

Study Brief: Decision Making by Amateur Winter Recreationists in Avalanche Terrain

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Background

Over the past 10 winter seasons (1995/96 – 2004/05), backcountry recreationists have accounted for 89% of all avalanche fatalities in Canada. Of the 127 recreational fatalities, 65 were backcountry skiers, 33 snowmobile riders, and 12 out-of-bounds skiers. Furthermore, 63% of all fatal avalanche accidents occur within British Columbia (Canadian Avalanche Centre, 2005).

Avalanche professionals use established knowledge-based methods for comprehensively evaluating avalanche hazards. The proper use of these methods requires extensive training, practical experience and a thorough understanding of the avalanche phenomenon. Because amateur recreationists generally spent considerably less time in avalanche terrain, they are normally not able to achieve a similar level of expertise. As a consequence, professional methods are too complicated and the recommendations too vague for assisting amateur recreationists in recognizing and responding to dangerous avalanche conditions. To address the need for practical decision aids for amateur recreationists, a number of rule-based decision frameworks were introduced in Europe during the last decade (e.g., Reduction Method, SnowCard, Stop-or-Go, Nivotest; McCammon and Hägeli, 2005). The tragic winter of 2002/03, where Canada experienced an exceptional high number of recreational avalanche fatalities, prompted the Canadian avalanche community to plan a project for the design of a practical, science-based decision frameworks tailored to the specific avalanche conditions and dominant backcountry recreational user groups in Western Canada. The resulting ADFAR project (Avalanche Decision-Making Framework for Amateur Recreationists) is administered by the Canadian Avalanche Association (CAA) and is sponsored by Parks Canada with a grant from the New Search and Rescue Initiatives Fund (NIF) of the National Search and Rescue Secretariat (NSS).

Clearly, a sound understanding of the characteristics, behaviours, motivations, and decision-making patterns of recreationists in the three target groups, namely backcountry skiers, snowmobile riders and out-of-bounds skiers, is an important prerequisite to the development of an effective decision making tool for Canadian amateur recreations. This project brief outlines the results of the initial studies into this area.

Study purpose and Objectives

The overall purpose of the research is to investigate the motivations, perceptions and decision making of the three target amateur winter recreation groups - backcountry skiers/boarders, out-of-bounds skiers/boarders, and snowmobilers with special emphasis on their experience with and behaviour in avalanche terrain, as well as their risk attitudes and perceptions. The primary objectives include the following.

- to understand the characteristics of the three target groups (demographics, motivations, activities, experience, training, etc.)
- to understand some of the factors influencing the observed behaviour of amateur recreationists in avalanche terrain (decision making, planning, preparation, etc)
- to understand the factors and key drivers of behavioural intentions at two key points in the decision making process: 1) decisions made prior to trip initiation (macro scale – route / site choice), and 2) decisions made while actively recreating (micro scale – slope choice)
- to investigate and compare risk perception and propensity associated with the three user groups.
- to investigate the influence of a hypothetical decision tool on stated recreational choice.
- to collect information on avalanche incident history of amateur recreationists.

Study Area

The study area focused on backcountry skiing/boarding and snowmobiling locations near the town of Golden in British Columbia, Canada and included Glacier National Park (backcountry skiing and snowboarding), Kicking Horse Mountain Resort (out of bounds skiing and snowboarding), and Quartz Creek (backcountry snowmobile riding).



Fig. 1: Location of study area

Research Activities and Population Samples

A short intercept survey and a full-sized web survey were designed and administered in the 2005 winter season. The intercept survey targeted backcountry users at each of the three study areas (administered late January 2005 through early April 2005) and queried respondents' trip activities that day, awareness of current avalanche conditions, group backcountry experience/training and avalanche incident history. In total, 400 groups including 1450 individuals were interviewed. From this group, respondent were recruited for the web survey that followed in late May and June 2005. The web survey was used to acquire more detailed information on respondents' risk perceptions and propensity, recreational behaviour and motivations, and factors affecting decision-making in avalanche terrain. To ensure the

statistical validity of the results of the web survey it was necessary to increase the number of interviewees from additional sources. Additional backcountry skiers were recruited from friends of the research team members and Zac's on Tracks (a provider of avalanche awareness courses for snowmobile riders) included a link to the web survey in their snowmobile newsletter. In total, 362 individual on-line surveys were completed.

Methods

An advanced social science research method known as the Discrete Choice Experiment (DCE) was implemented in the web survey in order to quantitatively model the decision factors and preferences of amateur winter recreationists. The DCE is a stated preference technique that originated in transportation research, and has been applied extensively in the fields of applied decision making and market research (Adamowicz et al., 1998; Louviere et al., 2000).

In a typical DCE study, respondents are presented with choices involving sets of multi-attribute alternatives and are asked to evaluate the alternatives and choose one option. The alternatives are described by a common set of attributes, which summarize the important aspects of the alternatives. The attributes and attribute levels appearing in a choice experiment are determined by an underlying experimental design plan.

The web survey employed two stated preference choice experiments which explored behaviour and decision making at two different scales: pre-trip decisions and active trip decisions. Both decisions were framed with a realistic avalanche bulletin and weather forecast as background information. The first choice task was presented as a decision between different recreation areas (e.g., backcountry ski routes, or snowmobiling areas). The goal was to realistically simulate the trip planning stage at home. The different recreation areas were described with variables that are generally available on maps or in guide books. In the case of backcountry skiing, the following six variables were used: avalanche exposure terrain rating, percentage of time spent in alpine, at tree-line and below tree-line, total elevation climbed, route characteristics, number of parties expected to encounter on trip and a guide book recommendation. The goal of the second choice task was to simulate the decision process at the slope scale. In this case, respondents were asked to choose between slopes that could be skied or ridden during a backcountry trip. Interviewees were presented with nine variables that described the slopes and any avalanche related observations in detail. The slope description for backcountry skiers included the following variables: maximum slope incline, solar aspect, wind exposure, size of potential avalanche, character of run-out zone, avalanche related observations, snow quality, number of tracks on slope and additional hiking time. In order to examine the effect of a future decision support tool, a number of choice sets included the travel recommendation from a hypothetical decision support tool.

To further investigate the influence of perceived risk on behaviour, respondents also rated a series of single slopes in terms of perceived risk and estimates the potential worst case negative consequences associated with triggering an avalanche on the slope.

INSTRUCTIONS - Please choose the out-of-bounds area you would prefer to visit under the given conditions and considering the characteristics of your ski party. Alternatively, you may also choose "None/Ski in-bounds".

	AREA 1	AREA 2	AREA 3
Terrain Rating	Challenging	Simple	Simple
Terrain Type	Primarily at the treeline	Primarily below the treeline	Primarily below the treeline
Lift Ticket Price	\$45	\$20	\$65
Out-of-Bounds Character	Open bowls	Tree skiing	Tree skiing
# of other parties in out-of-bounds areas	3-6 parties	0-2 parties	7 or more parties
Recommendation	★	★★★	★★★★★

Which out-of-bounds area would be your first choice?

Area 1 Area 2 Area 3
 None of these areas / I would stay home or ski in-bounds

[Continue](#)

Mountain Range Forecast

Expected Avalanche Conditions

Alpine:	High
Treeline:	High
Below Treeline:	High

Avalanche Bulletin **Danger Scale**

Expected Weather

Cloud Cover:	Sunny
Temp:	Warm (0°C to +5°C)
Wind:	Strong

Fig. 2: Example choice set – ski area choice

The choice preferences of all the respondents are aggregated and analysed using statistical methods based on choice theory to obtain utility or value functions for each attribute over the range of attribute levels used in the experiment. The part-worth utilities associated with each attribute level demonstrate their overall importance or contribution to the choices made by the survey respondents.

Important Results

Demographics – Web Survey

Table 1 summarized the general demographics of the three user groups as interviewed in the web survey. The intercept survey showed that there is considerable overlap between backcountry skier and out-of-bound skier groups, while the snowmobile group is more distinct in terms of demographics.

Table 1. General characterization of user groups (web survey results)

Characteristic	Back country skiers	Out-of-bounds skiers	Snowmobilers
Age	Younger	Younger	Older
Education	University or post-graduate degree	University or trades training	Trades certificate or diploma
Household Income	↓	↓	↑
Employment	Student, seasonal, full time	Seasonal or full time	Full time
Years experience in sport	Middle	Least	Most
Day/year spent recreating	Most	Middle	Least

Motivations for Recreation – Web Survey

For backcountry skiers, the most important motivations for recreation are beautiful surroundings, to be close to nature, and solitude. In contrast, for out-of-bounds skiers the opportunity for 'good snow' is the single most highly rated factor. In addition, challenging terrain, having fun and enjoying the beautiful outdoors are important for out-of-bounds skiers. Snowmobile riders rate 'having fun' as the most important factor, although like the other two groups 'beautiful surroundings' is also important. Significant differences between the groups are observed for many of the shared motivational factors. For example, backcountry skiers are significantly more motivated by solitude/peacefulness and spending time with friends/family than out-of-bounds skiers and snowmobile riders. This pattern also emerged in the first choice experiment. Backcountry skiers were considerably turned off by trips with a high number of potential encounters, while this variable did not have a significant on the decision of snowmobile riders and out-of-bounds skiers.

Avalanche Terrain Awareness, Bulletin Use, and Training – Intercept Survey

The majority of backcountry skiers and snowmobilers indicated that they had been travelling in avalanche terrain the day they were intercepted. Although backcountry users did recognise the hazard, the awareness did not necessarily translate into checking the local avalanche bulletin. In particular, even though 84% of snowmobile riders indicated that they had travelled in avalanche terrain, less than half of them indicated that they had checked the avalanche bulletin although. Incidence of checking the bulletin may be influenced by convenience of access and availability. The majority of backcountry skiers and out-of-bounds users intercepted obtained the avalanche hazard bulletin at their recreation site (e.g. Glacier NP or KHMR). In contrast, snowmobilers who used the bulletin predominantly accessed the information through the internet.

Important differences in avalanche training are evident between the user groups. Out-of-bounds and snowmobilers intercepted predominantly had no formal avalanche training (42% and 52% of respondent respectively) followed by training at the introductory level. In contrast, the predominant training category for backcountry skiers was CAA professional level 1 (26%), followed by introductory training (22%) and no training (19%).

General Recreational Risk Perception and Propensities – Web Survey

In general both backcountry skiers and out-of-bounds skiers are significantly more likely to engage in risky recreational activities than snowmobilers. Overall mean risk propensities are not significantly different between backcountry and out-of-bounds skiers. The study findings also suggest that the propensity to engage in risky activities is associated with a lower overall perception of risk associated with recreational activities.

To investigate the voluntary acceptance of avalanche risk, respondents indicated avalanche outcomes they would consider acceptable while travelling in the backcountry. In general, snowmobilers are less willing than the other user groups to find any avalanche related outcome acceptable, which corresponds well with their more conservative position with respect to risk propensity and perception. Since a significant number of snowmobile interviewees were drawn from the email list of a recreational avalanche course provider, these results have to be interpreted very carefully. Interestingly, out-of-bounds skiers display relatively high acceptance ratings for negative avalanche outcomes; almost 15% of out-of-bounds users consider the possibility of sustaining major injuries or being killed an acceptable outcome while recreating in the backcountry.

Recreation Area Choice (Pre-trip decisions) – Web Survey

All three user groups display a significant preference for choosing to recreate (as opposed to staying home). The avalanche danger rating has a strong influence on the pre-trip decisions of all three user groups; higher hazard ratings are associated with significant declines in preference for recreation choices. For back country skiers, the most important variables for route choice include elevation band (time spent in alpine, at tree-line and below tree-line), cloud cover, and number of encounters, while ski area choices for out-of-bounds skiers are influenced predominantly by the type of skiing available, and to lesser extent temperature and elevation band. The primary relevant variables for snowmobilers are the type of riding and cloud cover.

As expected, the addition of the travel recommendation from decision tool as an additional choice variable makes all user groups behave more conservatively; however, the effect is most pronounced for snowmobilers. However, the decision tool also made it more likely for responders to choose to recreate during good travel conditions.

Slope Choice (Active trip decisions) – Web Survey

In contrast to the recreation area choice task, all three user groups indicate significant preferences for choosing the null option (not choosing either slope option and going back). Although this result may indicate a tendency for recreationists to be more risk averse during active trip decisions, other explanations are equally plausible. For instance, the slope options probably contained more negative or undesirable choices than expected in real life scenarios. In addition, the cost associated with not choosing a slope was probably too vague and insignificant in comparison to risking injury by skiing a slope.

Like the recreation area choice task, increases in avalanche danger rating have a strong negative influence on slope choice behaviour. However, there are some interesting differences between the three user groups. Backcountry skiers and snowmobile riders focused primarily on the local danger rating of the given elevation band. Both user groups viewed the danger scale as a linear scale. In other words, they perceived the difference between moderate and considerable to be the same as between considerable and high. This perception is different from the view of experts, who generally agree that the danger scale has quadratic or exponential character. Out-of-bounds skiers did not pay attention to the local danger rating. Instead they primarily focused on the quadratic component of the combined danger rating of all the elevation zones. This means that they primarily chose not to go out-of-bounds when the overall danger rating was high regardless of the danger rating relevant to their skiing activity. These results strongly demonstrate that there are significant differences in perception among the three user groups. The future design of effective risk mitigation methods and decision support tools will have to take such differences into account.

Slope choices among backcountry skiers are primarily influenced by snow quality, slope incline, and local avalanche observations. Snow quality also has a large influence on out-of-bounds skiers. In addition, both backcountry skiers and out-of-bounds skiers show small but significant tendencies to avoid slopes with leeward exposures, and potential cliff or terrain traps. Furthermore, evidence of extensive tracking has a significant effect on the slope choices of backcountry skiers. Snowmobile riders are concerned with slope incline and potential avalanche size. Not surprisingly, this group also shows a significant interest in avoiding slopes that present a high risk of potential damage to their machine.

Study Limitations

The results of 2005 Winter study provides some interesting insights into the characteristics, behaviour, and decision making of amateur winter recreationists in the three user groups. However, since the results are based on a limited and likely unrepresentative sample of the population, readers should exercise caution in generalizing the results to the population of amateur winter recreationists in British Columbia. For example, respondents who were on the mailing list of an avalanche training providers bolstered the snowmobile sample for the web survey. In addition, this first testing year was limited to one geographic location in British Columbia.

Another potential limitation of the study is the difficulty associated with replicating the real world decisions made by recreationists in avalanche terrain in the survey environment. However, the fact that snow quality emerged as the primary factor in the slope choice experiment seems a notable indicator for the success and potential of the method to provide realistic decision scenarios.

Ideas for future research:

The present study provides interesting first insights into the decision-making processes of amateur recreationists. However, there is an abundance of questions that have not been examined yet. The following list contains a number of ideas for related research in the immediate future.

1. Add more behavioural realism to the research by developing decision models that contain information on both revealed (actual behaviour) and stated preferences.
2. Assess avalanche awareness in comparison to bulletin danger ratings.
3. Conduct a detailed examination of the avalanche involvement history collected in both the web and intercept surveys.
4. Ask avalanche professionals to evaluate the risk associated with slopes shown in the discrete choice experiments and compare expert and amateur risk assessments and choices.
5. Run additional statistical analysis on the choice data. For example, it would be interesting to develop a model that investigates how the slope risk assessment influences slope choice, i.e., how does perceived risk influences behaviour?
6. Expand the sample to get a better representation of the population of amateur winter recreationists in BC, in particular snowmobile rider and out-of-bounds skiers. Possible collaborations with ACC, MEC, snowmobile clubs, ski resorts should be explored.
7. Develop a standard method to evaluate decision making for long-term and comparative studies. This method could be used for a quantitative comparison of amateur and professional decision-making or for studying the long-term effect of the future decision tool on the behaviour of amateur recreationists.

A detailed understanding of the decision-making process and involved human factors is crucial for the future development of effective avalanche risk mitigation measures. This is true in the amateur as well as in the professional environment. The research presented clearly complements avalanche research currently conducted in Canada and will further strengthen the leading role of Canada in avalanche safety.

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