heuristic Traps and Training

Participants of the online survey without training are more likely affected for heuristic traps. Wilcoxon rank-sum tests indicate that they are more likely to agree that they trust the safety judgment of better riders and interpret their riding skills as avalanche skills, that they pushed their riding further while others were watching or filming, and are committed when riding and rarely deviate from their original plans (Table 5.27).

Table 5.27. Heuristic traps and training – Online

Variable	Level	n	Median	IQR	p-value
					Wilcoxon
Expert Halo:					
I sometimes overly trust the safety judgment of better riders and interpret their riding skills as avalanche skills.	Without training	131	4	3, 5	
	With Training	99	3	1, 4	<0.001
Social Facilitation:					
Having other riders watch or a camera running really motivates me to push my riding further.	Without training	129	4	2, 5	
	With Training	99	3	2, 5	0.021
Commitment:					
I am pretty committed when riding and I rarely deviate from my original plans.	Without training	131	4	3, 5	
	With Training	98	3	2, 4.75	0.028

*1 (strongly disagree), 7 (strongly agree)

Locus of Control and Training

Online participants without training viewed luck to play a significantly larger a role in avoiding avalanches in the mountains (n = 374, Median: 50, IQR: 20, 60) than those with training (n = 281, Median: 30, IQR: 20, 50) (Wilcoxon rank-sum test: p-value <0.001) (Figure 5.47). No significant differences were found when it came to luck involved with riding out of avalanche or surviving an avalanche once caught.

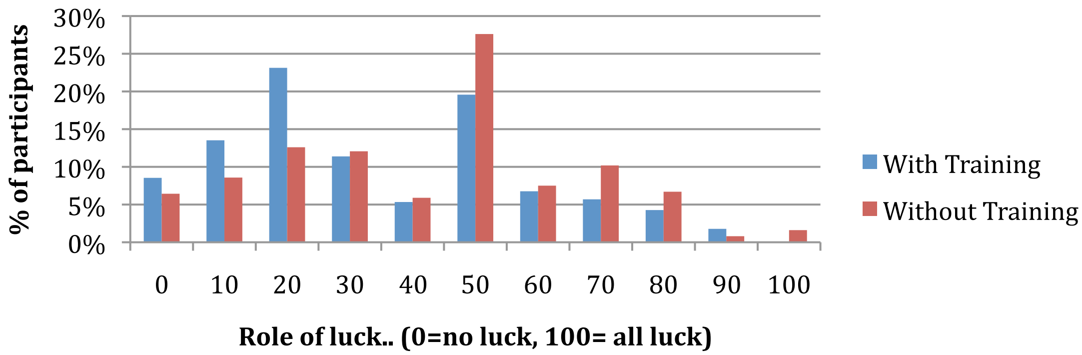


Figure 5.47. Influence of luck in avoiding avalanche involvements and training – Online

Barriers to Taking a formal Avalanche Course and Training

Participants of the online survey without training received less support from their family members and riding partners to take a formal avalanche course. It was also less important to their family members and riding partners to keep informed about current avalanche conditions. Despite similar median and interquartile range values, a series of Wilcoxon rank-sum tests indicates the differences are significant (Table 5.28). Their motivation to comply with the beliefs of family members and approval of riding partners were not significantly different from those with formal training.

Table 5.28. Subjective norms and training – Online

Variable	Level	N =	Median*	IQR	p-value
Subjective norms:					Wilcoxon
Close family members would not be/be supportive of me taking a formal avalanche safety course	Without training	376	3	3, 3	
	With training	281	3	3, 3	0.029
It is not/very important to my family that I keep myself informed about current avalanche conditions	Without training	378	2	2, 3	
	With Training	281	3	2, 3	0.013
My riding partners would not be/be supportive of me taking a formal avalanche safety course	Without training	376	3	2, 3	
	With Training	279	3	3, 3	0.003
It is not/very important to my riding partners that I keep myself informed on avalanche conditions	Without training	378	3	2, 3	
	With Training	281	3	3, 3	<0.001

*-3 (not supportive), 3 (very supportive)

Online participants without training were more likely to agree that their free weekends are limited and making time for a formal avalanche course would be a challenge (n = 118, median: 4, IQR: 2, 6) than those with training (n = 93, median: 2, IQR: 1, 4) (Wilcoxon rank-sum test: p-value <0.001). Participants without training were also more likely to agree that the costs associated with taking a formal avalanche awareness course are a big concern (n = 118, median: 2, IQR: 1, 4) than those with training (n = 93, median: 4, IQR: 1, 4) (Wilcoxon rank-sum test: p-value <0.001) (Figure 5.48).

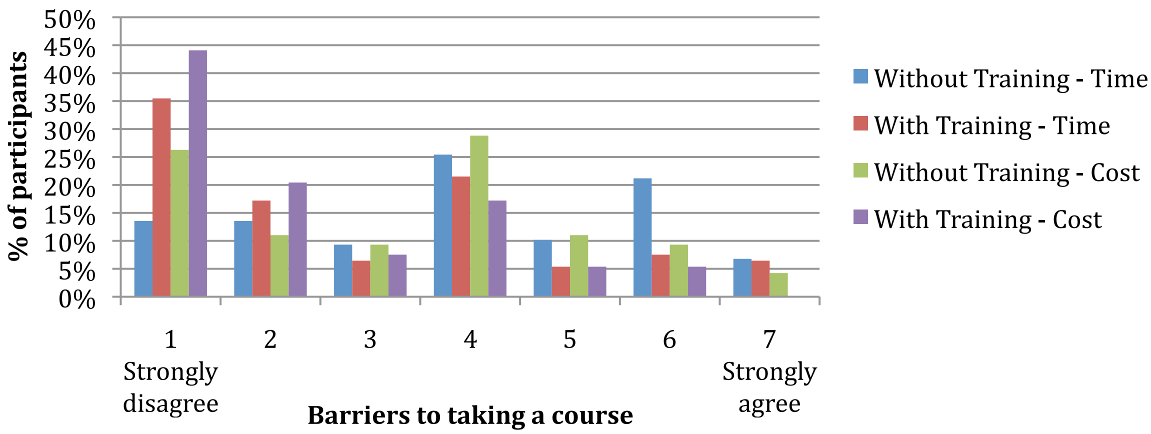


Figure 5.48. Barriers to taking a course and training – Online

Views of the avalanche centre, the resources it provides and avalanche course instructors were extremely positive for both groups. Ironically, online participants without formal training were more likely to agree with the statement ‘avalanche courses teach the necessary skills to safely explore the mountains under all conditions’ (n = 117, median: 5, IQR: 4, 6) than those with training (n = 93, median: 5, IQR: 3, 6) (Wilcoxon rank-sum test: p-value = 0.033). No other significant differences were found between online participants with and without training.

5.5. Comparing Participants Who Check the Bulletin

Avalanche Bulletin Use

Three percent (18 of 662) of online participants had no bulletin available to check for any of the areas they ride and another 3% (22 of 662) did not know if there was a bulletin, therefore these two groups were not presented with any further questions on their use of the avalanche bulletin. Of the remaining participants who had an avalanche bulletin available for at least one of their favourite areas, 13% (80 of 622) did not regularly check it[24]. Thirty-three percent (333 of 997) of intercept participants did not check the avalanche bulletin before the day they took the survey.

Demographics and Bulletin Use

Participants of the online survey who did not regularly check the avalanche bulletin were more likely to live in jurisdictions outside of western Canada (n = 620, Pearson's chi-squared test: p-value = 0.031) (Figure 5.49). No other demographic differences were found between groups.

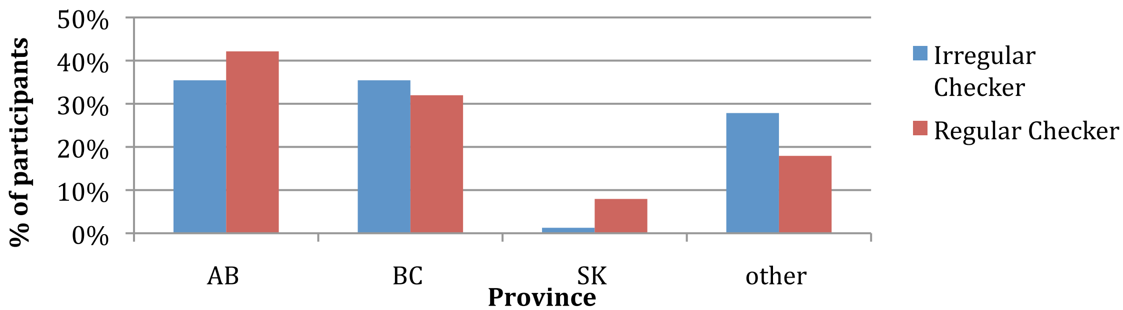


Figure 5.49. Avalanche bulletin checking by province – Online

Training and Bulletin Use

Online participants who did not regularly check the avalanche bulletin were less likely to have formal avalanche training (26%, 21 of 80) than those who did (47%, 255 of 542) (n = 622, Pearson's chi-squared test p-value <0.001) (Figure 5.50). Not surprisingly, they also reported significantly lower levels of awareness and engagement through their selected PAPM statements (n = 80, median: 4, IQR: 4, 6), than those who regularly check the bulletin (n = 542, median: 6, IQR: 4, 7) (Wilcoxon rank-sum test: p-value <0.001).

[24] Participants who indicated checking the online avalanche bulletin as part of their pre-trip planning: *'frequently' or 'always'* were regrouped as regular checkers; those who selected *'sometimes', 'rarely',* or *'never'* were regrouped as irregular checkers.

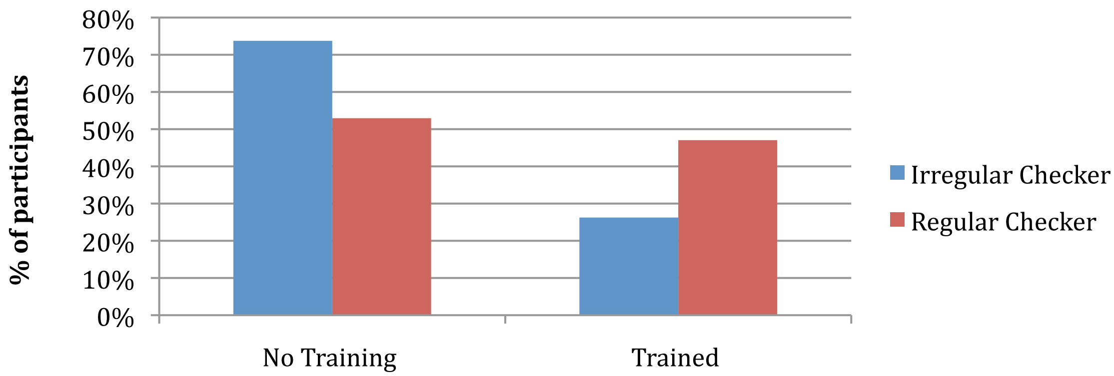


Figure 5.50. Bulletin checking and training – Online

Safety Equipment and Bulletin Use

Online participants who did not regularly check the bulletin were significantly less likely to carry an avalanche transceiver (84%, 67 of 80 versus 95%, 513 of 542; n = 622, Pearson's chi-squared test: p-value <0.001). They were also less likely to carry a probe (83%, 66 of 80 versus 94%, 507 of 542; n = 622, Pearson's chi-squared test: p-value <0.001), and avalanche balloon packs (30%, 24 of 80 versus 45%, 245 of 542; n = 622, Pearson's chi-squared test: p-value <0.001). There was no significant difference in their use of shovels (Figure 5.51).

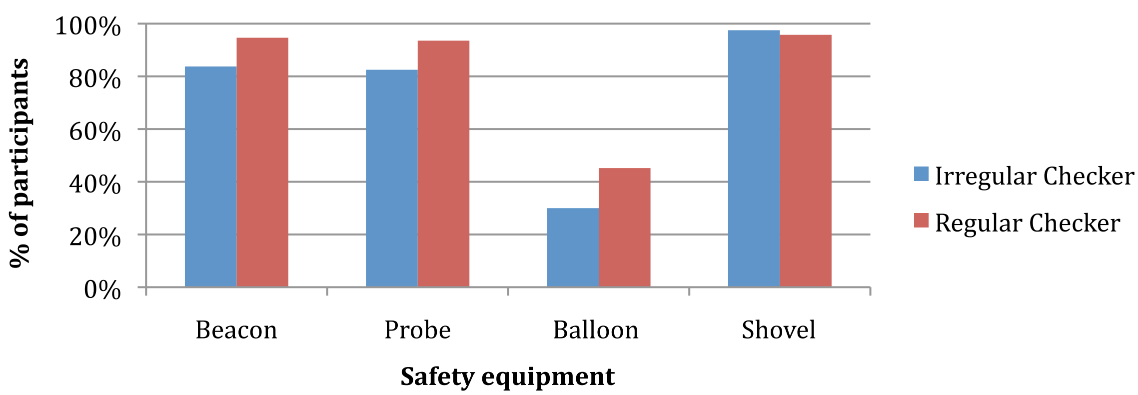


Figure 5.51. Avalanche safety equipment use and bulletin use – Online

Personal Avalanche Safety Knowledge/Confidence and Bulletin checking

Online participants who did not regularly check the bulletin had significantly lower levels of current avalanche knowledge (n = 80, Median: 50, IQR: 40, 70 versus n = 538, Median: 60, IQR: 50, 70; Wilcoxon rank-sum test: p-value <0.001) (Figure 5.52). Perceived knowledge needed to effectively manage avalanche hazard was not different between groups.

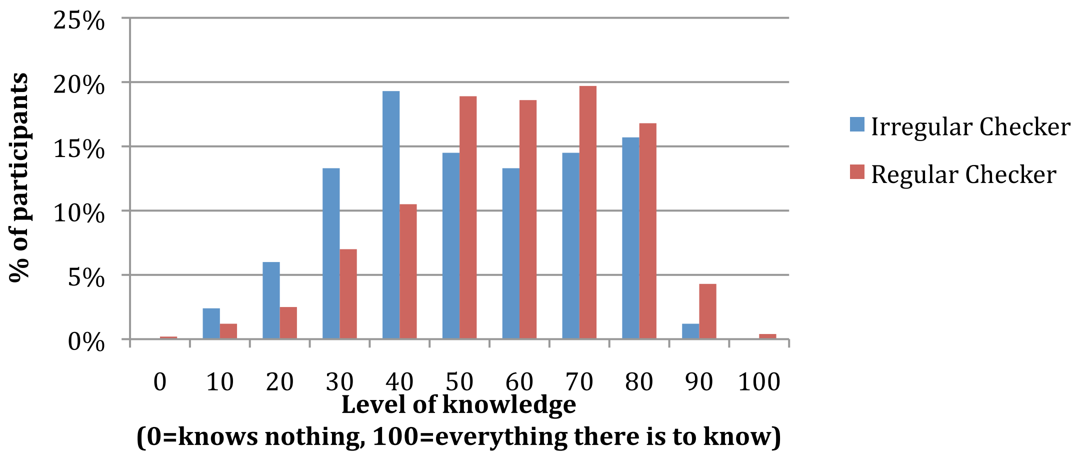


Figure 5.52. Current avalanche information and bulletin checking – Online

Participants who did not regularly check the bulletin had significantly lower levels of confidence in their ability to talk a partner out of riding a particular slope (n = 79, Median: 60, IQR: 60, 90 versus n = 538, Median: 60, IQR: 50, 70; Wilcoxon rank-sum test: p-value = 0.002). They also had significantly lower levels of confidence in their ability to find and rescue a buried partner (n = 80, Median: 70, IQR: 40, 80 versus n = 540, Median: 70, IQR: 60, 90; Wilcoxon rank-sum test: p-value = 0.013). Participants who did not regularly check the bulletin were less likely to have changed plans or cancelled a trip before leaving home due to avalanche conditions (41%, 32 of 79 versus 66%, 360 of 541; Chi-Squared test: p-value <0.001). They were also less likely to have changed plans or cancelled a trip before leaving the staging area due to avalanche conditions (39%, 31 of 80), than those who did (53%, 289 of 542), (Pearson's chi-squared test: p-value = 0.045), (Figure 5.53).

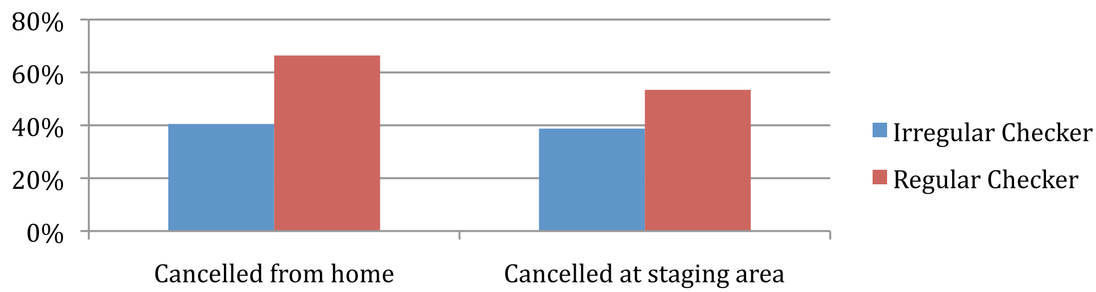


Figure 5.53. Cancelled or change a trip due to avalanche conditions – Online

In the field, participants of the online survey who did not regularly check the bulletin sought out observational information at similar levels, however they reported significantly lower levels of confidence in their ability to ask the right questions when talking about local avalanche conditions (n = 29, Median: 60, IQR: 40, 70) compared to regular bulletin users (n = 179, Median: 70, IQR: 60, 80) (Wilcoxon rank-sum test: p-value <0.001).

Barriers to Checking the Bulletin

Participants who did not regularly check the bulletin received significantly less support from their family members and riding partners to take formal avalanche training. It was also significantly less important to their family members and riding partners to keep informed about current avalanche conditions (Table 5.29).

Table 5.29. Subjective norms and bulletin use – Online

Variable	Level	n	Median*	IQR	p-value
Subjective norms:					Wilcoxon
Close family members would not be/be supportive of	Irregular Checker	80	3	2, 3	
me taking a formal avalanche safety course	Regular Checker	537	3	3, 3	0.005
It is not/very important to my family that I keep	Irregular Checker	80	2	2, 3	
myself informed about current avalanche conditions	Regular Checker	540	3	2, 3	0.002
My riding partners would not be/be supportive of me	Irregular Checker	79	3	2, 3	
taking a formal avalanche safety course	Regular Checker	536	3	3, 3	0.013
It is not/very important to my riding partners that I	Irregular Checker	80	3	3, 3	
keep myself informed on avalanche conditions	Regular Checker	539	3	3, 3	<0.001

*-3 (not supportive), 3 (very supportive)

Unlike those without training, online participants who did not regularly check the bulletin placed significantly less importance on complying with the beliefs of their family members and the approval of their riding partners (Table 5.30).

Table 5.30. Motivation to comply with the beliefs of family/riding partner and bulletin use – Online

Variable	Level	n	Median*	IQR	p-value
Motivation to comply:					Wilcoxon
How import is it to comply with your family member's beliefs concerning avalanche safety	Irregular Checker	80	5	4, 6	
	Regular Checker	541	6	5, 7	0.003
How import is it to comply with your riding partner's beliefs concerning avalanche safety	Irregular Checker	79	5	4, 6	
	Regular Checker	541	6	5, 7	<.001

*1 (not important at all), 7 (extremely important)

Views of the Canadian Avalanche Centre, the resources it provides and AST course instructors were all very positive and there were no significant differences in the responses from different types of bulletin checkers in the online survey.

Participants who did not regularly check the bulletin were significantly less comfortable navigating the Internet (n = 27, Median: 5, IQR: 3, 6) than regular bulletin checkers (n = 192, Median: 5, IQR: 5, 5) (Wilcoxon rank-sum test: p-value <0.001). When irregular checkers did check the bulletin, they reported to check the danger ratings significantly less frequently, study the graphics that describe the current avalanche problems significantly less frequently, read the additional paragraphs on weather, snowpack and avalanches significantly less frequently and take the time to think in detail how the current conditions apply to their intended riding area significantly less frequently (Table 5.31).

Table 5.31. Use of bulletin information – Online

Variable	Level	n	Median*	IQR	p-value
Bulletin information:					Wilcoxon
Check the danger rating	Irregular Checker	26	4	3, 5	
	Regular Checker	193	5	5, 5	<0.001
Study the graphics that describe the current avalanche problems	Irregular Checker	26	2	2.25, 3.75	
	Regular Checker	193	4	5, 5	<0.001
Read the additional paragraphs on weather, snowpack and avalanches	Irregular Checker	26	2	3, 4	
	Regular Checker	192	4	5, 5	<0.001
took the time to think how the current conditions apply to their intended riding area	Irregular Checker	26	3	3, 4	
	Regular Checker	192	4	5, 5	<0.001

*Never (1), Rarely (2), Sometimes (3), Frequently (4), Always (5)

No other significant differences were found between participants who regularly checked the bulletin and those who didn't.

5.6. RISP Results:

This section presents the results of the RISP analysis. SEM provides a more comprehensive perspective on how the variables collected in the online survey play together to affect the avalanche safety information seeking behaviour of snowmobilers than the univariate comparisons presented in the previous sections. The theoretical foundation of RISP offers insight into the predictors of information seeking using a multivariate approach. The RISP—Engagement model included two classes (with and without training) to investigate what factors affect risk perception and informational subjective norms for each group, offering insight on how training impacts the theorized RISP relationships. Subsequently, a binary logistic regression model was used to investigate factors affecting participants' engagement in avalanche safety if they didn't already have formal training. The RISP—Bulletin-use model used a single class approach to investigate factors affecting the frequency of bulletin use. Together the results from these models provide a better understanding of what might influence snowmobilers to take an avalanche course and check the current avalanche conditions prior to a backcountry trip.

5.6.1. RISP—Engagement

After removing participants with missing data and those who selected the PAPM stages 'disengaged' or 'non-emerging', 631 participants were included in the first RISP—Engagement analysis. Forty-three percent (270 of 631) had formal training, while 57% (361 of 631) did not.

WLSMV Goodness-of-fit indices revealed a good fit: CFI =.98, RMSEA =.03, SRMR =.05. An acceptable CFI is >0.90, and >0.95 indicates a good fit. A RMSEA and SRMR of <0.08 indicates and acceptable fit, <0.06 indicates a good fit (Bentler, 1990; Steiger & Lind, 1980; Hu & Bentler 1998). Table 5.32 lists the mean scores for the model's parameters and the two classes (with and without training), Figure 5.54 and Figure 5.55 show their respective path diagrams.

Table 5.32. Mean Scores and SD of items in RISP—Engagement

Variable	With training		Without training	
	Mean	SD	Mean	SD
Individual characteristic				
Riding experience (1-7)	4.63	1.68	4.18	1.86
Sensation-seeking (1-7)	4.05	1.18	4.08	1.21
Previous avalanche involvement (0-1)	0.15	0.36	0.08	0.28
Self-efficacy - ability to: (0-100)				
Recognize situations in which you are likely to trigger an avalanche	74.04	15.33	61.91	20.19
Identify locations to safely watch other snowmobilers ride	85.3	12.84	73.02	19.37
Locate and rescue a partner who is completely buried by an avalanche	80.56	15.11	58.14	23.04
Perceived hazard characteristics				
Role of luck in avoiding avalanches (0-100) (Locus of control)	43.11	23.1	42.44	23.85
Probability of being caught in an avalanche (1-11)[25]	4.6	1.35	4.42	1.68
Trust in group: Confidence in riding partners's ability to…				
Select appropriate terrain (0-100)	76.41	18.04	72.33	19.24
Locate and rescue a partner who is completely buried by an avalanche (0-100)	76.59	18.96	64.52	24.06
Affective Response				
Worry of being caught in an avalanche (0-100)	63.52	29.2	62.66	28.25
Informational subjective norms				
Family members (-21 to 21)	14.56	5.89	14.28	6.04
Riding partners (-21 to 21)	14.7	6.29	13.24	6.87
Information insufficiency:				
(A) Perceived current Information (0-100)	67.96	14.81	49.61	18.61
(B) Information sufficiency threshold (0-100)	76.3	17.32	74.46	20.49
For binary analysis: (B) – (A) =Information insufficiency	8.33	20.76	24.85	24.31
With Training (n = 270), Without Training (n = 361)				

[25] Probability of being caught in an avalanche code: 1 = less than 1 in 10,000 years; 2 = 1 in 10,000 yrs; 3 = 1 in 1,000 yrs; 4 = 1 in 100 yrs; 5 = 1 in 10 yrs; 6 = 1 in 5 yrs; 7 = 1 in 2 yrs; 8 = 1 in a year; 9 = 2 in a year; 10 = 5 in a year; 11 = more than 5 in a year

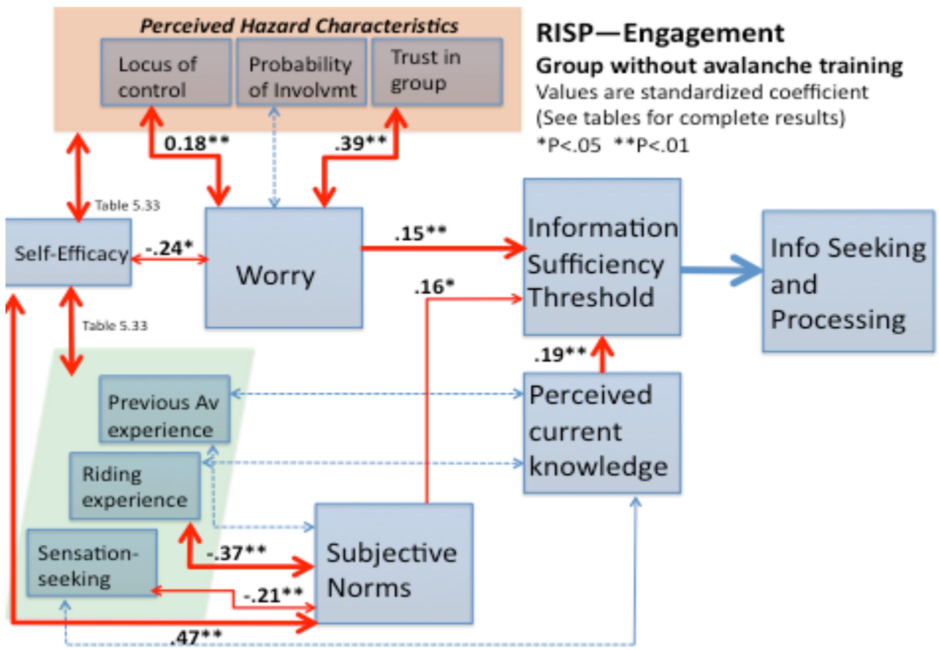


Figure 5.54 ***RISP—Engagement for participants without training (n = 361) (Red paths indicate significant relationships while the standardized coefficients denote the strength of the relationship)***

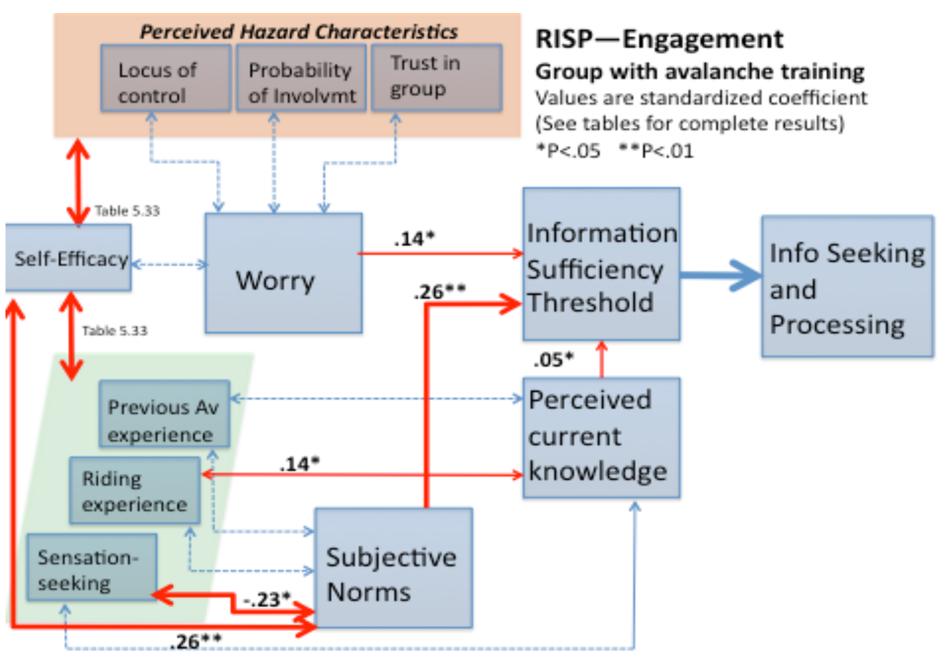


Figure 5.55 ***RISP—Engagement for participants with training (n = 270) (Red paths indicate significant relationships while the standardized coefficients denote the strength of the relationship)***

RQ1: Relationship of self-efficacy with the other individual characteristics

The latent variable of avalanche safety self-efficacy was estimated using three self-reported measurement which included the ability to 'recognize situations in which you are likely to trigger an avalanche', 'Identify locations to safely watch other snowmobilers ride', and 'locate and rescue a partner who is completely buried by an avalanche'.

The standardized coefficients in Table 5.33 show a highly significant positive relationship between the latent variable of avalanche safety self-efficacy and sensation-seeking for both groups, in support of H1a. The same table also shows a significant positive relationship between self-efficacy and riding experience for both groups, which supports H1b. A two sample z-test revealed that the two groups are significantly different, while both groups confirmed this positive relationship, the relationship was significantly stronger for the group without training (b = 0.41, SE = 0.06 versus b = 0.13, SE = 0.06; t = 3.38, p-value <0.001). A positive relationship between self-efficacy and previous avalanche involvement was found only for those with training, thus supporting H1c for this group.

Table 5.33. Individual characteristics and self-efficacy – RISP—Engagement

Individual characteristics		Self-efficacy
Riding experience	With Training	**0.18***
	Without Training	**0.47****
Sensation-seeking	With Training	**0.19****
	Without Training	**0.22****
Previous hazard experience	With Training	**0.17****
	Without Training	0.07

(with training n = 270, Without training n = 361) Significant standardized regression coefficients are in bold
*p-value <0.05, **p-value <0.01 Shaded boxes indicate significant difference between groups (z-test p-value <0.05)

RQ2: Relationship of perceived hazard characteristics with individual characteristics

Three separate dimensions of perceived hazard were analyzed in the model. Perceived probability of getting caught in an avalanche and the perceived role luck plays in avoiding avalanches (locus of control) were both measured using a single indicator variable. The latent variable of trust in group was measured with two assessments, 'partner's ability to select appropriate terrain given the current avalanche danger' and 'partner's ability to perform an emergency rescue in the case of a burial'. This portion of the model was largely exploratory, nonetheless H2 was partially supported with significant relationships between some variables.

The standardized coefficients in Table 5.34 show a significant negative relationship between riding experience and trust in their riding partners for both groups, a two sample z-test revealed that this negative relationship is significantly stronger for the group without training (b = -0.40, SE = 0.06 versus b = -0.10m, SE = 0.05; t = -3.83, p-value <0.001). This can possibly be attributed to the fact that the online survey attracted participants who had relatively high levels of training and experience. Furthermore, a significant positive relationship was found between riding experience and perceived probability of harm for the group without training. A z-test showed this relationship to be significantly stronger for the group without training (b = 0.18, SE = 0.07 versus b = -0.04, SE = 0.05), t = 2.65, p-value = 0.008). Interestingly, a significant positive relationship was found between riding experience and the perceived role luck plays in avoiding avalanches for the group with training, however this relationship was not significantly different between groups.

Table 5.34. Individual characteristics and perceived hazard characteristics – RISP—Engagement

Individual characteristics		Perceived hazard characteristics		
		Perceived probability of harm	**Role of luck in avoiding avalanches (Locus of control)**	**Trust in riding partners**
Riding experience	With Training	-0.06	**0.19***	**-0.15***
	Without Training	**0.19****	0.05	**-0.62****
Self-efficacy	With Training	-0.14	**-0.21****	**0.62***
	Without Training	**-0.14***	**-0.16***	**1.05****
Sensation-seeking	With Training	**0.27****	**0.16***	**-0.13***
	Without Training	**0.33****	**0.13***	**-0.41****
Previous hazard experience	With Training	**0.25****	0.03	0.09
	Without Training	**0.11***	-0.02	0.08

(with training n = 270, Without training n = 361) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01 Shaded boxes indicate significant difference between groups (z-test p-value <0.05)

Sensation-seeking exhibits a positive relationship with perceived probability of harm and the perceived role of luck in avoiding avalanches, and a negative relationship with trust in riding partners. All three of these relationships were significant for both groups; however, a two sample z-test showed the negative relationship between sensation-seeking and trust in riding partners was significantly stronger for the group without training (B = -0.39, SE = 0.08 versus b = 0.30, SE = 0.07; t = -2.66, p-value = 0.004).

The latent variable of personal avalanche safety self-efficacy shows a negative relationship with the perceived role of luck in avoiding avalanches for both groups. Self-efficacy and trust in riding partners share an extremely positive relationship for both groups, which is consistent with the homogenous character of the riding groups that responded to this survey and also indicates that participants assessed the related questions in a very similar manner.

Interestingly, self-efficacy had a negative relationship with perceived probability of harm for the group without training, however this relationship was not significantly different between groups.

On the other hand, Previous avalanche experience had a positive relationship with perceived probability of harm for both groups, but no significant differences were observed in the strength of these relationships between groups either.

RQ3: Relationship of perceived hazard characteristics and avalanche safety self-efficacy to worry

This research question looked at how worry is affected by perceived hazard characteristics as well as avalanche safety self-efficacy. Similar to the analysis related to the RQ2, this inquiry was also largely exploratory. Partial support for H3 was found from the group without training (Table 5.35). Trust in riding partners and the perceived role of luck in avoiding avalanches had a positive relationship with worry. Furthermore, a two sample z-test showed that the positive relationship of trust in riding partners with worry was significantly stronger for the group without training ($b = 0.93$, $SE = 0.28$ versus $b = 0.13$, $SE = 0.25$; $t = 2.15$, p-value $=0.032$). Conversely, self-efficacy had a negative relationship with worry, where higher levels of self-efficacy related to lower levels of worry. These relationships can likely be attributed to the affect that years of experience has on self-efficacy for participants without training. No significant relationships were found for the group with training in this dimension of the model.

Table 5.35. Perceived hazard characteristics, self-efficacy and worry - RISP—Engagement

Perceived hazard characteristics		Worry
Perceived probability of harm	With Training	0.05
	Without Training	0.10
Role of luck in avoiding avalanches (Locus of control)	With Training	0.09
	Without Training	**0.18****
Trust in riding partners	With Training	**0.05**
	Without Training	**0.39****
Self-efficacy	With Training	-0.08
	Without Training	**-0.24***

(with training n = 270, Without training n = 361) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01 Shaded boxes indicate significant difference between groups (z-test p-value <0.05)

RQ4: Relationship of individual characteristics to informational subjective norms

The latent variable of informational subjective norms was measured using two indicators, subjective norms of family and subjective norms of riding partners. This research question looked how subjective norms is affected by individual characteristics as well as avalanche safety self-efficacy. Similar to the previous research questions, this inquiry was also largely exploratory.

Partial support of H4 was found for both groups. Informational subjective norms were positively related to self-efficacy and negatively related to sensation-seeking (Table 5.36). The strength of these relationships were comparable for both groups. On the other hand, untrained participants' riding experience had a significant negative relationship with their informational subjective norms, which suggests that untrained participants with more years of riding experience had less pressure from family members and riding partners to become trained or stay informed. No equivalent relationship was observed among participants with training. Previous hazard experience and informational subjective norms were seemingly unrelated for both groups.

Table 5.36. Individual characteristics and informational subjective norms - RISP—Engagement

Individual characteristics		Informational subjective norms
Riding experience	With Training	-0.09
	Without Training	**-0.37****
Self-efficacy	With Training	**0.26****
	Without Training	**0.47****
Sensation-seeking	With Training	**-0.23***
	Without Training	**-0.21****
Previous hazard experience	With Training	0.01
	Without Training	0.06

(with training n = 270, Without training n = 361) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01 Shaded boxes indicate significant difference between groups (z-test p-value <0.05)

RQ5: Relationship of perceived current knowledge and individual characteristics

Results of the RISP analysis indicate a highly significant positive relationship between self-efficacy and perceived current knowledge exists for both groups (Table 5.37). There is also a significant positive relationship between riding experience and perceived current knowledge only for the group with training. These findings offer partial support for H5. No significant difference was found between groups concerning the strength of these relationships.

Table 5.37. Individual characteristics and perceived current knowledge - RISP—Engagement

Individual characteristics		Perceived current knowledge
Riding experience	With Training	**0.14***
	Without Training	0.07
Self-efficacy	With Training	**0.71****
	Without Training	**0.73****
Sensation-seeking	With Training	0.02
	Without Training	0.05
Previous hazard experience	With Training	-0.051
	Without Training	-0.04

(with training n = 270, Without training n = 361) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01 Shaded boxes indicate significant difference between groups (z-test p-value <0.05)

RQ6: Relationships of information insufficiency (threshold) and worry, information subjective norms and perceived current knowledge

Consistent with prior applications of the RISP model, the present analysis reveals that a higher information sufficiency threshold could be attributed to higher levels of worry about avalanches or the perception that friends and riding partners expected them to stay informed about avalanche conditions and get avalanche training (Table 5.38). These results support H6a, H6b, and H6c for both groups and therefore confirm the validity of the theories and concepts included in the RISP framework. None of the relationships were significantly different between groups.

Table 5.38. Predictors of information sufficiency threshold – RISP—Engagement

Variables		**Information sufficiency threshold**
Worry	With Training	**0.14***
	Without Training	**0.15****
Informational subjective norms	With Training	**0.26****
	Without Training	**0.16***
Perceived current knowledge	With Training	**0.05***
	Without Training	**0.19****

(with training n = 270, Without training n = 361) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

RQ7: Relationships of engagement in precautionary behaviour with information insufficiency, information subjective norms and worry.

The final portion of the RISP—Engagement analysis used a binary logistic regression to examine the potential predictors of precautionary engagement for participants who self-identified as ‘unaware’, ‘unengaged’, or ‘engaged’ in the PAPM. Together these stages comprise all without training in this portion of the analysis. ‘Engagement’ was used as a binary variable and information insufficiency, information subjective norms and worry were tested as potential predictors.

The results of this analysis indicate a significant positive relationship between informational subjective norms and engagement, and a highly significant positive relationship between worry and engagement, supporting H7a and H7b (Table 5.39 and Figure 5.56). On the other hand, Information insufficiency did not have a significant relationship with engagement, thus H7c was not supported.

Table 5.39. ***Binary regression analysis of engagement and information insufficiency, worry, and informational subjective norms - RISP—Engagement***

	Estimate	Standard error	p-value
Intercept	0.41	0.56	0.457
Information insufficiency	-0.06	0.09	0.535
Subjective norms	**0.10****	0.03	**0.004**
Worry	**0.17***	0.07	**0.020**

(n = 361) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

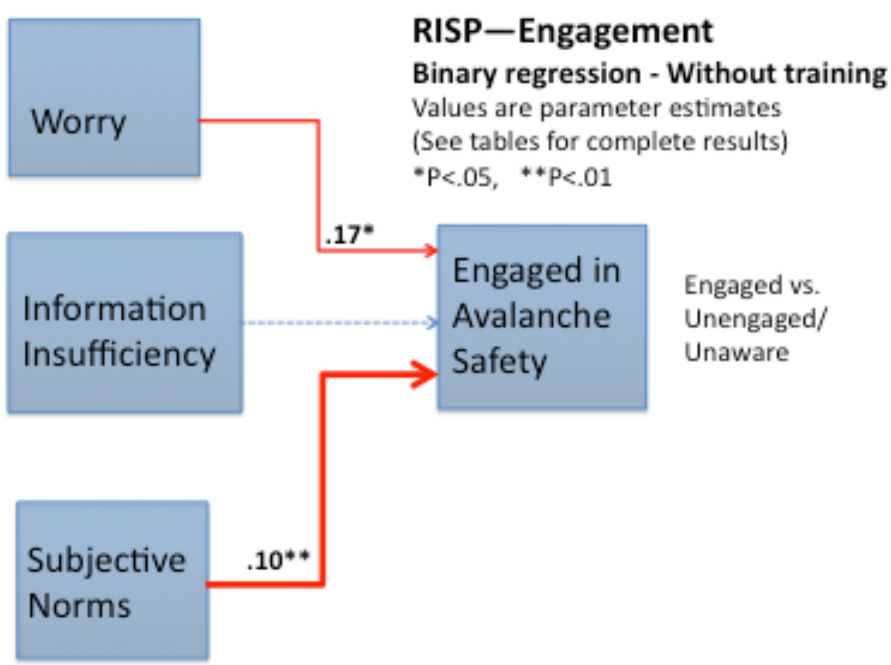


Figure 5.56. ***Binary logistic regression results for RISP—Engagement (Red paths indicate significant relationships while the estimates denote the strength of the relationship)***

5.6.2. RISP—Bulletin-use

The RISP—Bulletin-use model aimed to provide insights into the factors affecting information seeking in the context of bulletin use. In comparison to the RISP—Engagement model where formal avalanche training was used to define the two classes, formal avalanche training was included in this model as a binary covariate at the same level as individual characteristics and self-efficacy. After removing participants with missing data and those who had no bulletin available, 549 participants were included in this RISP analysis (Table 5.40), which investigated information-seeking in the context of checking the bulletin.

The same goodness-of-fit indices were used for the WLSMV estimator in the RISP—Bulletin-use analysis as well. The results indicate a slightly less desirable, but still acceptable fit: CFI = 0.94, RMSEA = 0.06, SRMR = 0.06. This could be due to the additional parameters used in this model. Figure 5.57 shows the associated path diagram for the present analysis and Table 5.40 lists the mean scores for the various model parameters.

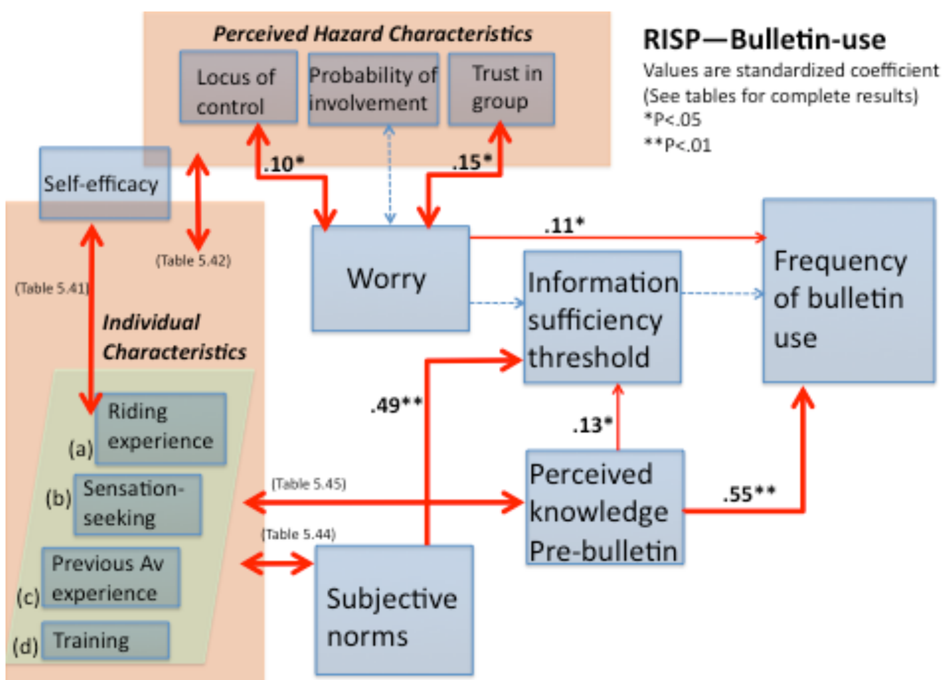


Figure 5.57. ***Path diagram of RISP—Bulletin-use use (Red paths indicate significant relationships while the standardized coefficients denote the strength of the relationship)***

Table 5.40. Mean scores and SD of items in RISP—Bulletin-use

Variable	Mean	SD
Individual characteristic		
Riding experience (1-7)	4.37	1.8
Sensation-seeking (1-7)	4.06	1.2
Previous avalanche involvement (0-1)	0.14	0.35
Self-efficacy - ability to: (0-100)		
Recognize situations in which you are likely to trigger an avalanche	67.1	19.22
Identify locations to safely watch other snowmobilers ride	78.27	17.93
Locate and rescue a partner who is completely buried by an avalanche	67.73	22.89
Formal Training (0-1):	0.43	0.49
Perceived hazard characteristics:		
Role of luck in avoiding avalanches (0-100) (Locus of control)	38.87	23.87
Probability of being caught in an avalanche (1-11)[26]	4.96	1.55
Trust in riding partners: Confidence in group's ability to		
Select appropriate terrain (0-100)	74.07	18.04
Locate and rescue a partner who is completely buried by an avalanche (0-100)	69.68	22.8
Affective response:		
Worry of being caught in an avalanche (0-100)	63.03	28.64
Informational subjective norms:		
Family members (-21 to 21)	14.4	5.97
Riding partners (-21 to 21)	13.87	6.66
Information insufficiency:		
(A) Information before checking the bulletin (0-100)	20.58	24.97
(B) Information sufficiency threshold (0-100)	76.5	15.57
(B) – (A) =Information insufficiency	17.78	24.26
Bulletin use:		
Checking prior to trip (1-5)	4.41	0.83
n = 549		

RQ1: Relationship of self-efficacy with the other individual characteristics

The analysis revealed a significant positive relationship between self-efficacy and sensation-seeking in support of H1a (Table 5.41), as well as a significant positive relationship between self-efficacy and riding experience in support of H1b, which is expected given the positive relationship between these variables for both groups in RISP—Engagement. Unlike the first model, a significant negative relationship between

[26] Probability of being caught in an avalanche code: 1 = less than 1 in 10,000 years; 2 = 1 in 10,000 yrs; 3 = 1 in 1,000 yrs; 4 = 1 in 100 yrs; 5 = 1 in 10 yrs; 6 = 1 in 5 yrs; 7 = 1 in 2 yrs; 8 = 1 in a year; 9 = 2 in a year; 10 = 5 in a year; 11 = more than 5 in a year

self-efficacy and previous hazard experience was found in support of H1c, which could be a attributed to the inclusion of training as a variable in this model. To no surprise, an extremely positive relationship was found between self-efficacy and training, which supports H1d.

Table 5.41. Individual characteristics and self-efficacy – RISP—Bulletin-use

Individual characteristics	Self-efficacy
Riding experience	**0.30****
Sensation-seeking	**0.16****
Previous hazard experience	**-0.11****
Formal training	**0.42****

(n = 549) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

RQ2: Relationship of perceived hazard characteristics with individual characteristics

Partial support for H2 was found with significant relationships between some but not all variables. A negative relationship was found between riding experience and trust in their riding partners (Table 5.42). This suggests that more experienced riders have less trust in their group. A positive relationship was found between riding experience and perceived probability of harm, meaning that participants with more years of experience view avalanche involvements as more likely. A positive relationship was also found between experience and the perceived role luck plays in avoiding avalanches.

Table 5.42. Individual characteristics and perceived hazard characteristics – RISP—Bulletin-use

	Perceived hazard characteristics		
Individual characteristics	Perceived probability of harm	Role of luck in avoiding avalanches (Locus of control)	Trust in riding partners
Riding experience	**0.12***	**0.16****	**-0.31****
Self-efficacy	**-0.13***	**-0.18****	**0.86****
Sensation-seeking	**0.33****	**0.16****	**-0.20****
Previous hazard experience	**-0.14****	-0.01	-0.03
Formal training	0.08	**-0.14****	**-0.14****

(n = 549) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

Sensation-seeking shared a positive relationship with perceived probability of harm, as well as with the role luck plays in avoiding avalanches (Table 5.42). Sensation-seeking also shared a negative relationship with trust in riding partners.

Self-efficacy had a negative relationship with the perceived role luck plays in avoiding avalanches, however unlike RISP—Engagement, self-efficacy also had a negative relationship with perceived probability of harm, which could be attributed to the inclusion of training in the model as well. Finally, self-efficacy had a positive relationship with trust in riding partners (Table 5.42).

Previous avalanche experience had a negative relationship with perceived probability of harm (Table 5.42). Formal training had a negative relationship with the perceived role luck plays in avoiding avalanches and trust in their riding partners. To no surprise, many of the relationships supporting H2 in this model were also found in RISP—Engagement for at least one of the groups, however the addition the training variable to the model lessened the influence of self-efficacy in several cases.

RQ3: Relationship of perceived hazard characteristics and avalanche safety self-efficacy to worry

Partial support of H3 was also found in the RISP—Bulletin-use model (Table 5.43). Both trust in riding partners and the perceived role luck plays in avoiding avalanches had positive relationships with worry.

Table 5.43. Perceived hazard characteristics, self-efficacy and worry – RISP—Bulletin-use

Perceived hazard characteristics	**Worry**
Perceived probability of harm	0.04
Role of luck in avoiding avalanches (Locus of control)	**0.10***
Trust in riding partners	**0.15***
Self-efficacy	-0.05

(n = 549) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

RQ4: Relationship of individual characteristics to informational subjective norms

Partial support for H4 and H5 was also found. Informational subjective norms positively related to self-efficacy and negatively related to sensation seeking and riding experience (Table 5.44). No relationships were found between informational subjective norms and previous hazard experience or formal training.

Table 5.44. Individual characteristics and subjective norms – RISP—Bulletin-use

Individual Characteristics	Informational subjective norms
Riding experience	**-0.26****
Self-efficacy	**0.65****
Sensation-seeking:	**-0.27****
Previous hazard experience	-0.01
Formal training	0.01

(n = 549) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

RQ5: Relationship of perceived current knowledge and individual characteristics

The knowledge participants reported having before they checked the bulletin had a highly significant positive relationship with their self-efficacy. It also had a highly significant negative relationship with training (Table 5.45). This finding reflects the value of training to accompany the bulletin, as those with training exhibit a higher awareness of how little they know about the conditions prior to using the bulletin. None of the other individual characteristics exhibited a significant relationship to knowledge prior to checking the bulletin.

Table 5.45. Individual characteristics and information prior to checking the bulletin – RISP—Bulletin-use

Individual Characteristics	Information prior to checking the bulletin
Riding experience	0.05
Self-efficacy	**0.55****
Sensation-seeking:	0.05
Previous hazard experience	0.03
Formal training	**-0.20****

(n = 549) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

RQ6: Relationships of information insufficiency (threshold) and worry, information subjective norms and perceived knowledge prior to checking bulletin

Consistent with the RISP—Engagement findings and prior applications of the RISP model, results of the RISP—Bulletin-use analysis support H6a and H6c (Table 5.47). These findings suggest higher information sufficiency threshold can be attributed to higher informational subjective norms and higher perceived knowledge prior to checking the bulletin. Similar to the results of the RISP—Engagement, informational subjective norms exhibited the strongest relationship with information sufficiency threshold. Unlike

RISP—Engagement, H6b was not confirmed, as higher levels of worry about avalanches did not have a significant relationship with information sufficiency threshold.

Table 5.46. Worry, information subjective norms and perceived knowledge prior to checking bulletin and information insufficiency threshold – RISP—Bulletin-use

	Information sufficiency threshold
Worry	0.07
Informational subjective norms	**0.49****
Perceived knowledge prior to checking bulletin	**0.12***

(n = 549) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

RQ7: Relationships of frequency of bulletin use with information insufficiency, information subjective norms and worry.

The last research question relates to the part of the model that connects frequency of bulletin use with information insufficiency, information subjective norms and worry. The analysis revealed that both worry and informational subjective norms had a significant relationship with frequency of bulletin use (Table 5.47) and much like RISP—Engagement, information insufficiency did not.

Table 5.47. Information sufficiency threshold and bulletin use – RISP—Bulletin-use

	Frequency of Bulletin Use
Worry	**0.11***
Informational subjective norms	**0.55****
Information insufficiency	-0.07

(n = 549) Significant standardized regression coefficients are in bold *p-value <0.05, **p-value <0.01

6. Discussion

The goal of this research was to provide a quantitative foundation of knowledge for facilitating the development and delivery of avalanche safety material tailored to the needs of snowmobilers. The discussion section addresses the aforementioned research objectives:

1. What are the general characteristics of mountain snowmobilers (e.g. demographics, snowmobile characteristics, experience, training, trip details, etc)?
2. What factors affects the avalanche risk perception and safety behaviour of snowmobilers?
3. What barriers prevent snowmobilers from taking formal avalanche training?
4. What barriers prevent snowmobilers from checking the avalanche bulletin?
5. How do snowmobilers adjust their terrain preferences in response to avalanche safety information?

6.1. General Characteristics of Mountain Snowmobiler

The typical snowmobiler who responded to the online survey presented in this report is male, 25 to 45 years old, and from Alberta or British Columbia. They are likely to be married and may have children. They completed high school and probably received some post secondary education, most likely a trades certificate or diploma and work a blue-collar job requiring specialized skills. Similar socio-demographic characteristics were exhibited by the snowmobilers surveyed in the ADFAR1 study (Longland et al., 2005). Snowmobile riding skill levels range from intermediate to advanced, most have at least three years of experience and ride upwards of 10 days per year. As expected, more experienced riders have a higher level of technical riding ability. Most of the participants of the present survey used a stock snowmobile with an 800-900 cubic centimetre engine and a track length of 153 to 162 inches, which is capable of entering avalanche terrain in deep snow conditions (ability permitting). The typical snowmobiler included in our survey has a roughly even chance of being avalanche trained or not. If he or she does not have formal avalanche training, they are aware about the possibility of avalanches and concerned about their safety. If they do have formal training, they most likely took an AST1 course. They use the traditional avalanche safety equipment (transceiver, probe and shovel) and may also use an avalanche balloon pack, but have probably never had to deploy it. Most participants like a fair amount of excitement and are keen on experiencing the backcountry. Their levels of sensation-seeking are very similar to the responses of out-of-bounds skiers presented in Haegeli et al. (2012), where experience-seeking and boredom susceptibility scored highest.

Typical snowmobiling groups consist of three to six riders with similar levels of riding experience and ability. Common exceptions include higher skilled riders taking in a less skilled rider (in terms of experience and ability). Avalanche training levels within groups are typically also similar, most riding partners carry a beacon, probe and shovel. Group members make decisions collectively and the riders most familiar with the area tend to lead the group.

Trips were planned weeks or days in advance, lasting for two to three days (unless they live in the mountains) and involved at least one day of travel. Avalanche bulletins are available and regularly checked from home and slightly less regularly on the road. Groups usually discuss avalanche conditions both before leaving home and again before leaving the staging area. Trip plans may be amended from home, as well as before leaving the staging area, though this is slightly less likely, particularly among snowmobilers without formal training. The typical snowmobiler enjoys a variety of terrain including more technical rides and hill climbs, but they are probably not sending big airs on a regular basis, and are probably not skiers either.

The typical snowmobiler included in our study thinks that they are just as likely to die in an avalanche as they are to get injured in a car accident and even more likely to get caught and buried. Most view luck to play at least a small role in avoiding avalanches.

They have an extremely positive view of the Avalanche Centre, avalanche courses, and the services the CAC provides. They are interested in taking a course, and are also interested in learning, especially about the mountains and weather. They are not reckless risk takers, but may become less cautious in terrain they are familiar with. They are extremely motivated to ride deep untracked powder.

Results from both RISP models indicate that snowmobilers with more years of riding experience are more confident in their personal ability to prevent avalanche accidents, which in turn leads to less worry. Bandura (1997) identified experience as one of the primary factors affecting self-efficacy, which is reflected in the findings of our study. Furthermore, while riding experience is also connected to group trust via self-efficacy, which share a strong positive relationship, there is also a direct pathway between riding experience and group trust that exhibits a negative relationship. The combination of these two pathways results in a weaker, but still positive overall relationship between riding experience and group trust.

Those with a higher desire for sensation-seeking view luck to play a larger role in avoiding avalanches. they also view getting caught in an avalanche as more likely, and have less trust in their riding partners' avalanche skills, which could make snowmobiling a more stimulating experience as it is perceived to be more dangerous. At the same time, sensation-seeking snowmobilers have higher levels of confidence in their ability to prevent avalanche accidents. This can be related to Llewellyn et al. (2008), who proposed that climbers with higher-levels of sensation seeking were more likely to take additional risks and attempt harder routes, which increases their climbing skills. While we also observe the relationship between sensation seeking and self-efficacy, there is a fundamental difference between the two activities. Climbing offers instant relevant feedback making it an easy learning environment to advance your skills. Furthermore, better climbing skills relate directly to improved personal safety. In snowmobiling, however, the more frequent riding of sensation-seeking snowmobilers will primarily result in improved riding skills and not necessarily avalanche safety skills as avalanches are relatively rare events and bad decisions to not necessarily lead to avalanche involvements. This makes snowmobiling and other backcountry activities a challenging and potentially misleading learning environment for avalanche safety skills.

6.2. Factors Affecting a Snowmobiler's Avalanche Safety Behaviour

6.2.1. Formal Training

The results of this study confirm that formal avalanche training is the most important factor affecting participants' avalanche safety behaviour. These findings are consistent with those of avalanche experts (CAC, 2012; Jamieson, Svederus, & Zacaruk, 2007; McClung & Schaerer, 2006), as well as past academic research (Gunn, 2010; Tase 2004).

Participants with training are more likely to carry beacons and probes as well as balloon packs. They are more likely to regularly check the avalanche bulletin and also more effective readers of the bulletin, by more frequently looking at the avalanche problem graphics and reading the additional information on weather and snowpack. Participants with training are also more likely to have changed or cancelled a trip from home, as well as at the staging area, due to avalanche concerns, which is a big step in reducing avalanche involvement.

Participants with training are also more confident in their ability to assess avalanche conditions than those without. They are more aware of avalanches, as they more frequently scan the landscape for signs of avalanches, test the stability of small slopes before moving into larger terrain, examine exposure, and take the time to combine their observations into a mental picture of the current avalanche conditions, all more frequently than those without training. Their levels of self-efficacy are higher and probably more realistic. Their susceptibility of falling for common heuristic traps is lower. They view avoiding avalanches more as a matter of skill and less as a matter of luck. Consistent with the findings of Griffin et al., (2004), past experiences with avalanche hazard has led them to believe that avalanches are more likely to occur again in the future. Furthermore, past avalanche experiences have led them to believe they are better able to perform preventative measures and emergency rescue if needed. These findings relate to those of Gunn (2010), in which high-risk out-of-bounds skiers were less likely to have had a previous avalanche experience.

Avalanche training teaches mountain snowmobilers the basic essentials of reading terrain, mountain weather, assessing snowpack, and using avalanche rescue equipment. These tools complement the common sense and mountain experience many riders already have. For these reasons, we can safely conclude that taking a formal avalanche course leads to higher levels of risk perception and avalanche safety.

6.2.2. Bulletin Checking

Regular bulletin users exhibited a higher level of avalanche awareness (as indicated through their PAPM statements). Much like the riders with formal training, regular bulletin users were more likely to carry beacons and probes as well as balloon packs. They were obviously more familiar with the bulletin and made for more effective bulletin readers. Regular bulletin users were also more likely to have changed or cancelled a trip from home as well as at the staging area due to avalanche concerns.

Regular bulletin users were more confident in their ability to ask the right questions regarding avalanche conditions, making them more effective at gathering information on current conditions. They were also more confident in their ability to create a mental picture of the current conditions.

Reading the avalanche bulletin gives mountain snowmobilers high quality information on the snowpack, current conditions and future conditions as forecasted by avalanche professionals. This gives bulletin users an idea of what avalanche problems currently exist and what terrain should be avoided given the current conditions. Avalanche bulletins provide the informed reader with useful information, leading to higher levels of awareness and better informed judgements.

6.2.3. Avalanche Safety Equipment Usage

The use of traditional avalanche safety equipment (beacon, probe and shovel) was high in both the intercept and the online surveys. However, 5% of the online survey participants and 10% of the intercept participants reported to only carry a shovel without an avalanche transceiver and probe. All three pieces of equipment are needed. The use of avalanche balloon systems was high as well, 42% of online participants reported using a balloon system and 35% of intercept participants used a balloon system on the day of the survey. Participants who reported using a balloon backpack were confident their balloon pack would prevent them from being buried once caught in an avalanche.

Their confidence in the ability of balloon packs to keep them afloat through an avalanche was considerably higher than their confidence into their personal skills to avoid avalanches and in the same range as their confidence in their partners rescuing them. These comparisons highlight that there is considerable potential for snowmobilers to view avalanche balloon packs offer a convenient technical solution for preventing injury or death from avalanche burials. Since avalanche balloon packs do not prevent burial under all circumstances (Haegeli *et al.*, under review), the observed general trust in avalanche balloon packs should be a serious concern for avalanche educators. At the same time, the present study did not find any evidence of potential risk compensation behaviour among users of avalanche balloon packs. An investigation into differences between users and non-users (not shown in results section) did not reveal any significant differences in risk perception or avalanche involvement in this study, nor were avalanche balloon pack users more likely to be riding under considerable, high or extreme avalanche danger on the day the intercept.

Being involved in an avalanche at any level is a powerful experience. Participants who have been caught or witnessed someone else caught, recognize the potential for future avalanches more than those without such experiences, as they viewed being caught, buried, injured, and damaging their snowmobile in an avalanche all as more likely. Consistent with Tase (2004), higher levels of training were also found in those with avalanche experience, however this does not suggest causation. To examine this question in more detail, future studies should include questions to investigate whether participants' avalanche involvements occurred before or after taking a formal avalanche course. In both RISP models previous avalanche experience seemingly made for a more perceptive and cautious snowmobiler.

6.2.4. Other Factors

The participants who viewed luck to be a factor in avoiding avalanches were more worried about avalanches in general. Participants with more years of riding experience perceived avalanches to be more likely, as did those with higher levels of sensation seeking.

6.3. Barriers to Taking an Avalanche Course

The time involved with taking a course is one the main barriers to becoming trained. Participants who had not taken a course reported that their free weekends were limited and making time was tough. The costs involved with taking a course were also an issue for those who had not taken one, especially for younger snowmobilers. Participants without formal avalanche training also rated the expectations from family members and riding partners for taking a formal avalanche course and their motivation to comply with this expectation (informational subjective norms) lower than participants with formal training.

Results from the binary logistic regression indicate a positive relationship exists between informational subjective norms and being engaged in avalanche safety (Step 4 on the PAPM scale: *"I sometimes worry about being caught in an avalanche. I would like to learn more about avalanche safety, but have not taken a formal course with a field component (e.g., AST1 or more advanced) yet."*). This result supports the recommendations of McCammon (2009), who suggests that appealing to peer expectations and cultural norms can help facilitate the transition to becoming engaged. Such cognitive strategies target one's subjective norms, which makes sense given the finding of this research. In addition, the binary logistic regression indicates a positive relationship exists between worry and being engaged in avalanche safety. McCammon (2009) also mentions strategies such as vulnerability signage and fear appeal to facilitate the transition to becoming engaged in the precautionary process, which appeal to attitudes and emotions. McCammon's suggested remedies reflect the relationships found between these variables in both RISP models. Furthermore, these findings support the inclusion of informational subjective norms and affective response as direct behaviour antecedents to information seeking in this study, as well as in future studies as suggested by Kahlor (2007) and Griffin et al. (2008).

Somewhat surprisingly, information insufficiency did not share a relationship with engaging in precautionary behaviour. It is possible that perceived knowledge needed to effectively manage avalanche risk is specialized knowledge that is gained from taking a course, where those without training may not fully recognize their shortcomings. The difference in what trained participants knew prior to taking a course and their perceived level of required knowledge at the time of the survey reflects this potential.

Results from both RISP models offer further insight on the antecedents of subjective norms and worry. The negative relationship between years of riding experience and perceived pressure to stay informed and get trained suggests two possibilities. One is that they never had enough pressure from their riding partners or family to get training in the first place. Another possibility is that they believe that their many years of experience has taught them everything they need to know about mountain travel and avalanche safety and an avalanche safety course would not actually benefit them. This can affect the snowmobiler's interest in taking a formal avalanche course in two different ways. First, their higher levels of self-efficacy would lead to lower levels of worry. Furthermore, their high level of self-efficacy might also make them confident that they have already satisfied the existing expectations of friends and family. Second, their families and friends might also perceive the snowmobiler to be highly experienced and therefore does not further require formal avalanche training. As a consequence, they might not offer extra encouragement for becoming avalanche trained.

The indirect relationship between self-efficacy and adoption of precautionary behaviour supports the findings of de Vries, Dijkstra, & Kuhlman (1988) in which self-efficacy was identified as a direct antecedent to behavioural intent, in addition to subjective norms and affective response. From this, control beliefs in the form of self-efficacy were added to a revised version of the Theory of Reasoned Action (Ajzen & Fishbein, 1980; Ajzen & Fishbein, 1975) which came to be called the Theory of Planned Behaviour (Ajzen, 1991; Ajzen & Fishbein, 1980). Self-efficacy should continue to be investigated at some capacity in future RISP type models as it was found to have direct and indirect relationships with many the model’s other components.

6.4. Barriers to Checking the Bulletin

The absence of available bulletins in some locations is undoubtedly a barrier for snowmobilers wanting to check those bulletins; however, only a very limited percentage of snowmobilers who participated in this survey had such problems. In most cases when a bulletin was available, avalanche training made for a more frequent and effective bulletin reader as they checked the danger ratings, studied the graphics and avalanche problems, and read the additional information more frequently. Internet literacy affected only few bulletin users, participants who did not regularly check the bulletin were less comfortable navigating the Internet. Because we used an online survey for this study, our sample was likely biased towards participants with considerable internet experience. It is therefore reasonable to assume there might be many more people outside of this study who find the internet challenging. Internet literacy issues are important to acknowledge as this is where avalanche bulletins are primarily retrieved.

Similar to those without training, irregular bulletin checkers received less support from family members and riding partners to stay informed about avalanche conditions. Unlike those without training, their motivation to comply with the beliefs of family members was significantly less important, as was the importance of receiving approval from riding partners.

Results from RISP—Bulletin-use offer additional useful insight on the antecedents of bulletin usage. Subjective norms and current knowledge both shared a relationship with information insufficiency, however information insufficiency did not have a postive relationship with bulletin-use. The strongest relationship in the model was between subjective norms and frequency of bulletin-use directly, followed that of worry and bulletin-use. The direct relationship that worry and subjective norms have with bulletin use is similar to the findings of Kahlor (2007) and consistent with the finding of RISP—Engagement, therefore risk communicators should target these dimensions in future safety messages. The addition of training as a variable in RISP—Bulletin-use lessened or reversed several of the relationships self-efficacy had with perceived hazard characteristics, which makes sense given that training is a more realistic and objective measurement of efficacy than one's own perception. The addition of training as a variable in the model also has an interesting effect on participants' perceived knowledge before checking the bulletin. Participants with training feel like they actually know less prior to checking the bulletin than those without. In order words, the untrained do not fully realize their shortcomings. This is a potential barrier because if participants underestimate their level of information insufficiency they might be less likely to pursue further information seeking.

6.5. Factors that Affect How Snowmobilers Adjust Terrain Choice

The DCE results from this study presented in Haegeli et al. (2012) offers useful insight on how snowmobilers adjust their terrain preferences in response to avalanche safety information:

a. Similar to the findings of Gunn (2010) and Björk (2007), the avalanche danger ratings were interpreted on a linear scale, when in fact it is an exponential scale. This misconception could lead snowmobilers to underestimate the magnitude of a given risk and fail to adjust their terrain choices accordingly.

b. Participants were less responsive to persistent avalanche problems in the snowpack. Since the persistence of avalanche problems is a more advanced avalanche safety concept, it is possible that many snowmobilers are not familiar and therefore do not incorporate it into their decision making.

c. As the danger rating increases, participants first move towards higher traffic areas before retreating to safer terrain. This weakness in decision-making has the potential to result in accidents involving larger numbers of victims.

d. Instability observations are interpreted more significantly than the other warning signs of avalanche hazard.

e. Under moderate and considerable avalanche danger, the additional impact of observed warning signs decreases as the number of warning signs increases.

Both (d) and (e) differ from the decision-making approach promoted by the Avaluator 2.0, which places equal weight on all warning signs. Because of the considerable percentage of survey participants with training, the observed weaknesses are of concern and could suggest that snowmobilers with training are not entirely emergent in the precautionary process or that other deficiencies exist within the entire population.

A detailed discussion of DCE is presented in Haegeli et al. (2012), See Appendix G.

Heuristics traps (McCammon, 2002) are another aspect that has the potential to affect terrain choices. To assess their impact among our survey participants, we included a scenario for each of the five traps in our survey and asked participants how well these scenarios match with their personal snowmobiling behaviour. Participants reported to be most susceptible of becoming less cautious in familiar terrain and needing to go further due to the scarcity of fresh powder. While these heuristic traps do not directly relate to how snowmobilers adjust their terrain choices given avalanche hazard information, they are certainly active in the interplay.

6.6. Limitations and Shortcomings

While direct observations of riding behaviour, terrain preferences and group dynamics in the backcountry would be best for studying the behaviour of snowmobilers, such an approach is unrealistic for a multitude of reasons. It is difficult to get a truly accurate account of backcountry decision-making through a survey due to the complex and variable nature of mountain snowmobiling in which the physical and emotional environments of mountain snowmobiling are difficult to capture in an online survey.

The possibility of response bias must be taken into account when interpreting the results of the present study. Neither the intercept nor the online survey sample can be considered as representative samples of the mountain snowmobile community. Due to the recruitment strategies (e.g., use of snowmobile clubs and avalanche course providers for the promotion of the online survey) used for this study and the voluntary nature of the surveys, the convenience samples are likely biased towards individuals more committed to snowmobiling and with an existing interest in avalanche safety. While our analysis showed that online survey participants were more committed to snowmobiling and avalanche safety than the participants of the intercept survey, it is reasonable to assume that a similar response bias exists between respondents to the intercept survey and the general mountain snowmobile community. Furthermore, it is also reasonable to believe that online survey participants would be regular Internet users who are comfortable enough navigating the internet to check the online avalanche bulletin. Last it is possible that the observed homogeneity of riding partners might not transfer to group types missed by this study. As a consequence, results from avalanche safety surveys should always be examined critically and extra caution should be applied when relating the results to the general mountain snowmobile community. Future studies on snowmobilers may want to experiment with different recruiting techniques prior to launching any survey. Qualitative interviews with key members of the mountain snowmobile community might offer more valuable insights to the attitudes and motivations of the hard to reach segments of the overall population.

This study found that training and past avalanche involvement experience(s) were positively related, and past studies have found the same (Tase, 2004; McCammon 2000). A direct question concerning reasons for getting avalanche training or the timing of their avalanche involvements relative to their formal training could have countered the potentially misleading interpretation that taking an avalanche course causes avalanche involvement. It could also lead to more insight about the learning effect of personal incidents.

Alcohol questions should have been included in the survey. In a review of avalanche deaths, toxicology reports showed 20% of the snowmobilers had alcohol in their system at the time of death (Boyd et al., 2009). Alcohol is a variable that is commonly associated with risky behaviour (Leigh, 1999).

6.7. Recommendations and Conclusion

This study revealed several potential weaknesses in avalanche awareness of snowmobilers and the results offer useful insights for risk communicators and the avalanche community as a whole. Based on the results of this research, we have the following recommendations for further improving avalanche safety among snowmobilers:

1. *Continue to raise levels of training in the snowmobile community*

Snowmobilers with training performed better than those without training in most regards. They exhibited a smaller margin of information insufficiency and higher levels of self-efficacy to perform preventative measures. They utilized the available information more regularly (avalanche bulletins) and the available tools more effectively (avalanche safety equipment). Most importantly, they were more likely to amend plans due to avalanche danger. Increasing the level of formal training among all snowmobilers is in the best interest of the avalanche community. The percentage of snowmobilers with training in the general population of snowmobilers is likely to be much lower than was found in the present survey. The cognitive techniques outlined in McCammon (2009) offer ideas on how to target specific stages of the precautionary adoption process. Risk communication appealing to information insufficiency alone is unlikely to be as effective for those without training, because they do not fully realize the knowledge they lack. Communication efforts that focus on subjective norms and worry may be more useful, as well as those that focus on targeting their antecedents such as the perceived role luck plays in avoiding avalanches, trust in one's group and past experiences. These insights offers risk communicators a place to start for developing future avalanche skills and training campaigns.

Recommendation: Continue the "Sledder on Staff" position at the CAC, as well as the bursary program for snowmobilers interested in becoming CAA professionals.

Recommendation: Consult with BCSF and ABCBC snowmobile clubs to determine if it is feasible to offer a discount on trail fees for snowmobilers with training, because riders without training are less able to perform rescues and prevent avalanche involvement, they ultimately costs the community more as a whole. A sticker or license indicating completion of an AST course could be displayed on the snowmobile to signal they have taken a course.

Recommendation: Consult course providers to determine if more flexible course schedules are possible. This may help reach snowmobilers who do not take a course because they feel constrained by time.

2. *Continue to promote bulletin-use and expand the bulletin to cover new popular areas when needed*

The results of the present survey clearly show that danger ratings are the part of the bulletin most frequently used by snowmobilers. Formal avalanche training seems to play a critical role in expanding bulletin use for snowmobilers as the present results show that snowmobilers with formal avalanche training were more effective bulletin readers. Similar to the results for RISP—Engagement, communication strategies that appeal to information insufficiency are likely to be less effective in promoting bulletin-use, even though most participants seem to have a better awareness of the knowledge they lack prior to checking and the knowledge they gain from consulting the bulletin. Communication efforts that focus on subjective norms, worry and their antecedents might be more useful than strategies that rely on information insufficiency.

Recommendation: Emphasize the importance of the additional pieces of the bulletin as well as the danger rating.

Recommendation: Increase the utility of the online bulletin by incorporating additional functionality such as real-time weather or webcams of popular staging areas.

Recommendation: Develop an online class that teaches and tests bulletin reading skills, similar to the CAC's general online avalanche class and terrain choice exercises.

3. *Continue to promote research on the human dimension of avalanche safety*

Monitor levels of training and preparedness within the snowmobile community. Develop indicators to measure avalanche safety progress within the snowmobile community, as well as indicators to assess the effectiveness of the current products and services. Maintain a dialogue with the snowmobile community to stay informed on current riding preferences, behaviours and concerns.

Recommendation: Continue to observe the effect that balloon packs have on backcountry behaviour.

While the trend in snowmobile avalanche fatalities has declined since the beginning of this study, it is important to not lose sight of any potential weaknesses still present within the snowmobile community. Ensuring that future crisis situation are avoided should remain a top priority.

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Appendices

Appendix A – Avalanche Accidents 1997 to 2011

Avalanche accident database results

From 1997 to 2011, 196 people died in avalanches while recreating in Canada and 38%. (74 of 196) of these fatalities were snowmobile riders. The following section provides a brief overview of the characteristics of the snowmobile accidents and victims, as well as a comparison of snowmobile accidents versus accidents involving all other winter recreationists.

Victim characteristics

Ninety-nine percent (73 of 74) of snowmobile avalanche victims in Canada were male[27]. Snowmobile avalanche victims were significantly more likely to be male than other winter recreationists (Table A-1.1).

Table A-1.1. Avalanche victims - gender comparison.

	All Other	Snowmobiler %	n	P Value	Test
Gender	n = 110	n = 74	196	0.003	Chi Square
Male	94 (85%)	73 (99%)			
Female	16 (15%)	1 (1%)			

The mean age of snowmobile avalanche victims was 35 (n = 68, SD=9.39). There was no significant difference in the age of the victims between activities.

Eighty-nine percent (72 of 74) of snowmobile avalanche victims were Canadian, 3% (2 of 74) were American, and 8% (6 of 74) were from outside of North America. Fifty-three percent (39 of 74) were from Alberta, and 40% (30 of 74) were from British Columbia. Snowmobile avalanche victims were more likely to be Canadian than the other victims, and more likely to be from Alberta or British Columbia, (Table A-1.2).

[27] The only female who has ever died in an avalanche was riding double with her partner when they drove off of a cornice. This caused the cornice to fail and also released a large slab that buried her and her partner, her partner managed to escape.

Table A-1.2. Avalanche victims – national and provincial comparison.

	All Other	Snowmobiler	n	P Value	Test
Country	n = 122	n = 74	196	<0.001	Chi Square
Canada	64 (52%)	72 (97%)			
US	24 (20%)	2 (3%)			
Other	34 (28%)	0%			
Province/State	N = 122	N = 74	196	<0.001	Chi Square
AB	24 (20%)	39 (53%)			
BC	32 (25%)	30 (40%)			
Other/NA	64 (52%)	5 (7%)	69		
SK	2 (2%)	0 (0%)	2		

Snowmobile victims had a mean group size of six partners (7 of 65, SD=3.26). There was no difference in the victim's size of the group between activities.

Accident characteristics

Of the fatal avalanche accidents that occurred in Southwestern Canada, 96% percent (71 of 74) of snowmobile accidents occurred in British Columbia and the other 4% occurred in Alberta. Fatal snowmobile avalanche accidents were significantly more likely to occur in British Columbia (Table A-1.3).

Table A-1.3. Fatal avalanche accidents – provincial comparison

	All Other	Snowmobiler	N =	P Value	Test
Province/State	N = 122	N = 74	196	<0.001	Chi Square
AB	29 (24%)	3 (4%)			
BC	93 (76%)	71 (96%)			

Fifteen percent (9 of 61) of fatal snowmobile avalanche accidents occurred under moderate avalanche danger, 44% (27 of 61) occurred under considerable avalanche danger, and 41% (25 of 61) occurred under high avalanche danger[28]. Snowmobiler victims were significantly more likely to be involved in an avalanche under high or moderate avalanche conditions, whereas other winter recreationist were typically invovled under considerable conditions (Table A-1.4).

[28] Avalanche bulletins were either unavailable or unreported for the other 13 incidents.

Table A-1.4. Fatal avalanche accidents and avalanche bulletin danger rating

	All Other	Snowmobiler	N =	P Value	Test
CAC Bulletin	N = 83	N = 61	144	0.007	Chi Square
Moderate	5 (6%)	9 (15%)			
Considerable	58 (70%)	27 (44%)			
High	20 (24%)	25 (41%)			

Snowmobile avalanche accidents had a median avalanche size of 3 according to the Canadian avalanche size classification[29] (CAA, 2007), (29 of 69, IQR: 2.5, 3), they occurred at a mean elevation of 2,087 m (n = 44, SD=287.59) and buried the victim at a mean depth of 204 cm (n = 49, SD=115.77). There was no difference in the size of avalanche between victims. However, the avalanches affecting snowmobilers released at significantly lower elevations and buried them significantly deeper (Table A-1.5).

Table A-1.5 Fatal avalanche accidents, elevation of release and burial depth

	All Other	*Snowmobiler*	*N =*	*P Value*	*Test*
Elevation (m)	N = 80	N = 44	124	<0.001	Wilcoxon
Mean	2,320	2,087			
SD	320	288			
Burial Depth (cm)	N = 51	N = 40	196	0.013	Wilcoxon
Mean	160	204			
SD	98	116			

Information regarding the use of avalanche safety equipment (beacon, probe, shovel) and the presence of training within the group was limited and high amounts of missing data did not allow for a meaningful comparison.

The interested reader will find individual accounts of all avalanche accidents in Canada from 1996 to 2007 in 'Avalanche Accidents in Canada, Volume 5' (Jamieson et al., 2010).

[29] Could bury/destroy a car, damage a truck, destroy a timber frame house, break trees. (CAA, presentation)

Appendix B – Intercept Survey Questionnaire

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Version 111228

MOUNTAIN SNOWMOBILING INTERCEPT SURVEY 2011/12

Permission for this study has been obtained from the Office of Research Ethics at Simon Fraser University. Any concerns or complaints about this study (2011s0679) can be directed to Dr. Hal Weinberg, Director of the Office of Research Ethics at: hal_weinberg@sfu.ca or 778 782 6593. The information collected in this survey will be treated confidentially. Your participation is voluntary and you are free to skip any questions or terminate the survey at any time. Research results can be obtained from Dr. Pascal Haegeli at pascal_haegeli@sfu.ca.

Today's Date: Month / Day / Year

1. Your age and gender ____ years O Male O Female
2. Your current residence City/Town: ____ Prov./State: ____ Country: ____
3. How many years have you been snowmobiling in the mountains? O First O 1-2 O 3-5 O 6-9 O 10+ years
4. On average, how many days do you snowmobile in the mountains each winter? O 1-4 O 5-15 O 16-30 O 31-60 O 61+ days
5. Are you a member of a snowmobile club? O Yes O No ⇨ Club name: ____
6. When did you decide to take this trip to the [redacted] area? O Today O Yesterday O Days ago O Weeks ago O Months ago
7. How many days are you staying in [redacted] on this trip? O 1 O 2-3 O 4-7 O 7+ days O I live here
8. When did you decide to ride at [redacted] today? O Today O Yesterday O Days ago O Weeks ago O Months ago
9. What type of snowmobile were you riding today?

Manufacturer:	Track length:	Engine size:	Engine type:	Fuel type:	Turbo:	Other engine modifications:
O Arctic Cat	O 142" or less	O 500 cc or less	O 2-stroke	O Pump fuel	O Yes	O stock
O BRP/Ski-doo	O 143-152"	O 600-700 cc	O 4-stroke	O Race fuel	O No	O modified (not including 'bolt on' modifications)
O Polaris	O 153-162"	O 800-900 cc				
O Yamaha	O 163+"	O 1000+ cc				

10. Did you ski or snowboard today and the use of the snowmobile was primarily for access? O Yes O No
11. In what type of terrain were you riding your snowmobile today? (check all that apply) ☐ Trails ☐ Meadows ☐ Open trees ☐ Tight trees ☐ Rolling terrain ☐ Big hills ☐ Steep chutes ☐ Big drops
12. Please rate your riding ability as a mountain snowmobiler? O Novice O Intermediate O Advanced O Expert
13. Please rate your confidence in your ability...

	Cannot do at all					Moderately can do					Highly certain can do
... to recognize situations in which you are likely to trigger an avalanche? (circle one number)	0	10	20	30	40	50	60	70	80	90	100
... to locate and rescue a partner who is completely buried by an avalanche? (circle one number)	0	10	20	30	40	50	60	70	80	90	100
... to talk your partners out of riding a slope that you personally think is dangerous? (circle one number)	0	10	20	30	40	50	60	70	80	90	100

14. Which of the following statements best describes how you think about avalanches? (check only one)
   - O 1) I generally do not think about avalanches where I ride.
   - O 2) I know that avalanches can happen in some of the places I ride, but avalanche hazard generally does not affect the choices I make.
   - O 3) My personal experience in mountain snowmobiling has provided me with all the skills I need for managing avalanche hazard where I ride.
   - O 4) I sometimes worry about being caught in an avalanche. I would like to learn more about avalanche safety, but have not taken a formal course with a field component (e.g.,AST1 or more advanced) yet.
   - O 5) I have taken a formal avalanche course with a field component, but I haven't really applied what I learned.
   - O 6) I have taken a formal avalanche course with a field component and I am practicing my skills whenever I can.
   - O 7) I have taken a formal avalanche course and have several seasons of experience applying these skills when riding. Avalanche risk mitigation has become an integral part of my riding practice.
15. Did you check the relevant CAC avalanche bulletin before riding today? O Yes O No
   ↳ Do you remember the current local danger ratings? Alpine: ____ Treeline: ____ Below treeline: ____
16. What avalanche safety equipment did you have with you today? (check all that apply)
   ☐ Avalanche transceiver (beacon) ☐ Shovel ☐ Collapsible probe ☐ Balloon pack ☐ AvaLung ☐ SPOT ☐ Sat phone
17. Have you ever been caught in an avalanche or witnessed somebody in your party being caught? O Yes O No
18. We are currently developing an online survey that examines mountain snowmobiling and avalanche safety in more detail and we would very much appreciate your participation. Please provide us with your email address and we will send you a message when the survey is ready. Participants who complete the online survey will be entered into a prize draw for one of five **two-night stays at a BC snowmobile destination**. We will only use your email address to inform you when the survey is ready.

Email: ____

PLEASE PRINT CLEARLY!

Appendix C – Intercept Collection by Location

Intercept Collections

The following sections presents the background information that was recorded during the days when intercept surveys were collected.

Revelstoke: Frisby Ridge

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
1/7/12	3:45	Overcast	Flurries	+5° to -5°	0-10cm	Con	Con	Mod	45
1/18/12	NULL	Partly Cloudy	None	-15° to -25°	None	Con	Con	Mod	12
2/4/12	3:30	Sunny	None	+5° to -5°	None	Con	Con	Mod	22
2/18/12	4:00	Overcast	Light snowfall	+5° to -5°	0-10cm	Con	Mod	Mod	26
3/3/12	NULL	Overcast	Heavy snowfall	+5° to -5°	50-100cm	High	High	Con	8
3/17/12	3:30	Partly Cloudy	Flurries	+5° to -5°	0-10cm	High	High	Con	17
4/9/12	NULL	Sunny	None	+5°	None	Con	Mod	Mod	2

Revelstoke: Boulder Mountain

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
1/14/12	4:00	Overcast	Heavy snowfall	+5° to -5°	25-50cm	Con	Mod	Low	40
1/28/12	3:30	Partly Cloudy	Heavy snowfall	+5° to -5°	0-10cm	High	Con	Con	33
2/11/12	3:30	Overcast	None	+5° to -5°	None	Mod	Low	Low	22
2/25/12	3:45	Overcast	None	+5° to -5°	10-25cm	High	High	High	39
3/10/12	3:30	Overcast	Rain	+5°	10-25cm	High	Con	Con	15
3/24/12	3:30	Sunny	None	+5°	None	Con	Con	Con	47
4/7/12	NULL	Partly Cloudy	None	+5°	None	Con	Con	Mod	31

Sicamous: Owl's Head

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
2/10/12	6:00	Partly Cloudy	None	+5° to -5°	None	Mod	Low	Low	6
2/26/12	6:00	Overcast	Heavy snowfall	-5° to -15°	25-50cm	Con	Con	Con	5
3/10/12	6:00	Overcast	Flurries	-5° to -15°	10-25cm	High	High	Con	14

Sicamous: Eagle Pass

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
12/27/11	NULL	NULL	NULL	NULL	NULL	Con	Mod	Mod	11
12/28/11	NULL	NULL	NULL	NULL	NULL	High	High	Con	9
12/29/11	NULL	NULL	NULL	NULL	NULL	High	High	Con	3
1/23/12	NULL	NULL	NULL	NULL	NULL	High	Con	Con	7

Sicamous: Blue Lake

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
1/12/12	NULL	NULL	NULL	NULL	NULL	High	High	Con	4
2/9/12	5:00	Partly Cloudy	None	-5° to -15°	0-10cm	Mod	Low	Low	6

Golden: Gorman Lake

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
12/31/11	4:00	Overcast	Light snowfall	-5° to -15°	10-25cm	High	Con	Con	8
1/8/12	4:00	Overcast	None	+5° to -5°	0-10cm	Con	Con	Mod	10
2/4/12	3:00	Sunny	None	+5° to -5°	None	Con	Con	Mod	21
2/18/12	2:30	Partly Cloudy	None	+5° to -5°	0-10cm	Con	Mod	Mod	9
3/3/12	3:30	Overcast	Light snowfall	+5° to -5°	0-10cm	High	High	Con	9

Golden: Quartz Creek

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
12/30/11	4:00	Overcast	Flurries	+5° to -5°	10-25cm	High	High	Con	28
1/29/12	3:30	Overcast	Light snowfall	+5° to -5°	10-25cm	High	High	Con	32
2/12/12	2:30	Overcast	None	+5° to -5°	None	Mod	Low	Low	7
2/25/12	3:30	Partly Cloudy	Flurries	+5° to -5°	10-25cm	High	High	Con	17
3/10/12	3:30	Overcast	Light snowfall	+5° to -5°	10-25cm	High	High	Con	10
3/24/12	2:00	Sunny	None	+5°	None	High	Con	Con	2

Valemount: Clemina Creek

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
12/31/11	3:00	Partly Cloudy	None	-5° to -15°	None	High	Con	Con	21
1/14/12	4:30	Partly Cloudy	Light snowfall	-5° to -15°	0-10cm	Con	Mod	Low	34
1/28/12	3:40	Overcast	Light snowfall	-5° to -15°	0-10cm	High	Con	Con	22
2/18/12	4:30	Partly Cloudy	Flurries	-5° to -15°	0-10cm	Con	Mod	Mod	32
3/3/12	5:00	Overcast	Light snowfall	+5° to -5°	10-25cm	High	High	Con	20
3/17/12	NULL	Partly Cloudy	Light snowfall	+5° to -5°	10-25cm	High	Con	Con	17
3/31/12	NULL	Partly Cloudy	Flurries	+5° to -5°	10-25cm	Con	Con	Mod	16
4/7/12	4:00	Partly Cloudy	None	+5° to -5°	None	Con	Con	Con	7

Valemount: Allan Creek

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
12/31/11	4:00	Sunny	None	-5° to -15°	NULL	Con	Con	Con	40
1/7/12	4:00	Overcast	Flurries	-5° to -15°	0-10cm	Con	Con	Mod	28
2/11/12	4:30	Partly Cloudy	NULL	+5° to -5°	None	Mod	Low	Low	40
2/12/12	4:00	Sunny	None	+5° to -5°	0-10cm	Con	Mod	Mod	8
2/25/12	5:00	Partly Cloudy	Flurries	-5° to -15°	10-25cm	High	High	Con	28
3/11/12	4:00	Overcast	Flurries	+5° to -5°	0-10cm	High	High	Con	13
3/24/12	5:00	Sunny	None	+5° to -5°	None	Con	Con	Con	9
4/7/12	5:00	Partly Cloudy	Flurries	+5° to -5°	0-10cm	Con	Mod	Mod	8

Fernie: Coal Creek

Date	Time Spent	Sky	Precip	Temp	24-hour snow	Bulletin Alpine	Bulletin Treeline	Bulletin below Treeline	Count
1/8/12	4:45	Overcast	None	+5° to -5°	0-10cm	Mod	Mod	Low	14
2/11/12	4:00	Overcast	None	+5° to -5°	None	Mod	Low	Low	14
3/3/12	3:30	Overcast	Rain	+5° to -5°	0-10cm	High	High	Con	36
3/17/12	3:30	Overcast	Light snowfall	-5° to -15°	10-25cm	High	High	High	19
3/24/12	5:30	Overcast	None	+5° to -5°	0-10cm	Con	Con	Con	19
4/7/12	4:30	Partly Cloudy	Flurries	+5° to -5°	0-10cm	Con	Mod	Low	4

Appendix D – Online Survey Pages

1% Complete

Thank you very much for your interest in our study!

This survey will take approximately **30 minutes** to complete and consists of the following five sections.

1. You and your riding partners
2. Your typical snowmobile trips
3. Interactive **Going-for-a-Ride Exercise**
4. Your perspective on avalanche awareness initiatives
5. Personal background

Your personal survey username is: **TestA**.
Please write this down for your future reference.

If you get interrupted, you can use your username to log back into the survey at a later time and continue where you left off.

- **Please provide us with your contact information so we can enter your name in the prize draw at the end of the survey.**
  Click here for more information about the prize draw.

Prize Draw

Email:

- **How did you hear about our survey?**
  Please select one of the following options.

○ Snowmobile club or association
○ A flyer or post card
○ SnowandMud.com
○ SnoWest.com
○ Zac's Tracs online community
○ Other online forums
○ My avalanche course instructor
○ Manufacturer/dealership of my snowmobile
○ Team Thunderstruck
○ From SledNecks.com
○ Other snowmobile movie company (e.g., Krazy Canadian)
○ From a friend
○ Other

Please do not use the Back and Forward buttons on your browser when completing the survey.

Next >>

5% Complete

Your Mountain Snowmobile

If you own multiple snowmobiles, please answer these questions for **the snowmobile you ride most often** in the mountains.

- **What brand is your snowmobile?**
  Please select one of the following options.

  ○ Arctic Cat
  ○ BRP / Ski-doo
  ○ Polaris
  ○ Yamaha
  ○ Snow Hawk
  ○ Other

- **What are the specifications of your snowmobile?**
  Please select the appropriate option in each column.

Track length	Engine size	Engine type	Turbo	Other engine modifications*
○ 142" or less	○ 500 cc or less	○ 2-stroke	○ Yes	○ Yes
○ 143" to 152"	○ 600 to 700 cc	○ 4-stroke	○ No	○ No
○ 153" to 162"	○ 800 to 900 cc			*not including 'bolt on' modifications
○ 163" or more	○ 1000 cc or more			

- **Do you ever use race fuel for your snowmobile?**
  Please select one of the following options.

  ○ Yes
  ○ No

- **Do you bring your snowmobile to the shop for most non-warranty service work?**
  Please select one of the following options.

  ○ Yes, I bring my snowmobile to the shop.
  ○ No, I perform non-warranty service work myself.

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9% Complete

Your Mountain Snomobiling Experience

- **How much experience do you have in mountain snowmobiling?**
  Please select the appropriate option in each column.

Number of winters	Average number of days per winter
○ This was my first winter	○ 1-4 days per winter
○ 1-2 winters	○ 5-9 days per winter
○ 3-5 winters	○ 10-15 days per winter
○ 6-9 winters	○ 16-20 days per winter
○ 10-14 winters	○ 21-30 days per winter
○ 15-19 winters	○ 31-60 days per winter
○ 20 winters or more	○ More than 60 days per winter

- **How do you rate your riding ability as a mountain snowmobiler?**
  Please select one of the following options.

  ○ Novice
  ○ Intermediate
  ○ Advanced
  ○ Expert

- **Are you member of a snowmobile club?**
  Please select one of the following options.

  ○ Yes
  ○ No

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13% Complete

Your Personal Perspective on Avalanches (1 of 2)

- **Which of the following statements best describes your thinking about avalanches? ***
  Please select one of the following options.

  - I generally do not think about avalanches where I ride.
  - I know that avalanches can happen in some of the places I ride, but avalanche danger generally does not affect the choices I make.
  - My personal experience in mountain snowmobiling has provided me with all the skills I need for managing avalanche danger where I ride.
  - I sometimes worry about being caught in an avalanche. I would like to learn more about avalanche safety, but have not taken a formal course with a field component (e.g., AST1 or more advanced) yet.
  - I have taken a formal avalanche course with a field component, but I don't regularly apply what I learned when riding.
  - I have taken a formal avalanche course with a field component and I am practicing my skills whenever I can.
  - I have taken a formal avalanche course and have several seasons of experience applying these skills when riding. Avalanche risk mitigation has become an integral part of my riding practice.

➔ **What is the highest level of formal avalanche awareness training you have completed? ***
Please select one of the following options.

- Free avalanche awareness seminar
  (approx. 3 hrs)
- Classroom component of an introductory avalanche awareness course
  (e.g., CAC AST1; only classroom component)
- Complete introductory avalanche awareness course with a field day
  (e.g., CAC AST 1; complete 2-day course)
- Advanced avalanche awareness course
  (e.g., CAC AST 2; approx. 4-day course)
- Professional level avalanche training
  (e.g., CAA ITP Level 1 or higher)
- Other: ______

- **Please rate the level of general avalanche safety knowledge ...**
  Please rate the level of knowledge on a scale from 0 to 100, where 0 means that you know absolutely nothing and 100 means you know abolutely everything there is to know.

	Nothing at all										Absolutely everything there is to know
... you think you had prior to taking any avalanche awareness courses.	0	10	20	30	40	50	60	70	80	90	100
... you think you currently have.	0	10	20	30	40	50	60	70	80	90	100
... you think you need to have to effectively manage avalanche danger.	0	10	20	30	40	50	60	70	80	90	100

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17% Complete

Your Personal Perspective on Avalanches (1 of 2)

- **Please rate your confidence in your personal ability ...**
  Please rate your confidence on a scale from 0 (Cannot do at all) to 100 (Highly certain can do).

	Cannot do at all					Moderately can do					Highly certain can do
... to recognize situations in which you are likely to trigger an avalanche.	0	10	20	30	40	50	60	70	80	90	100
... to identify locations to safely watch other snowmobilers ride.	0	10	20	30	40	50	60	70	80	90	100
... to locate and rescue a partner who is completely buried by an avalanche.	0	10	20	30	40	50	60	70	80	90	100
... to talk your partners out of riding a slope that you personally think is dangerous.	0	10	20	30	40	50	60	70	80	90	100

Next >>

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Your Typical Riding Group

If you ride with multiple groups, please answer the following questions with respect to the group you most often ride with.

- **What is the typical size of your riding group?**
  Please enter the appropriate number.

  ☐ riders (including you)

- **What levels of riding experience are present within this group?**
  Please check ALL experience levels present in your group.

  ☐ Less experienced than you
  ☐ Approximately same experience level as you - 6-9 yrs of riding & 21-30 days per winter
  ☐ More experienced than you

- **What riding abilities are there in this group?**
  Please check ALL ability levels present in your group.

  ☐ Novice
  ☐ Intermediate - Your ability level
  ☐ Advanced
  ☐ Expert

- **What levels of avalanche awareness training are there in this group?**
  Please enter the approximate number of riders including you for each level of awareness training.

☐	No avalanche awareness training	
☐	Free avalanche awareness seminar (approx. 3 hrs)	
☐	Classroom component of an introductory avalanche awareness course (e.g., CAC AST1; only classroom component)	
☐	Complete introductory avalanche awareness course with a field day (e.g., CAC AST 1; complete 2-day course)	Your level of formal training
☐	Advanced avalanche awareness course (e.g., CAC AST 2; approx. 4-day course)	
☐	Professional level avalanche training (e.g., CAA ITP Level 1 or higher)	
☐	Other: ☐	
☐	Don't know	
____	Total number of riders	

Next >>

25% Complete

Your Riding Group - Decision Making

- **Which of the following statements best describes how decisions are made in your group of four riders?**
  Please select the most appropriate statement.

  - ○ We all make our own decisions about where we ride.
  - ○ Whoever is at the front of our group decides where we ride.
  - ○ We have a designated leader who generally decides where we ride.
  - ○ We have a small group of leaders who generally decide where we ride.
  - ○ We all contribute to the decision process and we decide together where we ride.

- **How would you describe your role within your riding group?**
  Please select the most appropriate statement.

  - ○ I am the primary decision-maker of my group.
  - ○ I am one of the decision-makers of my group.
  - ○ I speak up if I have any concerns, but I am generally not part of the decision process.
  - ○ I completely leave the decision process up to other riders in my group.

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29% Complete

Going on a Snowmobile Trip with Your Group

You have now completed the first section of our survey!

In the next section, we would like to look at the **character of snowmobile trips** that you and your partners typically go on together.

When answering these questions, please **picture yourself with the group of four riders you just described** in the previous section.

Prize Draw — Remember the **prize draw**! Click here for more information.

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33% Complete

Your Favourite Snowmobiling Areas

- **What are your most favourite riding areas and how often do you typically visit them?** *

Please list up to three of your most favorite snowmobile areas.

	Name of snowmobile area including closest town	Number of visits per winter
1.	Revi	2-3 times per winter
2.		Please select ...
3.		Please select ...

- **Are any of your favourite snowmobile areas far enough away from your home that you need to travel there the day before riding?**

Please check the appropriate option.

○ Yes
○ No

- **Are public avalanche bulletins available for your favourite snowmobile areas?** *

Please select one of the following options.

○ Yes, bulletins are available for all the areas listed above.
◉ Yes, but only for some of the areas listed above.
○ No, but there are bulletins that cover close-by areas (e.g., neighbouring mountain range).
○ No, there are no bulletins available for the areas listed above.
○ I don't know.

- **What type of riding does your group typically pursue when visiting your favourite riding areas?**

Please select ALL that apply.

☐ Socializing and watching other riders
☐ Non-technical exploring and touring
☐ Moderately technical exploring and touring
☐ Highly technical exploring and touring
☑ Hill climbing
☐ Big air

- **Does your group ever go backcountry skiing or snowboarding and use snowmobiles only for access?**

Please select one of the following options.

○ Never
◉ Sometimes
○ Most of the time
○ Always

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Planning a Snowmobile Trip from Home

- **How far in advance does your group typically plan their snowmobile trips?**
  Please select the most appropriate statement.

  ○ Months ahead of the trip
  ◉ Weeks ahead of the trip
  ○ Days ahead of the trip
  ○ On the evening before the trip
  ○ In the morning of the trip

- **How often do you and your partners consult the following sources to inform yourself about the avalanche conditions at your trip destination before leaving home? ***
  Please select the appropriate level for each information source.

You personally	Never	Rarely	Sometimes	Frequently	Always
Public avalanche bulletin	○	○	○	○	◉
Other sources (e.g., local snowmobile clubs, dealers, forums or knowledgeable riders)	○	○	○	○	◉

Your partners	Never	Rarely	Sometimes	Frequently	Always	Don't know
Public avalanche bulletin	○	○	○	○	◉	○
Other sources (e.g., local snowmobile clubs, dealers, forums or knowledgeable riders)	○	○	○	○	◉	○

- **How often does your group discuss avalanche conditions before leaving home?**
  Please select the appropriate level.

  ○ Never
  ○ Rarely
  ○ Sometimes
  ○ Frequently
  ◉ Always

- **Has your group ever cancelled a trip or changed your trip destination due to avalanche concerns before leaving home?**
  Please select the most appropriate statement.

  ◉ Yes
  ○ No

Next >>

41% Complete

At the Staging Area

- **How often do you and your partners consult the following sources between home and leaving the staging area? ***
  Please select the appropriate level for each information source.

You personally	Never	Rarely	Sometimes	Frequently	Always
Online public avalanche bulletins (e.g., via smart phone or at hotel)	○	○	○	○	◉
Posted public avalanche bulletins (e.g. in hotels and/or staging areas)	○	○	○	○	◉
Other sources (e.g., local snowmobile clubs, dealers, forums or knowledgeable riders)	○	○	○	○	◉

Your partners	Never	Rarely	Sometimes	Frequently	Always	Don't know
Online public avalanche bulletins (e.g., via smart phone or at hotel)	○	○	○	○	○	○
Posted public avalanche bulletins (e.g., in hotels and/or staging areas)	○	○	○	○	○	○
Other sources (e.g., local snowmobile clubs, dealers, forums or knowledgeable riders)	○	○	○	○	○	○

- **How often does your group discuss avalanche conditions at the staging area?**
  Please select the appropriate level.

  ○ Never
  ○ Rarely
  ○ Sometimes
  ○ Frequently
  ○ Always

- **Has your group ever cancelled or significantly changed the plans of a trip at the staging area due to avalanche concerns?**
  Please select the most appropriate statement.

  ○ Yes
  ○ No

- **Please rate the knowledge of current local avalanche conditions ...**
  Please rate the level of knowledge on a scale from 0 to 100, where 0 means that you know absolutely nothing and 100 means you know absolutely everything there is to know.

	Nothing at all										Absolutely everything there is to know
... you think you have before checking the avalanche bulletin.	0	10	20	30	40	50	60	70	80	90	100
... you think you have before leaving the staging area.	0	10	20	30	40	50	60	70	80	90	100
... you think you need to have to effectively manage avalanche danger while riding.	0	10	20	30	40	50	60	70	80	90	100

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45% Complete

Riding in the Mountains (1 of 3)

- **What type of personal avalanche safety equipment does your group normally carry?**
  Please indicate whether you personally carry this equipment and what portion of your group is carrying it.

	You personally	Your partners				
		None	Few	Most	All	Don't know
Avalanche transceiver (beacon)	☐	○	○	○	○	○
Shovel	☐	○	○	○	○	○
Collapsible probe	☐	○	○	○	○	○
Avalanche balloon pack	☐	○	○	○	○	○

- **What type of additional emergency gear does your group typically carry?**
  Please select ALL that apply.

☐ SPOT or other emergency notification and location device
☐ Satellite phone
☐ First aid kit
☐ Overnight supplies

- **Have you ever been involved in a serious (?) avalanche?**
  Please select one of the following options.

○ No, I have never been involved in a serious avalanche.
○ Yes, but I have always managed to ride out of the avalanche before it came to a stop.
○ Yes, I have been caught or buried at least once.

- **Have you ever witnessed one of your riding partners being involved in a serious (?) avalanche?**
  Please select one of the following options.

○ No, I have never seen them involved in a serious avalanche.
○ Yes, but they always managed to ride out of the avalanche before it came to a stop.
○ Yes, I have witnessed them being caught our buried at least once.

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49% Complete

Riding in the Mountains (2 of 3)

- **While snowmobiling in the mountains, what do you think is the likelihood that you or one of your partners would ...**

The scale for your answers represents the ***expected number of incidents per year****. Here are two examples of how to interpret the numbers:*

- ***1 in 10 years*** *means you expect to experience about 1 incident every 10 years.*
- ***5 in year*** *means that you expect to experience approximately 5 incidents per year.*

As ***reference points for the small values*** *we provide the likelihoods of getting injured or killed in a car accident for the average driver in British Columbia.*

	Less frequent	1 in 10,000 yrs	1 in 1,000 yrs	1 in 100 yrs	1 in 10 yrs	1 in 5 yrs	1 in 2 yrs	1 in year	2 in year	5 in year	More frequent
... be caught or buried in a serious (?) avalanche?	○	○	○	○	○	○	○	○	○	○	○
... have your snowmobile damaged in an avalanche?	○	○	○	○	○	○	○	○	○	○	○
... get seriously injured in an avalanche?	○	○	○	○	○	○	○	○	○	○	○
... get killed in an avalanche?	○	○	○	○	○	○	○	○	○	○	○
Average chance of getting	...	killed	...	injured	... in a car accident in British Columbia.						

- **Please rate your confidence in your riding partners' overall ability ...**

Please rate your confidence on a scale from 0 (Cannot do at all) to 100 (Highly certain can do).

	Cannot do at all 0	10	20	30	40	Moderately can do 50	60	70	80	90	Highly certain can do 100
... to select riding terrain that is appropriate for the present avalanche conditions.	○	○	○	○	○	○	○	○	○	○	○

- **If you were caught in a serious (?) avalanche, please rate your confidence in ...**

Please rate your confidence on a scale from 0 (Cannot do at all) to 100 (Highly certain can do).

	Cannot do at all 0	10	20	30	40	Moderately can do 50	60	70	80	90	Highly certain can do 100
... your personal ability to ride out of the avalanche.	○	○	○	○	○	○	○	○	○	○	○
... your group's ability to locate and rescue you if you are completely buried.	○	○	○	○	○	○	○	○	○	○	○
... the ability of your avalanche balloon pack to prevent you from being buried.	○	○	○	○	○	○	○	○	○	○	○

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45% Complete

Riding in the Mountains (1 of 3)

- **What type of personal avalanche safety equipment does your group normally carry?**
  Please indicate whether you personally carry this equipment and what portion of your group is carrying it.

	You personally	Your partners				
		None	Few	Most	All	Don't know
Avalanche transceiver (beacon)						
Shovel						
Collapsible probe						
Avalanche balloon pack						

- **What type of additional emergency gear does your group typically carry?**
  Please select ALL that apply.

  - SPOT or other emergency notification and location device
  - Satellite phone
  - First aid kit
  - Overnight supplies

- **Have you ever been involved in a serious (?) avalanche?**
  Please select one of the following options.

  - No, I have never been involved in a serious avalanche.
  - Yes, but I have always managed to ride out of the avalanche before it came to a stop.
  - Yes, I have been caught or buried at least once.

- **Have you ever witnessed one of your riding partners being involved in a serious (?) avalanche?**
  Please select one of the following options.

  - No, I have never seen them involved in a serious avalanche.
  - Yes, but they always managed to ride out of the avalanche before it came to a stop.
  - Yes, I have witnessed them being caught our buried at least once.

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49% Complete

Riding in the Mountains (2 of 3)

- **While snowmobiling in the mountains, what do you think is the likelihood that you or one of your partners would ...**

The scale for your answers represents the ***expected number of incidents per year****. Here are two examples of how to interpret the numbers:*

- ***1 in 10 years*** *means you expect to experience about 1 incident every 10 years.*
- ***5 in year*** *means that you expect to experience approximately 5 incidents per year.*

As ***reference points for the small values*** *we provide the likelihoods of getting injured or killed in a car accident for the average driver in British Columbia.*

	Less frequent	1 in 10,000 yrs	1 in 1,000 yrs	1 in 100 yrs	1 in 10 yrs	1 in 5 yrs	1 in 2 yrs	1 in year	2 in year	5 in year	More frequent
... be caught or buried in a serious (?) avalanche?	○	○	○	○	○	○	○	○	○	○	○
... have your snowmobile damaged in an avalanche?	○	○	○	○	○	○	○	○	○	○	○
... get seriously injured in an avalanche?	○	○	○	○	○	○	○	○	○	○	○
... get killed in an avalanche?	○	○	○	○	○	○	○	○	○	○	○
Average chance of getting	...	killed	...	injured	... in a car accident in British Columbia.						

- **Please rate your confidence in your riding partners' overall ability ...**

Please rate your confidence on a scale from 0 (Cannot do at all) to 100 (Highly certain can do).

	0 (Cannot do at all)	10	20	30	40	50 (Moderately can do)	60	70	80	90	100 (Highly certain can do)
... to select riding terrain that is appropriate for the present avalanche conditions.	○	○	○	○	○	○	○	○	○	○	○

- **If you were caught in a serious (?) avalanche, please rate your confidence in ...**

Please rate your confidence on a scale from 0 (Cannot do at all) to 100 (Highly certain can do).

	0 (Cannot do at all)	10	20	30	40	50 (Moderately can do)	60	70	80	90	100 (Highly certain can do)
... your personal ability to ride out of the avalanche.	○	○	○	○	○	○	○	○	○	○	○
... your group's ability to locate and rescue you if you are completely buried.	○	○	○	○	○	○	○	○	○	○	○
... the ability of your avalanche balloon pack to prevent you from being buried.	○	○	○	○	○	○	○	○	○	○	○

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53% Complete

Riding in the Mountains (3 of 3)

- **Even with the highest level of avalanche training, extensive experience and up-to-date information on current conditions, how much luck do you think is still involved in ...**
  Please rate your level of worry on a scale from 0 to 100.

	No luck					Some luck					All luck
... avoiding serious (?) avalanches when riding in the mountains?	0	10	20	30	40	50	60	70	80	90	100
... riding out of a serious (?) avalanche after triggering it?	0	10	20	30	40	50	60	70	80	90	100
... surviving a serious (?) avalanche after being caught?	0	10	20	30	40	50	60	70	80	90	100

- **How afraid are you of ...**
  Please rate your level of being afraid on a scale from 0 to 100.

	Not at all afraid										Extremely afraid
... being caught in a serious (?) avalanche?	0	10	20	30	40	50	60	70	80	90	100
... getting completely buried?	0	10	20	30	40	50	60	70	80	90	100
... getting seriously injured in an avalanche?	0	10	20	30	40	50	60	70	80	90	100
... dying in an avalanche?	0	10	20	30	40	50	60	70	80	90	100

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54% Complete
Going for a Ride - Exercise Intro
In the next section of this survey, you will be asked to make choices about hypothetical snowmobile trips you might take with your most common riding partners.
You will be presented with snowmobile areas that consist of three riding zones that are all easily accessible from a cabin.
Each of the three zones will be described by a photo that illustrates the general terrain character and information about the typical amount of rider traffic in the zone (see image).
Your task will be to specify how much time of your day you would likely be spending in each of the three zones.
We will present you with three hypothetical snowmobile trips. For each of the trips, we will ask you questions at different stages as new information about the existing conditions becomes available.
ZONE 1
... is typically a high traffic area.
Please select ...
There are no right or wrong answers to these questions!
It is important that you answer these questions as closely as possible to how you would normally choose when on a trip with your most common riding partners.
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63% Complete
Going for a Ride - 1 of 3 - At the Cabin
You have now ridden to the central cabin that offers easy access to all three zones described below. On your way to the cabin, you have made the following additional personal observations:
The snow quality is good.
You noticed a whumpf when you got off your snowmobile at the cabin.
The temperature is above freezing and the upper snowpack seems to be wet.
Previous information
Local Avalanche Danger Rating:
Considerable
Persistent avalanche problem
Given all the information available to you now, what fraction of your day would you likely be spending in the different zones of this snowmobile area? You can also choose to return to the staging area.
ZONE 1
ZONE 2
ZONE 3
NONE
Character of typical terrain within zone
I would not feel comfortable to ride in any of these zones under the given conditions and would return to the staging area.
This zone ...
... is rarely visited by riders.
... is rarely visited by riders.
... is typically a high traffic area.
Planning at Home
My entire day
At the Staging Area
¾ of my day
¼ of my day
At the Cabin
½ of my day
½ of my day
You indicated that you would likely be spending ½ of your day in Zone 2 (highlighted above).
Which of the following riding activity would you feel comfortable pursing in the terrain of Zone 2 under the given conditions?
Please check all options that apply.
Watching other riders from a distance
Moderately technical exploring and touring
Highly technical exploring and touring
Hill climbing
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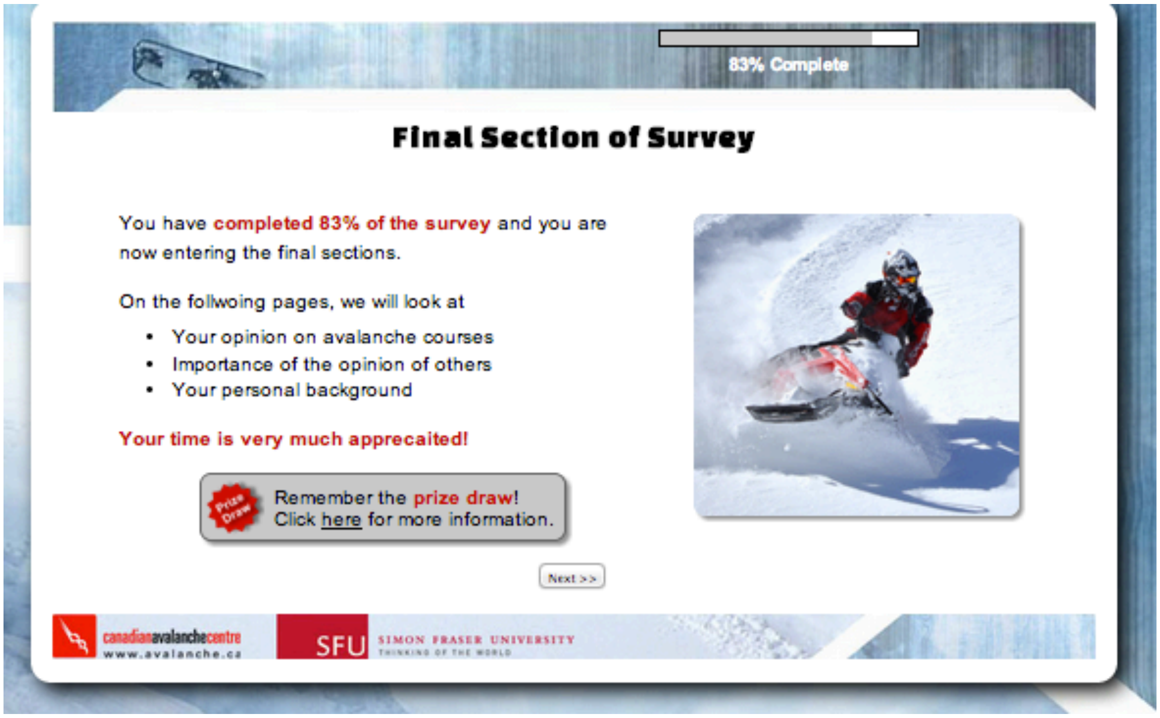
83% Complete
Final Section of Survey
You have completed 83% of the survey and you are now entering the final sections.
On the follwoing pages, we will look at
• Your opinion on avalanche courses
• Importance of the opinion of others
• Your personal background
Your time is very much apprecaited!
Prize Draw
Remember the prize draw!
Click here for more information.
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Avalanche Awareness Courses

Earlier you stated that have completed an **introductory avalanche awareness course** (e.g., AST1).

- **Please rate how much you personally would have agreed or disagreed with the following statements at the time you signed up for your course.**
  Please select the appropriate level between 'Strongly disagree' and 'Strongly agree' for each statement.

	Strongly disagree			Neutral			Strongly agree
My free weekends were limited and making time for a formal avalanche course was a challenge for me.	1	2	3	4	5	6	7
The cost associated with taking a formal avalanche awareness course was a big concern to me.	1	2	3	4	5	6	7

- **Please rate how much you personally agree or disagree with the following statements about avalanche courses and course providers.**
  Please select the appropriate level between 'Strongly disagree' and 'Strongly agree' for each statement.

	Strongly disagree			Neutral			Strongly agree
The skills taught in avalanche courses allow me to go farther and more fully experience the mountains.	1	2	3	4	5	6	7
Taking an avalanche course only teaches me that I should not ride in my favourite places anymore.	1	2	3	4	5	6	7
Avalanche courses teach me the necessary skills to safely explore the mountains under all conditions.	1	2	3	4	5	6	7
Avalanche course providers are safety geeks who simply don't have the balls to ride the stuff I do.	1	2	3	4	5	6	7
Avalanche course providers are as committed to the sport of mountain snowmobiling as I am.	1	2	3	4	5	6	7
Avalanche course providers just want to scare us to keep us out of the backcountry.	1	2	3	4	5	6	7
Avalanche courses have been developed by skiers for skiers and don't apply to snowmobilers.	1	2	3	4	5	6	7
I generally don't ride in avalanche terrain, so I do not need an avalanche course.	1	2	3	4	5	6	7

Next >>

87% Complete

Opinions of Others

- **How do you rate other people's opinion about your approach to avalanche safety?**
  Please select the appropriate level between the two extremes in each statement.

Close family members (e.g., spouse, partners, parents) would **not be supportive / be very supportive** of me taking a formal avalanche safety course (e.g., AST1).	Not supportive 1 ○	2 ○	3 ○	4 ○	5 ○	6 ○	Very supportive 7 ○
It is **not important / very important** to my close family members that I keep myself informed about current avalanche conditions.	Not important 1 ○	2 ○	3 ○	4 ○	5 ○	6 ○	Very important 7 ○
My riding partners would **not be supportive / be very supportive** of me taking a formal avalanche safety course (e.g., AST1).	Not supportive 1 ○	2 ○	3 ○	4 ○	5 ○	6 ○	Very supportive 7 ○
It is **not important / very important** to my riding partners that I keep myself informed about current avalanche conditions.	Not important 1 ○	2 ○	3 ○	4 ○	5 ○	6 ○	Very important 7 ○

- **How important are these people's opinions to you?**
  Please select the appropriate level between 'Not at all' and 'Extremely' for each statement.

	Not at all 1	2	3	4	5	6	Extremely 7
Doing what close family members think I should do while riding is important to me.	○	○	○	○	○	○	○
My riding partners' approval is important to me.	○	○	○	○	○	○	○

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90% Complete

Personal Background (1 of 3)

- **Besides snowmobile riding, what other recreational activities do you enjoy?**
  Please select ALL that apply.

☐ ATV/Off-roading	☐ Camping	☐ Dirt bike riding
☐ Fishing/hunting	☐ Golfing	☐ Hiking/climbing
☐ Motorcycle	☐ Mountain biking	☐ Rafting/kayaking
☐ Skiing/snowboarding	☐ Speed boat/jet skiing	☐ Team sports (e.g., hockey)
☐ Other ______	☐ Other ______	

- **Please rate how much the following statements apply to you personally.**
  Please select the appropriate level between 'Does not at all apply' and 'Strongly applies' for each statement.

	Does not at all apply 1	2	3	4	5	6	Strongly applies 7
Being healthy and fit is important to me.	○	○	○	○	○	○	○
I regularly work out to make sure I am in good shape for snowmobiling.	○	○	○	○	○	○	○
I am always curious about new technology and like to test new products.	○	○	○	○	○	○	○
I am always eager to learn how I can improve the performance of my snowmobile.	○	○	○	○	○	○	○
I like expanding my knowledge about the mountains and weather in general.	○	○	○	○	○	○	○

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93% Complete

Personal Background (2 of 3)

- **Please rate how well the following statements apply to you personally.**
  Please select the appropriate level between 'Strongly disagree' and 'Strongly agree' for each statement.

	Strongly disagree			Neutral			Strongly agree
I get restless when I spend too much time at home	1	2	3	4	5	6	7
I would like to explore strange places.	1	2	3	4	5	6	7
I like to do frightening things.	1	2	3	4	5	6	7
I like wild parties.	1	2	3	4	5	6	7
I would like to take off on a trip with no pre-planned routes or timetables.	1	2	3	4	5	6	7
I would like to do bungee jumping.	1	2	3	4	5	6	7
I would love to have new and exciting experiences, even if they are illegal.	1	2	3	4	5	6	7
I prefer friends who are excitingly unpredictable.	1	2	3	4	5	6	7

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96% Complete

Personal Background (3 of 3)

- **What is your gender?**
  Please check the appropriate option.

  ○ Male
  ○ Female

- **Which of the following age categories describes you?**
  Please select one of the following options.

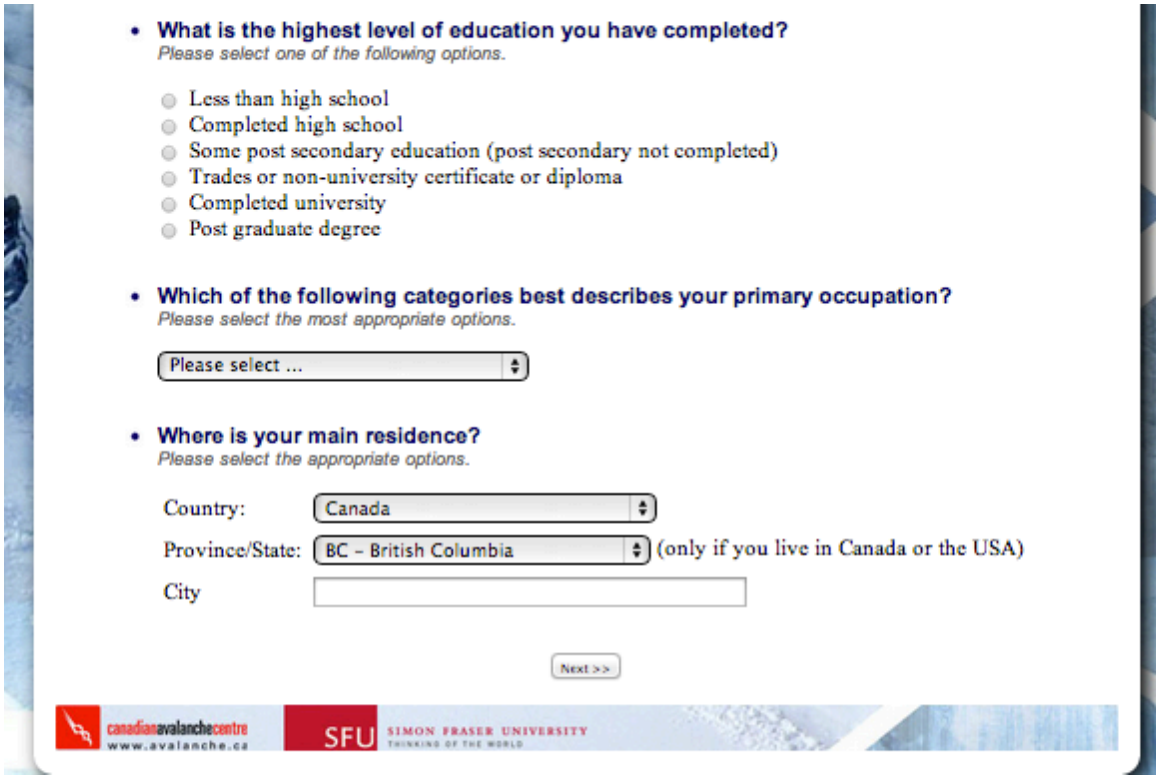
  ○ Under 20
  ○ 20 to 24
  ○ 25 to 34
  ○ 35 to 44
  ○ 45 to 54
  ○ 55 or over

- **Are you married?**
  Please check the appropriate option.

  ○ Yes
  ○ No

- **Do you have any children?**
  Please check the appropriate option.

  ○ Yes
  ○ No



- **What is the highest level of education you have completed?**
  Please select one of the following options.

  - Less than high school
  - Completed high school
  - Some post secondary education (post secondary not completed)
  - Trades or non-university certificate or diploma
  - Completed university
  - Post graduate degree

- **Which of the following categories best describes your primary occupation?**
  Please select the most appropriate options.

  Please select ...

- **Where is your main residence?**
  Please select the appropriate options.

  Country: Canada

  Province/State: BC – British Columbia (only if you live in Canada or the USA)

  City

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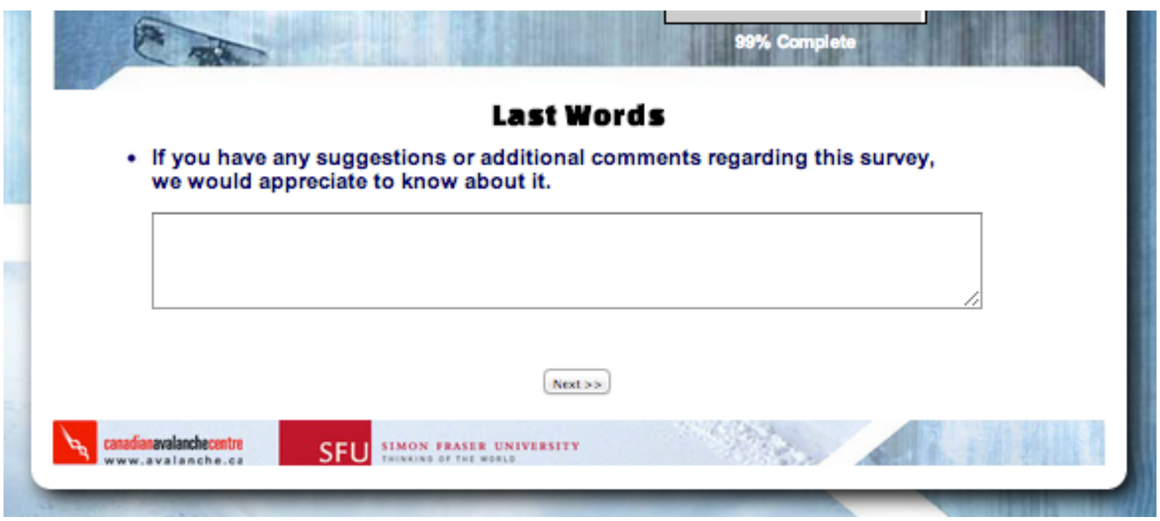

99% Complete

Last Words

- **If you have any suggestions or additional comments regarding this survey, we would appreciate to know about it.**

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Thank you for taking our Mountain–preparedness snowmobile Survey

Your answers will provide important information for the improvement of avalanche safety programs for snowmobile riders.

Your name has been entered for the prize draw. Winners will be contacted on May 30, 2012.

We wish you an exciting and safe spring in the backcountry.

For information on the current snow and avalanche conditions, please visit the web site of the Canadian Avalanche Centre at www.avalanche.ca.

Privacy Policy   Contact Information

We would like to thank Thunderstruck Films for providing the riding photos presented in this survey.

ARCTIC CAT POLARIS YAMAHA ski-doo SLEDNECKS TEAM THUNDERSTRUCK

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Appendix E – Online Survey Invitation Letter

Invitation to online survey

untain Snowmobile - Prize Inbox x

SFU Mountain Sled Project <avalanche@sfu.ca> 4/19/12

to me

Dear Mountain Snowmobiler:

Researchers from Simon Fraser University working with the Canadian Avalanche Centre would like to invite you to participate in a survey on mountain snowmobiling and avalanche awareness. The purpose of this study is to improve our understanding of how snowmobilers perceive avalanche hazards and make decisions about where to ride. Your answers will provide important background information for the development of avalanche awareness tools and services that better address the specific needs of mountain snowmobilers.

Please click on this link to access your online survey account:
http://mtnsled.rem.sfu.ca

Participants who complete the online survey before May 30, 2012, will be entered into a prize draw for TWO NIGHTS LODGING at one of five popular snowmobile destinations in BC. We sincerely appreciate you taking this time.

If you have any friends who might be interested in taking this survey, please forward them this mail.

We wish you all the best and safe riding for the rest of the season!

THANK YOU VERY MUCH!

Pascal Haegeli
Project Leader

Luke Strong
Project Assistant

REM - Simon Fraser University
Burnaby, BC

Appendix F – Validation

Data collected from the intercept was used to check for potential response bias in the online results using two comparisons. Each survey item was examined for significant differences between the two groups using Pearson's chi-square test for categorical data, t-test for normally distributed numeric data, and Wilcoxon rank-sum test for non-normally distributed numeric data. p-values of <0.05 were used to reject the null hypothesis that responses between the two groups were the same.

Intercept Participants: Completed Both Surveys vs. Intercept Only

A comparison of intercept responses by those who completed both surveys (n = 158) and those who completed only the intercept (n = 861) was done for the entire intercept survey. This comparison assessed for response bias present in the online survey responses provided by those who completed both surveys (Table F-1.1 through Table F-1.6).

Table F-1.1. Intercept response comparison.

Variable	Test	Level	Complete	Didn't Complete	P-Value
Gender	Chi square		n = 157	n = 845	0.337
		Female	9.55%	12.66%	
		male	90.45%	87.34%	
Age	T-test		n = 158	n = 844	**<0.001**
		Mean	36.85	33.65	
		SD	10.86795	10.21523	
Country	Chi square		n = 155	n = 857	0.230
		Canada	100%	98.13%	
		U.S.	0%	0.58%	
		Other	0%	1.28%	
Province/State	Chi square		n = 155	n = 852	0.187
		AB	67.10%	65.14%	
		BC	17.42%	23.00%	
		SK	13.55%	9.15%	
		Other	1.94%	2.70%	

Table F-1.2. Intercept response comparison – continued.

Variable	Test	Level	Complete	Didn't Complete	P-Value
Years Riding	Wilcox		n = 158	n = 851	0.476
		First	15.82%	17.51%	
		1-2 years	13.92%	13.87%	
		3-5 Years	20.89%	22.09%	
		6-9 Years	15.82%	15.75%	
		10+ Years	33.54%	30.79%	
Days/Year	Wilcox		n = 155	n = 815	0.961
		1-4 Days	18.71%	22.67%	
		5-15 Day	43.23%	36.04%	
		16-30 Days	23.23%	25.89%	
		31-60 Day	9.68%	10.98%	
		61+ Day	5.16%	4.42%	
Club Member	Chi square		n = 158	n = 818	0.135
		No	64.56%	70.88%	
		Yes	35.44%	29.12%	
Trip Decision	Wilcox		n = 154	n = 817	0.881
		Today	5.84%	6.36%	
		Yesterday	9.09%	10.40%	
		Days ago	22.08%	24.36%	
		Weeks ago	42.86%	34.64%	
		Months ago	20.13%	24.24%	
Length of stay	Chi square		n = 158	n = 844	0.289
		1 day	7.59%	9.72%	
		2-3 days	58.86%	57.35%	
		4-7 days	21.52%	17.89%	
		7+ days	3.16%	1.78%	
		I live here	8.86%	13.27%	
Area Decision	Wilcox		n = 148	n = 833	0.848
		Today	30.41%	31.93%	
		Yesterday	41.22%	37.33%	
		Days ago	16.89%	16.69%	
		Weeks ago	6.08%	7.92%	
		Months ago	5.41%	6.12%	

Table F-1.3. Intercept response comparison – continued.

Variable	Test	Level	Complete	Didn't Complete	P-Value
Sled Type	Chi square		n = 155	n = 830	0.624
		Arctic Cat	21.94%	24.34%	
		BRP	45.81%	44.82%	
		Polaris	20.65%	21.57%	
		Other	0.65%	0.12%	
		Yamaha	10.97%	9.16%	
Track Length	Wilcox		n = 144	n = 786	0.376
		142' or less	4.17%	6.62%	
		143-152'	17.36%	21.88%	
		153-162'	64.58%	54.96%	
		163+	13.89%	16.54%	
Engine Size	Wilcox		n = 143	n = 790	**0.049**
		500cc or less	3.50%	2.03%	
		600-700cc	4.90%	14.18%	
		800-900cc	75.52%	70.00%	
		1,000cc +	16.08%	13.80%	
Engine Type	Chi square		n = 146	n = 796	0.808
		2-stroke	85.62%	84.42%	
		4-stroke	14.38%	15.58%	
Fuel Type	Chi square		n = 145	n = 760	0.914
		Pump fuel	87.59%	87.50%	
		Race fuel	12.41%	12.50%	
Turbo	Chi square		n = 143	n = 775	0.986
		No	83.92%	84.39%	
		Yes	16.08%	15.61%	
Modifications	Chi square		n = 140	n = 749	0.670
		Mod	24.29%	26.44%	
		Stock	75.71%	73.56%	

Table F-1.4 Intercept response comparison – continued.

Variable	Test	Level	Complete	Didn't Complete	P-Value
Avalanche safety gear	Chi square		n = 158	n = 861	0.516
		Transceiver	85.44%	87.69%	
Avalanche safety gear	Chi square		n = 158	n = 861	0.297
		Shovel	97.47%	95.24%	
Avalanche safety gear	Chi square		n = 158	n = 861	0.191
		Probe	89.87%	85.60%	
Avalanche safety gear	Chi square		n = 158	n = 861	0.195
		Balloon pack	39.87%	34.15%	
Ever Caught/Witnessed	Chi square		n = 150	n = 816	0.055
		No	81.33%	73.53%	
		Yes	18.67%	26.47%	

Table F-1.5. Intercept response comparison – continued.

Variable	Test	Level	Complete	Didn't Complete	P-Value
Checked bulletin	Chi square		n = 155	n = 842	0.245
		No	29.03%	34.20%	
		Yes	70.97%	65.80%	
Correctly recalled alpine bulletin	Chi square		n = 86	n = 357	0.683
		Correct	73.23%	70.31%	
		Incorrect	26.74%	29.69%	
Correctly recalled Treeline bulletin	Chi square		n = 76	n = 309	0.977
		Correct	59.21%	58.58%	
		Incorrect	40.79%	41.42%	
Correctly recalled below Treeline	Chi square		n = 71	**n = 282**	**0.016**
		Correct	71.83%	55.67%	
		Incorrect	28.17%	44.33%	

Table F-1.6. Intercept response comparison - continued

Variable	Test	Level	Complete	Didn't Complete	P-Value
Ski access	Chi square		n = 112	n = 596	0.177
		No	94.64%	90.10%	
		Yes	5.36%	9.90%	
Ability	Wilcoxon		n = 148	n = 713	0.252
		Novice	13.51%	15.57%	
		Intermediate	43.24%	36.33%	
		Advanced	29.73%	36.75%	
		Expert	13.51%	11.36%	
Confidence to assess	Wilcoxon		n = 158	n = 860	0.219
		1st qtr	50	50	
		Median	70	70	
		3rd qtr	80	80	
Confidence to rescue	Wilcoxon		n = 158	n = 859	0.239
		1st qtr	50	50	
		Median	70	70	
		3rd qtr	80	80	
Confidence to talk out	Wilcoxon		n = 157	n = 857	**0.011**
		1st qtr	70	60	
		Median	80	80	
		3rd qtr	100	90	
PAPM	Wilcoxon		n = 157	n = 848	**0.002**
		1-Unaware	1.91%	3.18%	
		2-Unengaged	4.46%	6.96%	
		3-Disengaged	6.37%	12.50%	
		4-Engaged	38.85%	38.68%	
		5-Non-emergent	6.37%	8.02%	
		6-Emergent	23.57%	17.57%	
		7-Practitioner	18.47%	13.09%	

Significant differences between the two groups were found in their responses concerning:

- **Age -** Participants who completed both surveys were significantly older
- **Snowmobile Characteristics -** Participants who completed both surveys had a larger engine size
- **Self-efficacy to talk persuade a partner -** Participants who completed both surveys reported being more confident in their ability to talk a partner out of riding a slope they thought to be dangerous.

- **PAPM** - Participants who completed both surveys reported significantly higher levels of awareness and training through the PAPM statements
- **Recalling the bulletin correctly** - Participants who completed both surveys were significantly more accurate in their recollection of the avalanche danger rating below the tree line

The observed differences in PAPM stage between groups (those who completed both surveys and those who completed only the intercept) suggest that recruited participants who successfully completed both surveys were more aware of avalanches and probably more committed to avalanche safety. Their ability to correctly recall the below tree-line avalanche bulletin danger rating further suggests this possibility. Nonetheless, the online survey results provided by those recruited from the intercept can be viewed as a relatively accurate.

Intercept Participants vs. Online Participants

A comparison of responses by intercept (n = 1,019) and online survey (n = 662) responses was done using items that were included in both surveys. Each applicable item was examined for significant differences between the two groups. This comparison assessed for potential response bias in the online sample as a whole (Table F-1.7 through Table F-1.9).

Table F-1.7. Intercept vs. Online comparison

Variable	Test	Level	Intercept	Online	P-Value
Gender	Chi square		n = 1002	n = 657	**0.003**
		Female	12.18%	7.46%	
		Male	87.82%	92.54%	
Age	Wilcox		n = 1002	n = 661	**<0.001**
		Under20	5.29%	3.03%	
		20-24	13.07%	6.81%	
		25-34	39.52%	27.69%	
		35-44	23.15%	30.56%	
		45-54	15.37%	21.63%	
		55AndUp	3.59%	10.29%	
Years Riding	Wilcox		n = 986	n = 661	**0.001**
		First	5.89%	17.24%	
		1-2 years	9.06%	13.88%	
		3-5 Years	20.69%	21.90%	
		6-9 Years	19.79%	15.76%	
		10+ Years	44.56%	31.22%	
Days/Year	Wilcox		n = 993	n = 613	**<0.001**
		1-4 Days	22.05%	6.04%	
		5-15 Day	37.16%	23.98%	
		16-30 Days	25.48%	37.52%	
		31-60 Day	10.78%	25.29%	
		61+ Day	4.53%	7.18%	
Club Member	Chi square		n = 996	n = 661	**<0.001**
		No	69.88%	55.52%	
		Yes	30.12%	44.48%	

Table F-1.8. Intercept vs. Online comparison – continued.

Variable	Test	Level	Intercept	Online	P-Value
Sled Type	Chi square		n = 985	n = 660	**0.039**
		Arctic Cat	23.96%	25.30%	
		BRP	44.97%	38.33%	
		Polaris	21.42%	26.21%	
		Other	0.20%	0.61%	
		Yamaha	9.44%	9.55%	
Track Length	Wilcox		n = 930	n = 651	**0.006**
		142’ or less	6.24%	4.61%	
		143-152’	21.18%	16.44%	
		153-162’	56.45%	60.37%	
		163+	16.13%	18.59%	
Engine Size	Wilcox		n = 933	n = 648	**0.378**
		500cc or less	1.85%	2.25%	
		600-700cc	12.04%	12.75%	
		800-900cc	70.68%	70.85%	
		1,000cc +	15.43%	14.15%	
Engine Type	Chi square		n = 942	n = 650	0.116
		2-stroke	84.61%	87.54%	
		4-stroke	15.39%	12.46%	
Turbo	Chi square		n = 918	n = 626	0.326
		No	84.31%	86.26%	
		Yes	15.69%	13.74%	
Modifications	Chi square		n = 889	n = 634	0.255
		Mod	26.10%	28.86%	
		Stock	73.90%	71.14%	

Table F-1.9. Intercept vs. Online comparison - continued

Variable	Test	Level	Intercept	Online	P-Value
Ability	Wilcox		n = 861	n = 661	**<0.001**
		Novice	15.21%	6.66%	
		Intermediate	37.51%	35.40%	
		Advanced	35.54%	44.48%	
		Expert	11.73%	13.46%	
Confidence Assess	Wilcox		n = 1018	n = 662	**0.023**
		1st qtr	50	0.15%	
		Median	70	0.91%	
		3rd qtr	80	2.11%	
Confidence Rescue	Wilcox		n = 1017	n = 660	0.119
		1st qtr	50	1.97%	
		Median	70	3.79%	
		3rd qtr	80	4.70%	
Confidence Talk out	Wilcox		n = 1014	n = 661	0.150
		1st qtr	60	0.15%	
		Median	80	1.06%	
		3rd qtr	80	1.97%	
PAPM	Wilcox		n = 1005	n = 662	**<0.001**
		1	2.99%	1.51%	
		2	6.57%	2.42%	
		3	11.54%	4.68%	
		4	38.71%	38.22%	
		5	7.76%	4.98%	
		6	18.51%	20.85%	
		7	13.93%	27.34%	
Variable	Test	Level	Intercept	Online	
Ever Caught/Witnessed	Chi square		n = 966	n = 660	0.449
		yes	74.74%	76.52%	
		no	25.26%	23.48%	

Significant differences between the two groups were found in the responses concerning:

- **Gender** - The percentage of males who responded to the online survey was significantly higher than in the intercept.
- **Age -** Online survey participants were older.
- **Snowmobiling Experience -** Online survey participants had more years of riding experience, more riding day on average per year, and higher ability (skill) than intercept participants.

- **Club Membership** - The percentage of snowmobile club member was significantly higher in online survey.
- **Snowmobile Characteristic** - Online survey participants were more likely to ride a Skidoo BRP snowmobile, they were also more likely to have a shorter snowmobile track than intercept participants.
- **Self-efficacy to talk persuade a partner** - Online survey participants reported being more confident in their ability to talk a partner out of riding a slope they thought to be dangerous.
- **PAPM** - Online survey participants reported significantly higher levels of awareness and training through their chosen PAPM statements.

Online Participants: Recruited From Intercept vs. Other Introduction Source

Last, a comparison of online responses by those recruited from the intercept (n = 144) to those recruited from all the other sources (n = 511) was done on key characteristics and demographics. The other sources primarily included mailing lists of clubs, avalanche course provides, snowmobile movie companies, and other social networks. Since such a recruitment strategy likely results in a biased survey sample, the present comparison aims to assess the general differences between the two main recruitment sources (Table F-1.11 through Table F-1.12).

Table F-1.11. Intercept recruits vs. Other introduction sources

Variable	Test	Level	Other Intro Source	Intercept Recruit	P-Value
Gender	Chi square		n = 506	n = 144	0.192
		Female	6.72%	10.42%	
		Male	93.28%	89.58%	
Age	Wilcox		n = 510	n = 144	0.005
		Under20	2.35%	4.86%	
		20-24	5.88%	10.42%	
		25-34	26.08%	31.94%	
		35-44	32.35%	25.00%	
		45-54	21.76%	21.53%	
		55AndUp	11.57%	6.25%	

Table F-1.12. Intercept recruits vs. Other introduction sources - continued

Variable	Test	Level	Other Intro	Intercept Recruit	P-Value
Residence/	Chi square		n=508	n=144	**<0.001**
State		AB	33.07%	66.67%	
		BC	36.81%	18.75%	
		ID	2.76%	0.00%	
		MN	4.72%	0.00%	
		MT	3.74%	0.00%	
		SK	4.92%	13.19%	
		WA	3.35%	0.00%	
		Other	10.63%	1.39%	
Avalanche safety gear	Chi square		n = 511	n = 144	0.658
		Transceiver	91.19%	92.36%	
Avalanche safety gear	Chi square		n = 511	n = 144	**0.012**
		Shovel	96.48%	90.97%	
Avalanche safety gear	Chi square		n = 511	n = 144	0.650
		Probe	90.61%	88.89%	
Avalanche safety gear	Chi square		n = 511	n = 144	0.501
		Balloon pack	42.47%	38.89%	
Years Riding	Wilcox		n = 511	n = 144	**<0.001**
		First	2.15%	18.75%	
		1-2 years	8.22%	11.81%	
		3-5 Years	20.35%	22.22%	
		6-9 Years	20.16%	17.36%	
		10-14 Years	17.81%	14.58%	
		15-19 Years	9.20%	4.17%	
		20+ Years	22.11%	11.11%	
Days/Year	Wilcox		n = 477	n = 129	**<0.001**
		1-4 Days	3.35%	15.50%	
		5-9 Day	11.95%	13.18%	
		10-15 Day	23.48%	26.36%	
		16-20 Days	19.92%	19.38%	
		21-30 Day	18.87%	13.18%	
		31-60 Day	14.47%	7.75%	
		61+ Day	7.97%	4.65%	
Ability	Wilcox		n = 510	n = 144	**<0.001**
		Novice	4.71%	13.19%	
		Intermediate	33.73%	40.97%	
		Advanced	47.25%	35.42%	
		Expert	14.31%	10.42%	
Club Member	Chi square		n = 510	n = 144	**0.010**
		No	52.75%	65.28%	
		Yes	47.25%	34.72%	

Table F-1.14. Intercept recruits vs. Other introduction sources - continued

Variable	Test	Level	Other Intro	Intercept Recruit	P-Value
PAPM	Wilcoxon		n = 511	n = 144	**0.033**
		1-Unaware	1.17%	2.08%	
		2-Unengaged	1.96%	4.17%	
		3-Disengaged	4.50%	5.56%	
		4-Engaged	36.79%	44.44%	
		5-Non-emergent	5.28%	4.17%	
		6-Emergent	22.11%	13.89%	
		7-Practitioner	28.18%	25.69%	
Bulletin-use	Wilcoxon		n=432	n=135	0.174
		1-Never	0.69%	0.00%	
		2	2.31%	2.96%	
		3	10.42%	14.81%	
		4	25.69%	27.41%	
		5-Always	60.88%	54.81%	

Significant differences between the two groups were found in the responses concerning:

- **PAPM** - Online survey participants recruited from the intercept reported significantly lower levels of awareness and training through their chosen PAPM statements.
- **Age -** Online survey participants recruited from the intercept were significantly younger.
- **Province/State of Residence -** Online survey participants recruited from the intercept were significantly more likely to be from Alberta, British Columbia, or Saskatchewan.
- **Snowmobiling Experience** - Online survey participants recruited from the intercept had less years of riding experience, less riding days on average per year, and lower ability (skill) than intercept participants.
- **Club Membership** - Online survey participants recruited from the intercept were less likely to be a member of a snowmobile.

The observed differences in snowmobile experience, club membership and PAPM stage in the more random recruited sample suggests that online participants were probably more committed to snowmobiling and avalanche safety. If anything, the online survey results represent a more committed and probably more conservative portion of the mountain snowmobile community as a whole. It is likely the untrained, unaware and unengaged are underrepresented in this study.

Appendix G – How Mountain Snowmobilers Adjust Their Riding Preferences in Response to Avalanche Hazard Information Available at Different Stages of Backcountry Trips (ISSW 2012)

HOW MOUNTAIN SNOWMOBILERS ADJUST THEIR RIDING PREFERENCES IN RESPONSE
TO AVALANCHE HAZARD INFORMATION AVAILABLE AT DIFFERENT STAGES OF BACKCOUNTRY TRIPS

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ABSTRACT: Over the last five winters, mountain snowmobilers accounted for 53% (41 of 77) of all recreational avalanche fatalities in Canada, which is a significant increase from the 28% (18 of 64) during the previous five winters. This trend clearly highlights the need for the Canadian avalanche community to improve avalanche awareness among this user group. Creating an in-depth understanding of the perspectives, needs and challenges of mountain snowmobilers is an important first step in the development of more appropriate risk communication and prevention strategies. This paper presents preliminary results from an extensive online survey on mountain snowmobiling and avalanche awareness that was conducted in British Columbia during the 2011/2012 winter season. The survey included a series of discrete choice experiments, a stated preference technique, to examine how snowmobilers adjust their riding preferences as new avalanche hazard information becomes available during different stages of typical backcountry trips. The analysis revealed that participating snowmobilers interpret danger ratings on a linear scale and that the presence of a persistent avalanche problem does not affect their riding choices. Furthermore, under increasing avalanche danger, snowmobilers first gravitate towards areas with higher snowmobile traffic before they avoid complex and challenging avalanche terrain. The analysis also showed that instability observations (i.e..whumpfs) affect riding choices more than other relevant observations. The results of this study can help to develop evidence-based avalanche safety initiatives that effectively target existing weaknesses in the avalanche safety behavior of mountain snowmobilers.

KEYWORDS: Mountain snowmobiling, avalanche hazard information, decision making, terrain choices, discrete choice experiment.

INTRODUCTION

A detailed understanding of the attitudes and behavioral preferences of your target audience is critical for developing effective risk communications and prevention initiatives (Lundgren and McMakin, 2009). Traditionally, avalanche safety research has mainly focused on improving the physical understanding of the avalanche phenomenon, but over the last decade, an increasing number of social science projects have aimed to better understand the human dimension of avalanche safety (e.g., Tase, 2004; Silverton, 2006; Björk, 2007; Sole, 2008; McCammon, 2009; Bright, 2010; Gunn, 2010; Haegeli et al., 2010).

Initial studies in this area primarily focused on examining the general character of backcountry users with respect to their basic avalanche safety practices and sociodemographics (e.g., Tase, 2004; Silverton, 2006). More recent studies have employed established theories and models from psychology and health behavior to better tie avalanche safety research to the comprehensive body of work existing in prevention sciences. Examples include the examination of the theory of risk homeostasis (Wilde, 1982) by Sole (2008) and the use of the precaution adoption process model (Weinstein and Sandman, 2002) by McCammon (2009).

Despite these theoretical advances, relating the characteristics of backcountry users to their behavior has remained a challenge. Field monitoring campaigns and intercept surveys are generally ineffective for methodically collecting behavioral data as backcountry activities are pursued by relatively few people over large areas. Furthermore, the spatial and temporal variability of avalanche hazard complicates the systematic collection of information across the range of possible conditions. To overcome this challenge, Haegeli et al. (2010) and Gunn (2010) included discrete choice experiments (DCE; Louviere et al., 2000), a stated preference technique, in their surveys to systematically collect information on personal travelling preferences in avalanche terrain across a wide range of conditions. In a DCE, survey participants are presented with a series of hypothetical, but realistic decision situations where they have to make a choice among two or more alternatives. Each alternative is characterized by a common set of attributes, whose values are manipulated according to an underlying statistical design.

Matching the hypothetical decision situation as closely to reality as possible is crucial for deriving meaningful results from a DCE. A possible weakness of existing DCEs in avalanche safety studies is that they portray the decision situation of backcountry travelers as a single 'go/no-go' choice. While this approach seems reasonable for the often spontaneous choices made in out-of-bounds skiing (Gunn, 2010), the decision process in other backcountry activities—traditional backcountry skiing and snowmobile riding—is much more gradual and occurs in stages. Backcountry outings for these activities are typically planned in advance and may require overnight travel before engaging in the activity. As different types of avalanche hazard information becomes available during these trip stages, best practices suggest that trip objectives should be adjusted accordingly.

The goal of the present study is to explicitly model the gradual process of avalanche safety decision making and to examine how snowmobilers adjust their riding preferences as avalanche hazard information becomes increasingly available.

METHOD

For the present study, we will use the data from an online survey that was conducted as part of a large-scale initiative by the Canadian Avalanche Centre (CAC) to improve avalanche safety among mountain snowmobilers in Canada. The extensive online survey included detailed questions about participants' snowmobile riding preferences, the character of their typical riding partners, their attitude towards avalanche hazard and common avalanche safety practices. Most importantly, the survey included three consecutive DCEs that aimed to emulate the gradually progressing nature of the decision process that is typical among backcountry travelers.

Design of DCE

The goal of the first DCE was to examine participants' riding preferences independent of any avalanche hazard information. Survey participants were presented with a potential snowmobile area that consisted of three separate riding zones (Fig. 1a), each characterized by two attributes:

- Terrain character photo: *Simple*, *Challenging* or *Complex* (Fig 2) according to avalanche terrain exposure scale (Statham, McMahon, & Tomm, 2006)
- Typical snowmobile traffic: *Rarely visited*, *Regularly visited* or *High traffic zone*

The task of survey participants was to specify how much of their day they would most likely spend in the three different zones with their typical riding group. The response options included *"None of my day"*, *"1/4 of my day"*, *"1/2 of my day"*, *"3/4 of my day"* and *"All of my day".* Their selection(s) had to sum to a complete day. Participants were also able to choose not to ride at all if the selection of riding zones as a whole seemed too advanced or too boring.

Participants who chose to ride in the given snowmobile area were presented with a second DCE that emulated the decision situation at the staging area prior to riding (Fig. 1b). While the basic choice task remained the same as in the first DCE, survey participants were now introduced to large-scale avalanche hazard information typically included in public avalanche bulletins or reported by mainstream media. This information included:

- Avalanche Danger Rating: *Moderate*, *Considerable* or *High*
- Persistent avalanche problem: *"The avalanche bulletin warns about a persistent avalanche problem."*
- Recent avalanche fatality: *"The local radio station reports that there was an avalanche fatality in the general region yesterday."*

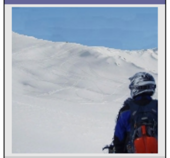
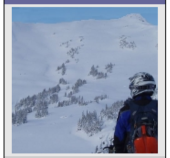
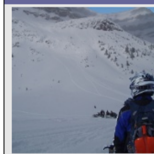
When the statistical design required the binary attributes (persistent avalanche problem, recent avalanche fatality) to be absent, the attributed were completely omitted from the decision scenario (see Fig. 1b for example). The goal of this second DCE was to examine how snowmobilers adjust their riding preferences according to large-scale information on avalanche conditions.

Survey participants who chose to ride in the second DCE were presented with a third final DCE (Fig. 1c). For this decision situation, participants had ridden to a central cabin in the snowmobile area that offered equal access to all three riding zones. During their ride, they were exposed to a maximum of five personal observations about the local conditions:

Going for a Ride - 1 of 3 - Planning a Trip at Home

b) Imagine you and your most common riding partners are planning a snowmobile trip for the **next weekend**. At this point in time, there is no weather or avalanche information available for the time of your trip. The zones shown below describe the only available riding possibilities in a potential snowmobile area for your trip.

Given all the information currently available to you, what fraction of your day would you likely be spending in each of the different zones of this snowmobile area? You can also choose not to visit this snowmobile area at all.

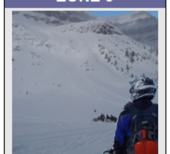
	ZONE 1	ZONE 2	ZONE 3	NONE
Character of typical terrain within zone				I would not be planning a trip to this snowmobile area, because it is ...
This zone ...	... is **rarely visited** by riders.	... is **rarely visited** by riders.	... is typically a **high traffic area**.	
➔	Please select ...	Please select ...	Please select ...	Please select ...

Going for a Ride - 1 of 3 - At the Staging Area

The weekend has arrived and it is a **beautiful sunny day**. You and your riding partners are now at the staging area of your destination, ready to unload your sleds. During your drive to the staging area you learned the following new information:

- The CAC rates the local avalanche danger rating for the day as **Considerable**.
- The avalanche bulletin warns about a **persistent avalanche problem**.

Given all the information available to you now, what fraction of your day would you likely be spending in the different zones of this snowmobile area? You can also chose not to go snowmobiling under the given circumstances.

	ZONE 1	ZONE 2	ZONE 3	NONE
Character of typical terrain within zone				I would not go riding in this snowmobile area under these conditions.
This zone ...	... is **rarely visited** by riders.	... is **rarely visited** by riders.	... is typically a **high traffic area**.	
Planning at home		½ of my day	½ of my day	
➔	Please select ...	Please select ...	Please select ...	Please select ...

Going for a Ride - 1 of 3 - At the Cabin

c) You have now ridden to the **central cabin that offers easy access to all three zones** described below. On your way to the cabin, you have made the following additional personal observations:

- The **snow quality is good**.
- You noticed a **whumpf** when you got off your snowmobile at the cabin.
- The temperature is **above freezing** and the upper snowpack seems to be wet.

Previous information

Local Avalanche Danger Rating:	**Considerable**
Persistent avalanche problem	

Given all the information available to you now, what fraction of your day would you likely be spending in the different zones of this snowmobile area? You can also choose to return to the staging area.

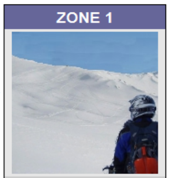
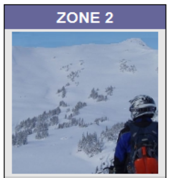
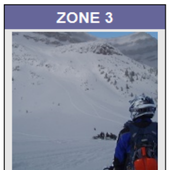
	ZONE 1	ZONE 2	ZONE 3	NONE
Character of typical terrain within zone				I would not feel comfortable to ride in any of these zones under the given conditions and would return to the staging area.
This zone ...	... is **rarely visited** by riders.	... is **rarely visited** by riders.	... is typically a **high traffic area**.	
Planning at Home		½ of my day	½ of my day	
At the Staging Area	¼ of my day		¾ of my day	
➔	Please select ...	Please select ...	Please select ...	Please select ...

Figure G-1.1. Example of DCE sequence.

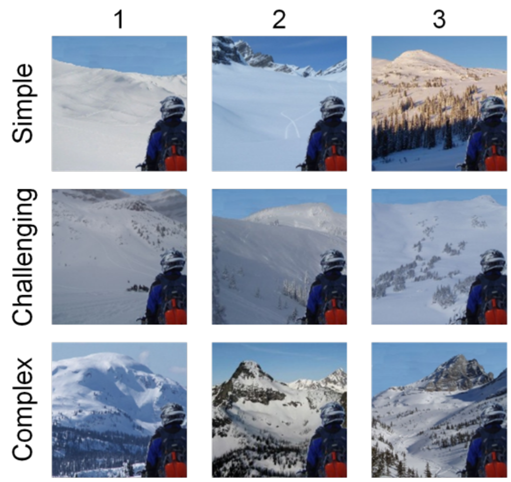


Figure G-1.2. Matrix of terrain photo used in DCE

- Snow quality: *"The snow quality is good."*
- Avalanche observations: *"Signs of a slab avalanche that occurred today or yesterday."*
- Recent loading: *"Approximately 50 cm of new snow that fell within the last 48 hours."*
- Signs of instability: *"You noticed a whumpf when you got off your snowmobile at the cabin."*
- Critical warming: *"The temperature is above freezing and the upper snowpack seems to be wet."*

While snow quality was good in all scenarios, the presence/absence of the avalanche hazard related observations was varied according to the statistical design. The avalanche danger rating and the persistent avalanche problem introduced in the second DCE, along with the four avalanche hazard related observations of the third DCE represent the six avalanche condition warning signs promoted in the Avaluator V2.0 decision aid for backcountry travelers (Haegeli, 2010).

The response task for survey participants was the same as in the previous two DCEs. The goal of this DCE was to examine how snowmobilers adjust their riding preferences in response to small-scale hazard information.

Survey sample

The sample for the survey was recruited using a variety of methods. Personalized links for the online survey were emailed to individuals who had provided their email addresses during intercept surveys that were conducted at staging areas in popular snowmobile destinations in British Columbia during the 2011/12 winter season. To further increase the sample size, the online survey was also promoted on popular snowmobile websites (e.g., snowandmud.com; snowest.com), through western Canadian snowmobile clubs, popular snowmobile movie producers (e.g., Slednecks, Team Thunderstruck) and prominent avalanche course providers. The survey was launched on April 9, 2012 and was continuously open for participation until May 31, 2012, when the sample for the present analysis was drawn.

Survey analysis

The theoretical basis for DCEs lies in random utility theory (McFadden, 1974), which is well documented. An in-depth technical description of the method is beyond the scope of this manuscript, but choice data are generally modeled using a multinomial logit models. The resulting estimates for the regression coefficients—commonly referred to as part-worth utility (PWU) coefficients—describe the relative preference (positive coefficient) or dislike (negative coefficient) of the sample population for each attribute level included in the design of the DCE. Curious readers are referred to Louviere et al. (2000) and Train (2009) for comprehensive descriptions of the method.

Two aspects of the present analysis require a more detailed description. To explicitly examine how snowmobilers adjust their riding choices as new avalanche hazard information becomes available, the preference pattern identified in the first DCE needs to be included in the analysis of the second DCE. Similarly, the preference patterns from the first and second DCE need to be included in the analysis of the third DCE. Analytically, this forward progression of preferences is achieved by summing the PWU estimates from the preceding DCE for each alternative and including them as additional constants in the multinomial logit model of the subsequent DCE. This approach basically locks the preference structure from the former DCE into the analysis of the latter DCE. The PWU estimates for the latter DCE therefore explicitly represent the change in preferences in response to the new avalanche hazard information.

In the present analysis, latent class logit models (Boxall and Adamowicz 2002; Train 2009) were used to examine the riding preferences for each of the three DCEs. The latent class approach—a model-based, probabilistic clustering technique (Vermunt & Magidson, 2002)—offers additional insights into the choice preferences of the sample population as it tests for latent heterogeneity in the choice data and clusters survey participants into a finite number of classes, each characterized by a relatively homogeneous preference pattern that differs significantly from other classes. The latent class approach is increasingly used in prevention science as it offers an effective method for identifying and characterizing distinct subpopulations within larger target audiences of prevention initiatives. Gunn (2010) was the first study to use a latent class approach in avalanche safety research.

RESULTS AND DISCUSSION

After eliminating records of survey participants who did not complete the survey, or had particularly unrealistic response patterns, the complete survey sample for the present study consisted of 660 individuals. The majority of the sample was male (93%), the most common age categories were 25 to 34 years old (28%) and 35 to 44 years old (31%), and the vast majority of survey participants were from Canada (81%). The median category for mountain snowmobile riding experience was 6-9 years and the interquartile range ranged from the 1-2 years to the 15-19 years categories. Fifty percent of the sample had started or completed an introductory formal avalanche course (e.g., Canadian AST Level 1).

Survey participants were presented with up to six different snowmobile areas for the first DCE until they decided to go snowmobile riding at least three times. Together, the 660 survey participants completed a total of 2222 DCE sequences.

DCE1: Riding preferences independent of avalanche conditions

The analysis of the first DCE classified survey participants into three latent classes according to their riding preferences. Eighty-nine percent of the sample were grouped into a class with a strong overall preference for going riding and moderately variable preferences for the different terrain photos. Six percent of the sample (41 of 660) were combined into a class with more conservative riding preferences. This class was more likely to choose the 'Too advanced' based alternative and had a significant dislike for most challenging and complex terrain photos. The remaining 5% exhibited more aggressive riding preferences. This group selected the base alternative 'Too boring' more frequently and exhibited significant preferences for all complex terrain photos. None of the three groups showed any significant preferences with respect to the amount of snowmobile traffic in the different riding zones.

DCE2: Response to information from avalanche bulletin and mass media
The analysis of the second DCE grouped the survey participants into two separate classes. The only parameter separating the two classes was their preference for the base alternative 'I do not go riding under the given conditions'. While the majority of survey participants (89%) exhibited a general preference for riding, a smaller group of more conservative riders (11%) showed a preference for not riding. The PWU coefficients for all other attributes presented in this DCE did not differ significant between the two classes.

The main effect for danger rating exhibited the expected pattern with strongly decreasing riding preferences being associated with increasing danger rating levels. The linear pattern of danger rating PWU, however, is inconsistent with the opinion of avalanche experts who generally agree that the odds of triggering an avalanche increases exponentially with the danger scale (Jamieson, 2009) This observation highlights the limited understanding of the danger scale by the survey sample.

The presence of a persistent avalanche problem did not have a significant impact on the riding choices of survey participants. For two reasons, this observation is not a complete surprise. First, information on avalanche problems has only recently been included in Canadian avalanche bulletins in a consistent fashion. Second, even though the presence of a persistent avalanche problem is one of the warning signs included in the Avaluator V2.0, it is a more advanced avalanche hazard concept. The radio report of a recent avalanche fatality in the general area did have a significant negative effect on participants' choice to ride. However, the effect was an order of magnitude smaller than the overall effect of the danger rating.

Of all possible interaction effects between the avalanche hazard context variables and alternative-specific attributes, only two emerged as having a significant effect on riding preferences. At a danger rating of Considerable, survey participants exhibited a significant preference for riding zones with regular or high snowmobile traffic. The preference pattern was exactly the same under a High avalanche danger rating, indicating that the additional increase in avalanche danger did not further enhance this compensation behavior. The second significant interaction effect was between the avalanche danger rating and the avalanche terrain exposure scale classification of the terrain photos. While there was no detectable shift in terrain preferences under a Considerable danger rating, a significant preference for simple terrain was observed for High danger ratings.

Together, the two interaction effects provide interesting insight about how survey participants choosing to ride under elevated avalanche danger adjusted their riding preferences. As the danger level increased from Moderate to Considerable, they first moved to riding zones with higher traffic and only once the danger level increased to High, they moved into simple terrain. This behavioral pattern is troubling for two reasons. First, possible compaction from snowmobile traffic is not a reliable indicator for locally low avalanche hazard and second, using the presence of other riders as a clue for decision making in avalanche terrain is frequently mentioned as a negative human factor in the avalanche safety literature (e.g., Tremper, 2008).

DCE3: Response to additional personal avalanche hazard related observations
A single-class model emerged as the most appropriate model for the third DCE. When analyzing the impact of the individual avalanche hazard related observations, an interaction effect between the individual observations and the danger rating level emerged. The impact of individual observations on the choice to ride was highest under Moderate danger ratings and decreased linearly with increasing avalanche danger ratings. While the observations for avalanches, loading and warming, were weighted equally, the impact of the instability observation (whumpf) was significantly higher at all danger rating levels. At the danger rating level High, the instability clue was only observation with a significant impact on the choice to ride. The analysis also revealed that the impact of the avalanche hazard indicators decreased as the number of indicators present in a scenario increased. This weakening effect was most pronounced under Moderate danger ratings. While the effect was less evident under Considerable, the effect disappeared under High danger ratings. Both the variable weighing of avalanche hazard relevant observations and the decreasing impact of multiple observations are inconsistent with the decision approach promoted by the Avaluator V2.0, which assigns equal importance to all warning signs under all conditions.

Only two alternative-specific interaction effects emerged as having a significant impact on participant's riding preferences in the third DCE. Both of them were only present when the decision scenario featured two avalanche hazard indicators. Similar to the choice pattern observed in the second DCE, there was a significant preference for regular or high traffic riding zones. In addition, the analysis revealed a significant preference for the terrain photos Simple-3 and Complex-1 (Fig. 2). While this preference pattern could not be explained with the avalanche terrain exposure scale ratings of these images, an examination of the general character of the terrain photos indicated that the revealed preference might be related to the amount of riding options in forested terrain available in these images.

The fact that no attribute-specific interaction effects were detected at other numbers of avalanche hazard indicators reveals that the presence of two indicators represented a critical transition in the riding preferences of survey participants. Under conditions with less than two indicators, survey participants did not feel that any terrain adjustments were necessary. At two indicators, they adjusted their terrain choices as described by the two interaction effects. When more indicators were present, the likelihood of survey participants choosing to stop riding increased considerably making terrain adjustments less prevalent.

CONCLUSION

The present study used three consecutive DCEs to systematically examine how snowmobilers adjust their riding preferences as avalanche hazard related information becomes available before and during their backcountry outings. For the promotion of avalanche safety among snowmobilers, the study provides the following important insights:

- The avalanche danger ratings were interpreted on a linear scale.
- The concept of persistent avalanche problems was not well understood.
- As the danger rating increases, snowmobilers first gravitate towards zones with higher snowmobile traffic before they adjust their riding preferences towards less serious avalanche terrain.
- Instability observations (e.g., whumpfs) are interpreted significantly more seriously than the other hazard indicators.
- Under Moderate and Considerable danger ratings, the additional impact of avalanche hazard related observations decreases as the number of present observations increases.

Results from avalanche safety surveys should always be examined critically. First, voluntary surveys about avalanche safety issues have the inherent potential to primarily attract participants who already have a special interest in avalanche safety and the context of a safety survey can further cause participants to provide answers that are biased towards more conservative behavior (i.e., social compliance). Preliminary comparisons between the samples of the present online survey and the complementary intercept survey indicates that participants in the online survey were significantly more experienced and avalanche-trained than the general mountain snowmobile population in British Columbia. The results of this comparison make the conclusions of our analysis even more concerning as they reflect the existing decision making weaknesses of a more advanced mountain snowmobiling sample.

We acknowledge that decision situations presented in online surveys are unable to fully capture the physical complexity and emotional involvement experienced when planning for and during real backcountry trips. However, the high degree of realism in the survey results indicates that careful sequencing of survey questions and the multi-attribute nature of the DCE are able to alleviate some of these concerns.

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Appendix H – Education and Employment

Full results from the online survey for employment (Table H-1.1) and education (Table H-1.2) are presented in this appendix.

Table H-1.1. Online survey participant full education results

Occupation	n
Agriculture	30 (5%)
Art, design, media and entertainment	7 (1%)
Business and finance	41 (6%)
Computer and database	15 (2%)
Construction and welding	76 (12%)
Education	12 (2%)
Engineering and architecture	28 (4%)
Forestry	22 (3%)
Government	17 (3%)
Health and science	14 (2%)
Hospitality and food service	8 (1%)
Legal	1 (0%)
Maintenance	58 (9%)
Military	2 (0%)
Office administrative	8 (1%)
Oil and Gas	117 (18%)
Other	70 (11%)
Public Safety	22 (3%)
Sales	49 (7%)
Sports	9 (1%)
Student	11 (2%)
Tourism and recreation	16 (2%)
Transportation and shipping	24 (4%)
Unemployed	4 (1%)
Total	661 (100%)

Table H-1.2. Online survey participant full education results

Education	n
Less than high school	19 (3%)
Completed high school	122 (19%)
Some post secondary education (post secondary not completed)	94 (14%)
Trades or non-university certificate or diploma	293 (44%)
Completed university	105 (16%)
Post graduate degree	26 (4%)
Total	659 (100%)